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ETHNOHISTORICAL RELATIONSHIPS ON THE IBERIAN PENINSULA

ABSTRACT: Population variability and ethnohistorical relationships in the Iberian Peninsula are examined using 17 craniometric variables derived from 11 human groups. Similarity and dissimilarity of size and size-related shape variance and distances are expressed by canonical variables analysis and un-weighted pair-group averages. The potentially confounding influence of size is tested empirically and population relationships are discussed in terms of shape or size-related shape variance. Results of the UPGMA clustering reveal several discernable clusters that reflect previously documented cranio-facial similarities of Greeks and Macedonians, and Bosnian and Croatians. Unique to these analyses and supported by the complex ethnohistory of the Iberian Peninsula is the relationship between Spanish populations to Norse, Egyptian and Hungarian groups, which is most likely reflective of multiple migrations and settlements.

KEY WORDS: Craniometrics – Multivariate statistics – Ethnohistory – Iberian Peninsula

INTRODUCTION

A discovery that has had a major impact on the study of modern human origins and the concept of "race" is the low levels of genetic variation observed among geographic regions compared to high levels of genetic variation within regions (Relethford 1994). The patterns of human variation among geographic populations have been examined using genetic markers, linguistics, and anthropometrics. Craniofacial variation defined by skull dimensions of size and shape is determined by a proportion of both intrinsic (genetic) and extrinsic (environmental) factors (Larsen 1997).

Existing evidence indicates that there is much diversity between local European populations. Population origins traced to early demic expansion are one preferred explanation for present-day European variability (Sokal 1991a, Piazza *et al.* 1995). A number of studies have found an association between European variability and language families, temporal periods and geography (Lalueza Fox *et al.* 1996, Rösing, Schwidetzky 1977, 1981, Schwidetzky, Rösing 1984, Sokal *et al.* 1987, 1988, 1989, Sokal, Uytterschaut 1987). In addition, Ross (2000) found considerable variation among European Balkan groups that were attributed to a combination of dissimilar ethnohistorical origins and culture change.

Recently, several studies have investigated the craniomorphometric variation within the Iberian Peninsula (Lalueza Fox *et al.* 1996, Garralda 1986, Garralda, Mesa 1984, de la Rúa 1992). Lalueza Fox *et al.* (1996) conclude that the major source of variation is found in the Basque population, while another source of variation separates the Muslims and Jews from the rest of Spain, which they deduce is morphologically homogeneous. In the study of contemporary population affinities, individuals are treated as continuous members of the human species with distinctive local variations (Howells 1995). Increased understanding of the forces that influence the variability present through the analysis of cranial morphology will expand the knowledge of biological formations.

The purpose of this study is to examine the pattern of craniometric variation within an historical context among a Spanish population, Eastern and Western Europeans, and North, East, and West African groups.

TABLE 1. Materials used in present study.

Sample name	N	Reference	Provenience
Berg	109	Howells (1973)	Central Europe, Carinthia, Austria
Bosnian	122	Ross (2000)	Eastern Europe, contemporary, Bosnia
Croatian	88	Ross (2000)	Eastern Europe, contemporary, Croatia, measurements provided by Doug Owsley and Richard L. Jantz
Dogon	99	Howells (1973)	West Africa, Mali
Egypt	111	Howells (1973)	Gizeh, 26th–30th Dynasties (600–200 B.C.)
Greek	32	Ross (2000)	Modern Greek cemetery in Adalia (present-day city of Antalya, Turkey), American Museum of Natural History
Macedonian	22	Ross (2000)	Categorized as Greek, Janitsa, American Museum of Natural History
Norse	110	Howells (1973)	Northern Europe, medieval, Oslo
Spain	94	Present study	Collection from Wamba, near the towns of Villanubla and Valladolid in northwestern Spain, 16th or 17th century, Departamento de Biología Animal, Universidad Complutense Madrid
Teita	83	Howells (1973)	East Africa, Kenya
Zalavar	98	Howells (1973)	Central Europe, 9th–11th century, Hungary

TABLE 2. Summary statistics for each sample.

	Max Cranial l.			Cranial Base l.			Basion-Bregma h.		
Sample name	Mean	S.D.	Var.	Mean	S.D.	Var.	Mean	S.D.	Var.
Berg	175.56	8.49	72.08	95.83	5.05	25.49	127.44	5.37	28.82
Bosnian	177.08	6.88	47.35	101.07	4.03	16.25	138.29	5.38	28.97
Croatian	177.90	6.32	39.96	102.36	5.12	26.21	137.40	6.50	42.27
Dogon	173.57	6.98	48.66	96.59	4.04	16.29	130.01	4.95	24.48
Egypt	183.83	7.38	54.45	98.82	4.47	19.95	130.72	5.59	31.26
Greek	179.34	5.87	34.43	101.25	4.55	20.71	129.78	5.58	31.14
Macedonia	175.05	6.32	39.95	100.36	3.80	14.43	133.91	6.77	45.80
Norse	184.23	6.53	45.62	99.55	4.20	17.68	128.85	5.45	29.73
Spain	176.84	7.64	58.31	95.03	4.48	20.05	128.07	5.72	32.69
Teita	178.41	6.82	46.56	98.72	4.45	19.89	126.69	4.79	22.90
Zalavar	181.14	7.28	59.95	99.09	4.77	22.74	132.05	5.94	35.33

Max Cranial			Bizygomatic b.			Biauricular b.		
Mean	S.D.	Var.	Mean	S.D.	Var.	Mean	S.D.	Var.
144.08	6.25	39.08	131.09	6.40	40.99	124.02	6.13	37.57
149.30	5.37	28.87	134.20	5.44	29.60	128.54	5.15	26.51
150.08	5.71	32.63	134.07	6.13	37.60	127.34	5.97	35.63
134.65	5.19	26.97	125.09	5.72	32.74	112.22	4.66	21.71
137.48	5.02	25.16	124.64	5.84	34.05	115.72	5.04	25.42
138.81	5.48	30.03	129.81	4.74	22.48	122.53	4.99	24.90
133.23	3.83	14.66	123.59	5.70	32.44	117.18	5.28	27.87
139.08	5.30	28.13	129.44	6.30	39.64	121.16	5.24	27.50
135.11	5.52	30.44	123.15	6.39	40.88	115.97	5.82	33.86
127.80	4.61	21.21	126.95	5.23	27.36	114.41	4.28	18.29
139.33	4.77	22.72	129.53	5.35	28.64	121.39	4.80	23.02

Nasal h.			Nasal b.			Maxilloalv. b.		
Mean	S.D.	Var.	Mean	S.D.	Var.	Mean	S.D.	Var.
50.02	3.42	11.72	25.18	1.87	3.50	62.28	3.51	12.35
51.92	4.59	21.05	23.72	1.85	3.43	62.22	4.13	17.02
52.63	3.71	13.78	24.34	2.20	4.85	61.30	5.09	25.93
46.91	2.66	7.08	28.04	1.68	2.84	62.74	3.61	13.05
50.41	2.85	8.14	24.44	1.67	2.79	54.09	3.04	9.25
54.09	3.04	9.25	25.34	2.03	4.10	61.41	4.43	19.60
50.05	3.63	13.19	23.45	1.26	1.59	56.23	2.11	4.47
50.56	3.00	8.98	24.80	1.79	3.21	61.86	3.26	10.63
48.69	3.64	13.27	24.39	1.95	3.79	56.20	3.29	10.85
47.93	3.55	12.58	27.48	1.87	3.50	60.66	3.44	11.81
50.08	3.11	9.64	25.04	1.61	2.60	62.57	3.48	12.14

MATERIALS AND METHODS

In the present study, 11 samples totalling 968 individuals were included for analysis. Males and females were pooled in order to incorporate all of the observed biological variation within a population. Population names, sample sizes and proveniences are presented in *Table 1*.

The 17 linear dimensions, which were selected according to measurement availability across samples and summary statistics, are given in *Table 2*. Measurements are defined in Martin (1956), Howells (1973) and Moore-Jansen *et al.* (1994).

Missing cranial variable values were estimated for Croatians, Bosnians, Greeks, Macedonians, and Spanish to increase sample sizes using the program *NORM: Multiple imputations of incomplete multivariate data under a normal model* (Schafer 1999), which was downloaded from the web. NORM is an iterative simulation technique that uses a type of Markov chain Monte Carlo technique to generate random draws, where the distribution of each draw depends on the previous draw (Schafer 1999).

In order to examine craniofacial variation while directly accounting for size effects, size and shape variables were computed according to Mosimann and colleagues (Mosimann, James 1979; Darroch, Mosimann 1985) using the raw measurements. *Size* is defined as the geometric mean (GM) of all 17 cranial variables. The GM of *n* variables is calculated as

$$GM_Y = n\sqrt{\prod_{i=1}^{n} Y_i}$$

and each raw measure is then divided by the GM to create shape variables, which are simple ratios of the geometric mean and are scale-free or dimensionless (Falsetti *et al.* 1993). Such ratios may or may not be correlated with size.

TABLE 2. Summary statistics for each sample (continued).

Orbital h.			Orbital b.			Interorbital b.		
Mean	S.D.	Var.	Mean	S.D.	Var.	Mean	S.D.	Var.
33.27	1.90	3.62	39.28	1.59	2.54	22.49	2.36	5.59
32.84	2.32	5.39	38.29	2.34	5.50	22.72	2.81	7.89
33.84	2.37	5.61	40.17	2.89	8.37	22.55	2.61	6.83
33.24	1.86	3.45	38.81	1.80	3.24	22.84	2.31	5.34
32.89	1.93	3.72	38.72	1.88	3.53	20.47	1.99	3.94
35.97	2.44	5.97	40.31	1.65	2.74	22.44	2.30	5.29
34.36	1.56	2.43	38.59	1.50	2.25	21.41	2.74	7.49
33.48	2.14	4.58	39.79	1.61	2.59	21.49	2.47	6.12
32.28	2.11	4.44	37.22	2.35	5.51	21.95	2.65	7.00
32.64	1.90	3.63	38.53	1.76	3.11	24.04	2.42	5.86
32.41	1.90	3.60	39.37	1.58	2.48	21.07	2.40	5.79

Biorbital b.			Frontal c.			Parietal c.		
Mean	S.D.	Var.	Mean	S.D.	Var.	Mean	S.D.	Var.
97.00	3.43	11.73	108.71	4.62	21.32	107.72	5.72	32.76
95.86	4.37	19.06	112.78	4.88	23.79	111.20	6.84	46.73
97.34	4.05	16.43	112.24	5.20	27.03	110.03	6.22	38.72
97.12	3.83	14.66	107.80	4.73	22.37	109.83	6.11	37.31
94.03	3.34	11.14	110.11	5.22	27.26	113.23	6.10	37.25
98.97	3.98	15.84	109.44	6.54	42.83	112.25	5.85	34.19
94.14	3.26	10.60	107.32	4.20	17.66	113.82	7.20	51.87
96.87	3.76	14.13	110.55	5.00	25.00	111.98	5.79	33.56
91.91	3.80	14.51	106.72	5.06	25.62	111.96	6.97	48.60
97.55	3.81	14.54	106.96	4.68	21.89	111.51	6.16	37.98
96.56	3.24	10.48	110.30	4.87	23.74	113.15	5.63	31.70

Occipital c.			Fol.		
Mean	S.D.	Var.	Mean	S.D.	Var.
92.75	5.23	27.35	37.64	3.12	9.71
93.20	5.55	30.83	37.69	2.37	5.64
95.19	6.48	42.04	37.11	2.76	7.64
94.24	5.09	25.94	34.09	2.63	6.94
96.09	4.50	20.26	34.83	2.24	5.03
96.31	5.82	33.83	36.78	2.74	7.53
95.09	6.78	45.99	37.27	1.86	3.45
96.29	4.40	19.40	35.66	2.51	6.28
91.87	4.35	18.91	35.81	2.32	5.38
91.41	5.05	25.51	35.10	2.12	4.50
95.27	4.78	22.86	36.28	2.66	7.07

TABLE 3. Significant canonical axes (shape variables).

No.	Eigenvalue	Proportion	Can. corr.	Approx. F	DF	Pr > F
1	3.019	.55	.867	23.15	170	.0001
2	.865	.16	.681	15.05	144	.0001
3	.526	.10	.587	12.11	120	.0001
4	.445	.08	.555	10.12	98	.0001

However, this must be tested empirically. These new variables, while they do not remove absolute size from the analysis, provide a better insight into the "geometric similarity" among the populations.

A one-way analysis of variance (ANOVA) was then performed on the size variable to test the null hypothesis that the mean size is not significantly different among the selected groups. Next, a canonical discriminant analysis, linear combinations of predictor variables that summarize between-population variation, was conducted on the newly transformed shape variables. In addition, the degree of differentiation among the groups was measured using Mahalanobis D^2 or generalized distance, which is a function of the group means and the pooled variances and covariances (Afifi, Clark 1996).

The UPGMA Clustering analysis was performed from the generalized distance matrix using the un-weighted pair-group method with arithmetic averages (Sneath, Sokal 1973). Clustering methods are useful because they provide a uni-dimensional representation of the distance matrix and permit one to assess the relationships among the groups as those being more or less similar. These analyses were performed using the SAS system for Windows Version 8 (2001).

RESULTS

The ANOVA for the *size* variable yielded a significant difference among the groups (R-square 0.193, PR > F 0.0001). The Pearson correlation revealed a weak relationship between CAN1, CAN4 and the GM ($r = 0.246$, $P < 0.0001$; $r = –0.197$, $P < 0.0001$) respectively, suggesting that some of variation observed on CAN1 and CAN4 using the transformed shape variables is influenced by size (size-related shape variation). Neither the second nor third axes are correlated to size, indicating that the difference observed on these axes is shape related and not influenced by size.

Table 3 presents the four significant canonical axes, which shows that roughly fifty-five percent of the among-group shape variation is accounted for on CAN1, sixteen percent on CAN2, ten percent on CAN3, and eight percent on CAN4. The first canonical axis separates the groups with respect to vault breadth and nasal breadth, while the second axis isolates the groups on vault length. The third canonical axis isolates the groups on maxillary breadth and the fourth axis on vault height. The total canonical structure, the correlation between the original variables and the canonical variates, for CAN1, CAN2, CAN3 and CAN4 is given in *Table 4*. *Figure 1* reveals that Bosnians, Croatians, and Berg have relatively broad, short cranial vaults and narrow nasals, while the other European series and Egyptians have relatively long, intermediate cranial vaults with the Norse having the longest cranial vaults. The East and West African groups have relatively short, narrow cranial vaults and broad nasals. *Figure 2* illustrates that the Balkan groups (Macedonians, Greeks, Bosnians, and Croatians), Spanish, and Teita have relatively high cranial vaults with the Macedonians having the highest vaults, while the remaining groups have intermediate vault heights. Egyptians have relatively the narrowest maxillo-alveolar breadths, while the Dogon, Croatians, Macedonians, Bosnians, and Zalavar have relatively narrow maxillo-alveolar breadths in varying degrees. Comparatively, the remaining groups have broad maxillo-alveolar breadths in varying degrees.

TABLE 4. Total canonical structure.

Variable	Can1	Can2	Can3	Can4
GOL	–0.347	0.755	–0.070	0.174
BNL	0.024	0.175	0.382	0.373
BBH	0.348	–0.163	0.365	0.639
XCB	0.813	–0.136	–0.337	0.192
ZYB	0.467	–0.156	–0.157	–0.368
AUB	0.827	0.098	–0.088	–0.331
NLH	0.334	0.313	0.105	0.121
NLB	–0.698	–0.434	–0.063	–0.178
MAB	–0.158	–0.230	–0.556	0.088
OBH	–0.142	0.044	0.118	0.008
OBB	–0.191	0.133	–0.252	–0.010
DKB	–0.136	–0.359	0.268	–0.389
EKB	–0.433	–0.217	–0.144	–0.344
FRC	0.124	0.134	–0.063	0.333
PAC	–0.264	0.353	0.256	0.290
OCC	–0.193	0.262	–0.121	0.381
FOL	0.336	0.080	0.125	–0.339

In the UPGMA cluster analysis (*Figure 3*), the Dogon and Teita represent the most dissimilar groups (i.e., expressing the widest range of variability) and form the base of this tree. The next major feature corresponds to Bosnians, Croatians, and Berg, which cluster together. Interestingly, the Howells Berg sample clusters with the groups that have similar Slavic origins (Bosnians and Croatians). The Berg sample comes from Carinthia, Austria and the exact time-period of this sample is unknown. It is very plausible that the individuals from this sample derive

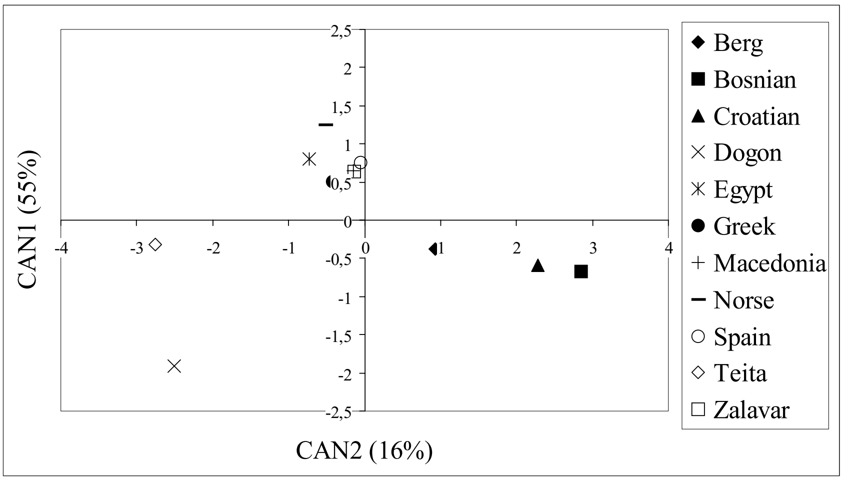

FIGURE 1. Class means on CAN1 and CAN2 using shape variables.

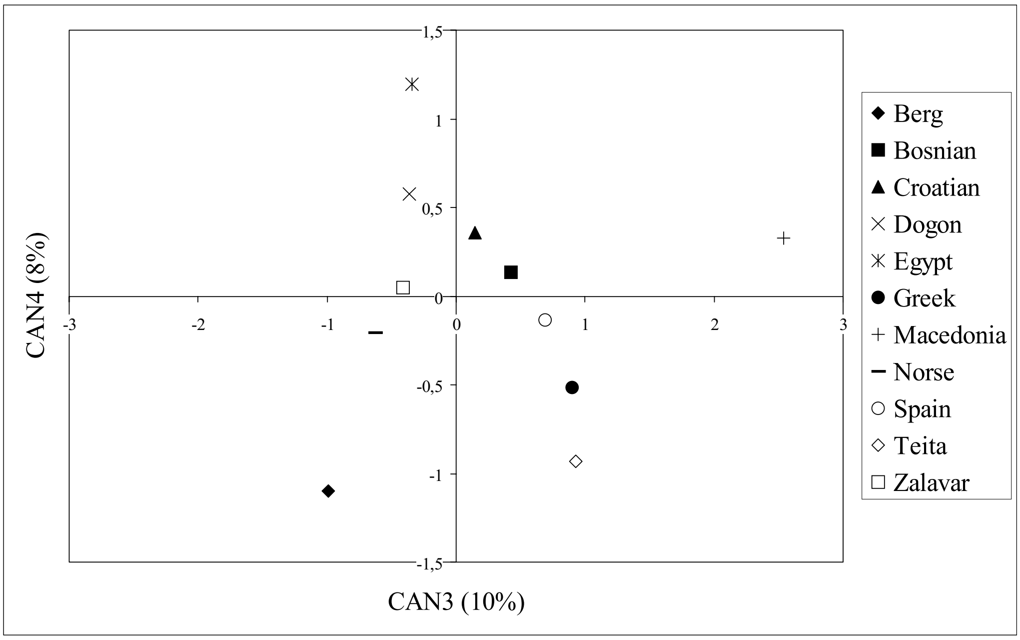

FIGURE 2. Class means on CAN3 and CAN4 using shape variables.

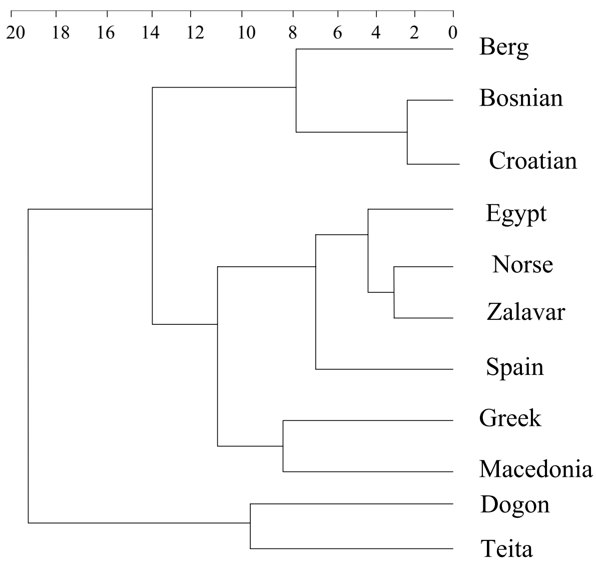

FIGURE 3. UPGMA phenogram.

from or are related to the early inhabitants of Caritnthia, the Carinthian Slavs, which would explain their morphological similarity to both Bosnian and Croatian groups. The remainder of the samples cluster together. Within this cluster, two distinct groups are discernible, the Greek-Macedonian group, and the Spanish sample clusters with the Norse, Zalavar, and Egyptian samples.

DISCUSSION

These results complement the vast literature addressing the diversity of European gene frequencies (Sokal 1991a, Sokal *et al.* 1993). According to Barbujani and Sokal (1990) European genetic variation is not related to environmental adaptation, but rather to the ethnohistorical origins of the local populations. Sokal (1991b) concluded that the pattern of European genetic variation is related to the persistence of ancient patterns of variation. He also stated that modern European genetic variance is a result of the number of ancient migrations originating and terminating in a particular locality.

Notably, the Berg affinity to both Croatian and Bosnian samples has both geographical as well as historical implications. Austria is near the frontier where West meets East and the early settlers of Carinthia were the Carinthian Slavs (*ca* 9th century), probably reflecting the early ethnohistorical origins of both Bosnians and Croatians, which are known to have originated from the same Slav ancestry.

Lalueza Fox *et al.* (1996) observed that Muslims and Jews comprised a major source of morphological variation on the Iberian Peninsula. They further concluded that with the expulsion of the Jews in 1492, the Muslims between 1502–1525, and the Moors between 1609–1614, would have eliminated this component of the variation from Iberia. However, the proximity of the Spanish sample to the Howells Egyptian series suggests a North African component within this population. We can further extrapolate that this morphological similarity is probably the result of a biological affinity to the Muslim invaders that began in 711 and endured for approximately eight hundred years. In addition, the proximity of the Spanish sample to the North (medieval Oslo) and Central (9th–11th century Hungary) European groups is most likely indicative of the regions numerous population influxes and settlement patterns, which have included a Mediterranean component, a Central European invasion (*ca* 800 B.C.), Romanization of the Peninsula, and Germanic invasions (*ca* 409 A.D.). All of these invasions, immigrations, and settlements have most likely had an enduring impact on the morphological variability of the Spanish population. The morphological variability observed in the Spanish sample can be most likely attributed to an amalgamation of the various ethnic groups that originally populated the Iberian Peninsula.

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