Arqueologia Medieval

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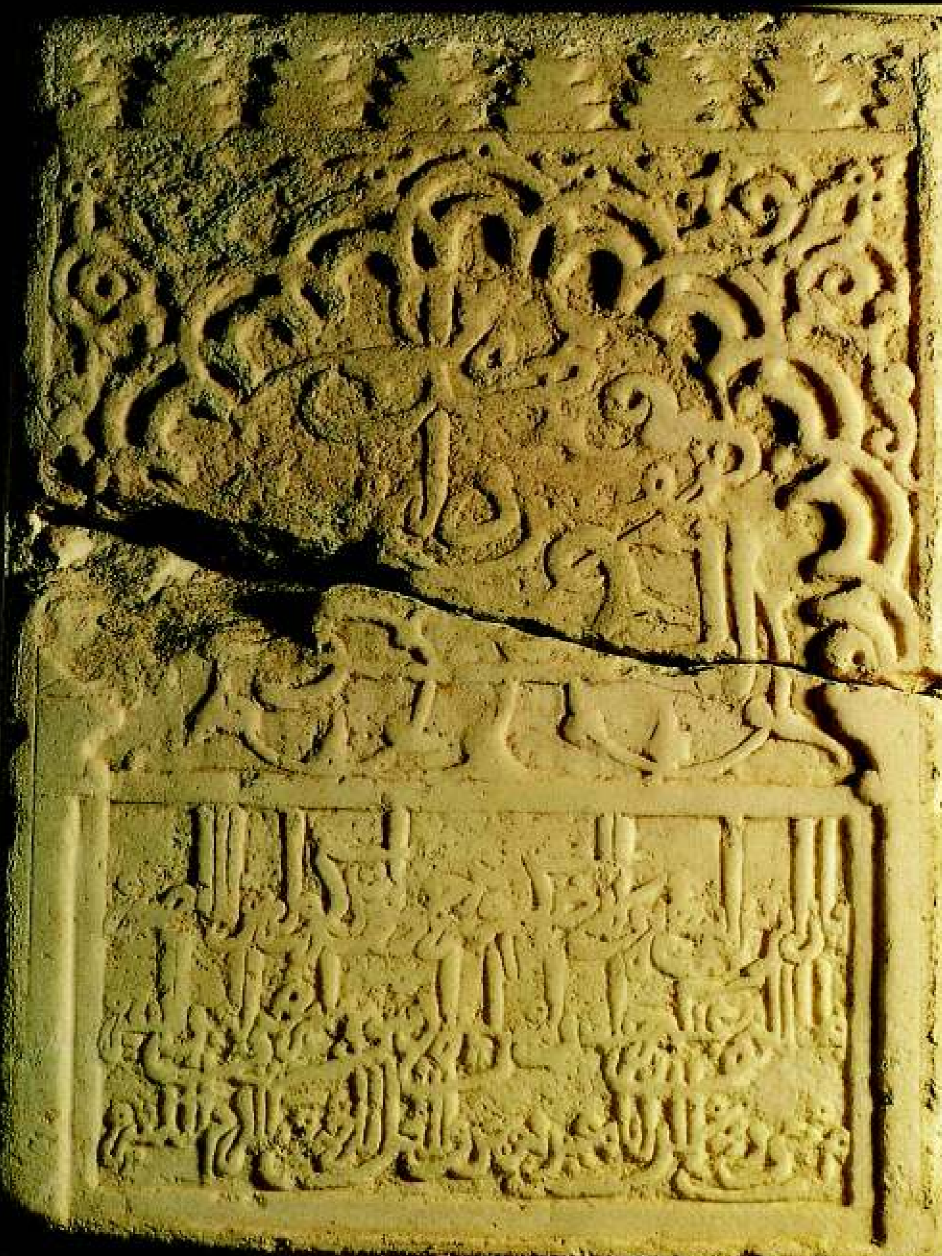

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A PRELIMINARY ANALYSIS OF THE PALEOCHRISTIAN AND ISLAMIC CEMETERIES OF ROSSIO DO CARMO, MÉRTOLA, PORTUGAL

GARNETT P. McMILLAN*

INTRODUCTION

During the summer of 1993 the Paleochristian and Islamic skeletal series from the site of Rossio do Carmo were analyzed. This initial study focused on issues of demographic changes that are thought to have occurred following the Islamic invasion of the Iberian Peninsula. Since there is a considerable diversity of opinion on this subject, this analysis was performed in order to gain direct information concerning the biological aspects of these changes. This analysis is directed towards answering such questions such as who was responsible for the Islamic occupation of the Iberian Peninsula, how did these populations adapt to local circumstances, and how does the biological evidence compare to archaeological interpretations (see Dinsmore 1994 for a detailed summary of previous research on this subject).

Skeletal series from before and during the Islamic occupation of Mértola were examined for age-sex characteristics and for representation of discrete traits of the cranium. The demographic information is necessary in order to develop life table models which provide estimates of the vital rates of the archaeological populations. These vital rates can be used in comparison with historical and archaeological information which assert different kinds of population growth patterns, as well as to evaluate variations in adaptedness of the medieval populations of Mértola. Discrete traits were used to test for genetic divergence between the Paleochristian and Islamic populations of Mértola, and to evaluate the kind and extent of population movements that are thought to have occurred during the Islamic invasion.

MATERIALS

The skeletal series subjected to analysis are from the site of Rossio do Carmo originally excavated in the late 19th century by Estacio de Veiga (Macias 1993). Recent excavations by the Campo Arqueológico de Mértola (CAM) in the 1980's and early 1990's uncovered parts of a basilica structure, associated burials, and an Islamic cemetery. Burials excavated from the site were given in-field age, sex, and gross pathological

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diagnosis by José Carlos and Carlos Pedro of the CAM.

The Paleochristian and Islamic series were distinguished on the basis of stratigraphy and differences in mortuary ritual. Burials located within the basilica, excavated into the schist bedrock, and in extended position on their backs were assigned to the Paleochristian cemetery. Burials from this period were also oriented in an East-West direction (Macias 1993: 53, fig. 19). Burials of the Islamic cemetery were designated by their semi-flexed to tightly flexed body position and head orientation looking east. Some burials were ascribed to the Islamic period as they were excavated into the roof tile layer comprising the fallen roof of the Paleochristian basilica. Furthermore, Islamic burials were not distributed with regard to the organization of the basilica. A total of 57 Paleochristian burials and 44 Islamic burials were analyzed.

In general, this region of Portugal is characterized by extremely acid soils allowing very poor bone preservation. The skeletal materials used in this analysis varied from excellent to extremely poor preservation. In some cases, burials were excavated without revealing any intact skeletal elements and only shadows of bone splinters remained to identify the presence of the burial.

ANALYTICAL METHODS

Genetic Distance

All individuals were subjected to identification of presence or absence of discrete traits of the cranium. Traits identified are presented in table 1. Frequencies of these traits were used to calculate genetic distance (Green and Suchey 1976) between the Paleochristian and Islamic series.

TABLE I

Discrete Traits of the Cranium Used in the Analisis

Bregmatic Ossicle	RT Ossicle at Asterion
Coronal Ossicle	LT Ossicle at Asterion
RT. Sup-Orbit Foram Complete	RT Ossicle in Mastoid Suture
LT. Sup-Orbit Foram Complete	LT Ossicle in Mastoid Sut
RT Front Notch	RT Petrosquamous Suture
LT Front Notch	LT Petrosquamous Suture
RT Front Foram	RT Mastoid Foramen
LT Front Foram	LT Mastoid Foramen
RT Zygo Foram	RT Mastoid Foram Extra-sutural
LT Zygo Foram	LT Mastoid Foram Extra-sutural
RT Access Zygo Foram	Palatine Torus
LT Access Zygo Foram	RT Accessory Lesser Palatine Foram
RT Os Japonicum	LT Accessory Lesser Pal
LT Os Japonicum	Pharyngeal Fossa
RT Suture into Infra-orbit	RT Foramen Ovale Complete
LT Suture into Infra-or	LT Formamen Ovale Complete
RT Zygo-Max Tubercle	RT Foramen Spinosum Open
LT Zygo-Max Tubercle	LT Foramen Spinosum Open
RT Max Torus	RT Double Condylar Facet
LT Max Torus	LT Double Condylar Facet
RT Epiteric Bone	RT Posterior Condylar Canal
LT Epiteric Bone	LT Posterior Condylar Canal
RT Fronto-Temp Artic	RT Hypoglossal Canal Double
LT Fronto-Temp Artic	LT Hypoglossal Canal Double
RT Parietal Notch	RT Mandibular Torus
LT Parietal Notch	LT Mandibular Torus
RT Parietal Foram	RT Ment Foram Double
LT Parietal Foram	LT Ment Foram Double
Sagittal Ossicle	RT Accessory Mandib Foramen
Ossicle at Lambda	LT Accessory Mandib Foramen
Os Inca	RT Mylo-Hyloid Bridge
RT Lambdoid Ossicle	LT Mylo-Hyloid Bridge
LT Lambdoid Ossicle	

The estimation of genetic distance involves quantification of trait presence in terms of sample proportions and then applying an arcsine transformation in order to stabilize the sample variance. Divergence measures which estimate the difference in genetic composition of the gene pools are calculated using this transformed data.

Average divergence (**D**) is measured as:

$$D = \sum_{i=1}^{r} \frac{(\theta_{1i} - \theta_{2i})^2 - \left(\frac{1}{n_{1i}+\frac{1}{2}} + \frac{1}{n_{2i}+\frac{1}{2}}\right)}{r} \qquad (1)$$

Where r = number of traits (i) observed,
θ = arcsine transformed sample proportion,
n = number of observations in sample 1 or 2 for trait i.

Variance of mean divergence is:

$$VAR(D) = \frac{2}{r^2} \sum_{i=1}^{r} \left(\frac{1}{n_{1i}+\frac{1}{2}} + \frac{1}{n_{2i}+\frac{1}{2}}\right) \qquad (2)$$

Since expected divergence is zero,

$$\frac{\theta_1 - \theta_2}{\sqrt{\frac{1}{n_1+\frac{1}{2}} + \frac{1}{n_2+\frac{1}{2}}}} \qquad (3)$$

and therefore,

$$\frac{D}{\sqrt{VAR(D)}} \qquad (4)$$

should distribute normally.

A significance test of average divergence can be performed by comparing the value of equation (4) to a standard normal distribution (details of the transformation techniques and analytical methods are outlined in McMillan n.d.).

In the Rossio do Carmo data, five traits (Bregmatic Ossicle, Right and Left Parietal Notch, Right and Left Ossicle at Asterion) were removed from the analysis as no observations of these were available for the Islamic series. In total, 60 traits were examined for presence. Sample sizes varied from 1 to 12 for the Islamic data and 2 to 19 for the Paleochristian series. Trait frequencies and transformations are shown in appendix 1.

Demography

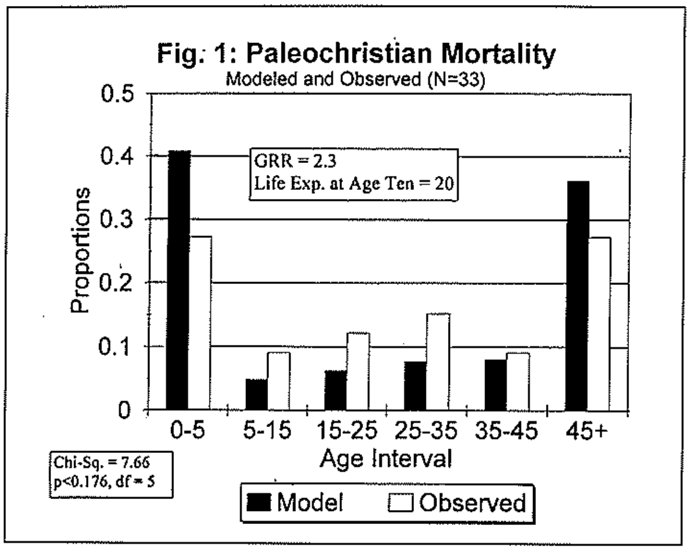
All individuals from these skeletal series were given age and sex estimations. Ageing methods included dental eruption (Ubelaker 1984: 64), dental development (Smith 1991), pubic symphyseal morphogenesis by Todd, Suchey-Brooks, and Mckern-Stewart methods (Suchey et. al. 1984, 1986; Bass 1987), and epiphyseal formation and union (Bass 1987). Burials for which only limited age assessments could be made were assigned to adult/subadult ages.

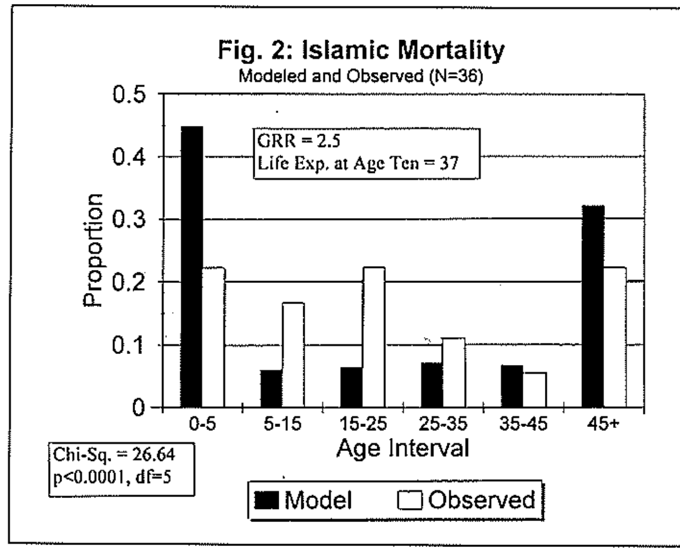
In order to further improve the proportion of individuals for whom ages could be assigned, an assessment of the usefulness of dental wear ageing was performed. All individuals who could be placed in a ten year age interval by accurate means were seriated by dental wear. It is assumed that if dental wear is associated with age in a predictable manner, then dental wear can be a useful method for estimating relative age in adults for whom

TABLE 2

Comparison of Ranks of Estimated Age and Dental Wear. Cell Values are Burial Identifications of Individuals for whom Accurate Age and Dental Wear could be Assigned

Rank By Est. Age	Rank By Dental Wear
38F-001	38F-001
34F-003	45F-001/163A
45F-001	34F-003
163A	39F-001
39F-001	110
40F-002	40F-002
110	30
30	
Tau = 0.7636 $p < 0.05$ d.f. = 8	





teeth survived but other primary indicators of age did not. The seriation was analyzed for deviation from randomness by Kendall's Tau Coefficient of Rank Concordance (Sokal and Rohlf 1981 : 601). Individuals of the Islamic and Paleochristian period were pooled in order to increase sample size. The results of this analysis are shown in table 2. Concordance was significant ($\tau = 0.7636$, $p < 0.05$, d.f. = 8) beyond that expected from random ranking of age with dental wear. Dental wear is therefore an accurate estimate of relative age for these series. Individuals were subsequently assigned to ten year age intervals based on placement within this seriation.

Sex estimates were performed by classification according to primary (e.g. pelvic aspects), secondary (e.g. cranial vault characteristics), and sexual dimorphic traits (e.g. size and robusticity). Precedence in sex identification was given in that order. Identifications based on secondary or sexual dimorphic traits were given a «Possible [sex]» identification.

Model life table profiles were fit to the Paleochristian and Islamic mortality profiles. This was performed to determine if the mortality profiles represent samples from stable populations and therefore if various population parameters, such as intrinsic growth, could be estimated. The model fitting procedure was taken from Paine (1989) using a computer program developed by that author. This procedure involves adjusting Gross Reproductive Rate and Life Expectancy at age 10 to produce a stable model fit by maximum likelihood. The procedure then tests the goodness-of-fit between the model and the mortality profile in question. The model profiles are shown in figures 1 and 2 with the sample mortality profiles.

Representativeness of the mortality profiles was assessed by testing deviation from random sex allocation to the cemeteries. Where sex-biased burial procedures were in effect, we would observe a deviation from a one to one sex ratio and could assert that sex-bias is influencing the mortuary profile.

RESULTS

Genetic Distance

In the introduction I pointed out that the nature of actual population movements during the Islamic invasion of the Iberian peninsula has been addressed primarily by indirect means such as archaeological and historical patterning. The genetic distance study was performed in order to evaluate the extent to which Paleochristian and Islamic populations of Mertola differed from one another. No divergence may indicate that Islamization was primarily an indigenous process, while a significant difference between the Paleochristian and Islamic series would indicate a demographic as well as cultural rupture between these time periods.

The test of genetic distance by discrete trait characterization yielded a Mean Measure of Divergence (**D**) of -0.14 and a variance of 0.0096 which converted to a standard normal deviate of -1.434. This showed no significant deviation from zero divergence when compared to a standard normal distribution for alpha set at 0.05. For the traits measured there lacks sufficicent evidence to conclude that there is significant genetic divergence between the Paleochristian and the Islamic populations.

Demography

Demographic characterizations of archaeological populations has been a subject of intense methodological interest. Recent advances in the subject have made it possible to estimate vital rates of the living populations through life table modelling. This procedure was undertaken here in order to determine differences in adaptedness of the Paleochristian and Islamic series, as well as to evaluate the likelihood that pre-Islamic populations could account for the population growth observed in the archaeological record (Boone n.d.).

The first problem is assessing the degree to which these skeletal series are representative samples of any kind of living population. The first means of testing this is a goodness-of-fit test of the sample sex ratios with an assumed random distribution of sex allocation to the cemetery. It is important to note that this does not test the actual sex ratio as much as it tests the potential representativeness of the skeletal sample. Results in table 3 showed no significant deviation from randomness for either the Paleochristian (Chi-square = 0.72; $p < 0.396$; d.f. = I) or the Islamic (Chi-square = 3.24; $p < 0.072$; d.f. = 1) period skeletal series. We lack sufficient evidence to conclude that either series deviates significantly from random distribution of sex. It must be pointed out, however, that the Islamic series comes very close to showing significant association of frequencies and sex. The female frequencies are very high relative to the males and the Chi-square test only produced a marginally insignificant association.

The second method of testing representativeness involves using a maximum likelihood procedure to fit a model mortality profile from a stable population to the skeletal samples. The results of these test are shown in figures 1 and 2 and in table 4.

The model profile fits the Paleochristian skeletal at standard test levels ($X^2 = 7.66$; $p<0.176$), while the Islamic series shows marked deviation from the best fitting model ($X^2 = 26.64$; $p<0.0001$).

DISCUSSION

Genetic Distance

A lack of divergence between two biological populations indicates one of two contra-

Table 3a

Test of PaleoChristian Sex-Bias

Males	Females
20 (57%)	15 (43%)
expecteds = 17.5	$X^2 = 0.72$; $p < 0.396$

Table 3b

Test of Islamic Sex-Bias

Males	Females
8 (32%)	17 (68%)
expecteds = 12.5	$X^2 = 3.24$; $p < 0.072$

Table 4

Goodness-of-Fit and Model Life Table Parameters Estimated from the Maximum Likelihood Procedure

Period	Chi-Square	P-value	GRR	Life Exp.	CBR	CDR	r
Paleochristian	7.66	0.176	2.3	20	39	50	-0.011
Islamic	26.64	0.0001	2.5	37	39	31	0.007

degrees of freedom = 4

GRR = Gross Reproductive Rate CBR = Crude Birth Rate (Annual Births per 1,000 people)
CDR = Crude Death Rate (Annual Deaths per 1,000 people) r = Crude Rate of Natural Increase

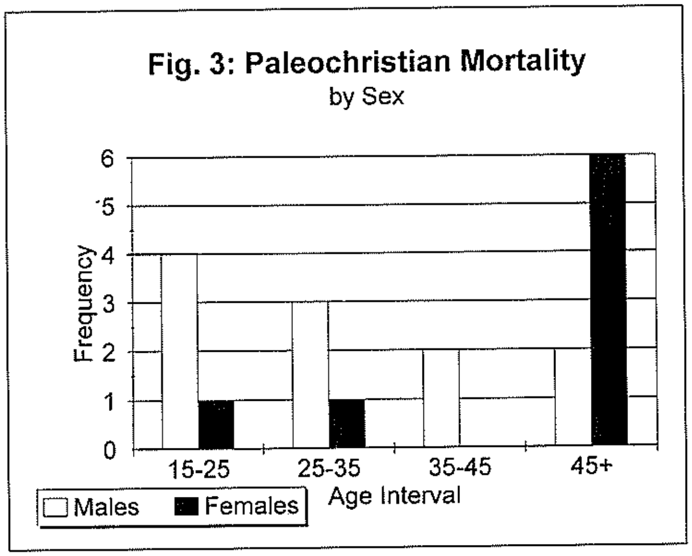


Fig. 3: Paleochristian Mortality by Sex

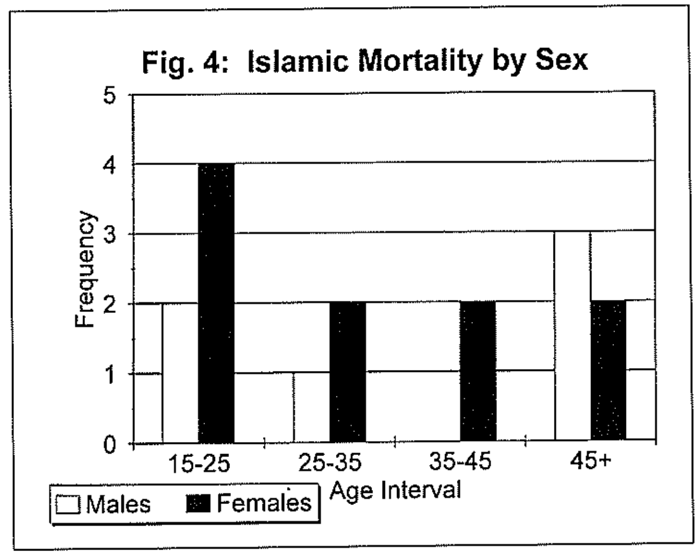


Fig. 4: Islamic Mortality by Sex

dicting points. I) There is truly no divergence between the populations, or 2) the study. does not measure the traits that reflect true divergence. This contradiction can be resolved by comparing a control population with known genetic affinity to one of the study samples. In this case, one could look at the same traits in Berber crania from North Africa and see if these diverge from the Paleochristian series. If they do, then we can be satisfied that we are seeing genetic continuity between the Islamic and Paleochristian peoples. If no divergence between the control and Paleochristian group is observed, then we are not using traits that characterize genetic divergence between the Islamic and Paleochristian samples and the results of this analysis are essentially meaningless.

Inter-trait correlation and its influence on the results of the test were not examined. With regards to this problem, Sjovold (1977) points out that inter-trait correlation will be problematically assessed when a large number of traits are used. Alpha error will produce at least some combinations which show significant inter-trait correlation leaving one without means of evaluating whether those traits should be omitted from analysis. This, however, is an empirical question which should be assessed for each combination of samples under consideration. This assessment was not performed due to the very small sample sizes that would come from re-classification by age and sex. Any significance test of association with age or sex would have been invalidated by random error.

Demography

It has been frequently argued that error in adult skeletal age estimation or age bias in burial ritual will inevitably lead to spurious characterizations of past living populations from cemetery populations (Roth 1992; Jakes 1992; Bocquet-Appel and Masset 1982), but without other evidence this is the best estimate of the demographic properties of the Paleochristian and Islamic populations. The purpose of matching the burial profile to a model stable population is to assess the degree of bias and to infer further into the various factors that cause the mortality profile to differ from expected.

It was shown that the Paleochristian series does not deviate significantly from the model life table. The negative intrinsic growth for the Paleochristian series is problematical. Empirical generalizations of growth rates from developing countries never show negative growth, but conversely tend to be positive and are usually very high (Palmore and Gardener 1983: 65, Table 22).

The negative growth observed may be due to a phenomena recently outlined by Keckler (n.d.). He argues that negative growth observed in time averaged archaeological data may be the result of periodic catastrophic mortality, particularly in prime aged adults. Killing off large numbers of adults will necessarily deflate population level fertility. Thus, negative growth relates less to individual decision making where concerned with achieved family size as it does to external forces acting upon people. Additionally, higher proportional representation of prime age adults will necessarily decrease the overall representation of infants simply because the mortality profile is a closed distribution. Thus the phenomena of negative growth can be due to one or two causes: periodic catastrophic mortality and/or a mechanical result of the model fitting process.

The Paleochristian series shows higher adult mortality than expected (figure 1). Although sample sizes are very small, this may be reflecting the kind of phenomena observed by Keckler. Catastrophic mortality is certainly a possibility for the early medieval period. Stories of plagues, particularly in poorly sanitized urban environments such as Mértola are very well known (Wrigley 1969: 63). Some historical evidence indicates that the Visigothic occupation of the Iberian peninsula was also one marked by political turmoil and warfare (O'Callaghan 1975: 57; Glick 1979: 11). Such aggression would certainly increase adult, particularly male mortality relative to other age groups.

Mortality profiles showing sex breakdown are presented in figures 3 and 4. For the Paleochristian series it is apparent that a larger proportion of males is present in the prime-age categories (fig. 3) peaking at the 25 to 35 year interval. Similarly, females appear in markedly greater proportions than males in the 45+ age category. Aside from sampling error, a number of causes may account for this distribution. Macias (1993: 50-52) argues that burial within the basilica was restricted to priviledged individuals. In 10 cases, headstones identify males who were associated with the church. These deceased may have been given selective access to burial in the basilica. This, in combination with male-specific mortality force such as accidental or violent deaths may explain the presence of more females in the oldest age category. Females who were perhaps not associated with violent activities simply lived longer and died later than most males.

The model life table fitting procedure showed significant deviation when comparing the Islamic profiles to model expectations. It must be concluded that the Islamic series is either a biased sample or that the living population from which the Islamic series was drawn was not, in fact, a stable population.

The Islamic series, as with the Paleochristian series, can only be subjected to a qualitative analysis due to small sample sizes. This profile shows very little patterning (see fig. 4). Males disappear from the profile in the 25 to 45 year age categories yet reappear in the 45+ age group. Higher male life expectancy in the adolescent age intervals may account for this disparity in age distribution by sex.

CONCLUSIONS

We lack sufficient evidence to conclude that the Paleochristian and Islamic populations of Mértola were derived from significantly different gene pools. Given the observation made by Macias (1993: 34-35) that the double apse architecture of the basilica in Mértola represents cultural as well as perhaps demographic diffusion from North Africa, it may not be surprising that some admixture occurred prior to Islamic expansion. Even a small influx of genetic material could reduce the overall divergence of the two populations. Another possible explanation is that the resident population of Mértola independently converted to Islam. This phenomena may have been highly localized, yet an eighth century peace treaty described by Collins (1989: 39-40) suggests that in at least one case the vanquished Hispano-Roman populations were permitted to retain ownership of lands and even local political power. A similar exchange may have occurred in Mértola.

The demographic analysis shows slightly more ambiguous results primarily due to the caveats of the model life table fitting procedure. If we are willing to accept the numerous assumptions made in the application of this procedure, then some interesting conclusions may be drawn.

Archaeological evidence from the surrounding hinterlands suggest that populations in the area grew very rapidly between the Paleochristian and Islamic periods and declined markedly between the Islamic and Late Medieval Periods (Boone n.d.). The vital rates, however, show the opposite pattern. The Paleochristian population was a low fertility, high mortality population which was declining during the sixth and seventh centuries. The Islamic population appears to have been growing during the Muslim occupation of

Mértola, although these conclusions are somewhat tenuous given the lack of fit between the model and the observed mortality profile. Using the intrinsic rate of growth as a simple measure of adaptedness, the Islamic population may have been better suited socially, economically, and biologically to the Alentejo landscape. The Paleochristian populations may have been plagued by endemic warfare or epidemic diseases which caused the population to be incapable of maintaining itself.

ACKNOWLEDGMENTS

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REFERENCES CITED

BASS, W. M. (1987) — *Human Osteology: A Laboratory and Field Manual.* Special Publications No. 2 of the Missouri Archaeological Society.

BOONE, J. L. (n./d.) — Rural Settlement and Islamization in the Lower Alentejo of Portugal: Evidence from Alcaria Longa. m.s.

BOQUET-APPEL, J. and C. MASSET (1982) — Farwell to Paleodemography. *Journal of Human Evolution,* 11: 321-333.

COLLINS, R. (1989) — *The Arab Conquest of Spain: 710-797.* Basil Blackwell, Cambridge.

DINSMORE, E. S. (1994) — *Rural Settlement and Political Change: An Intersite Analysis of Roman and Islamic Period Settlement Organization in the Baixo, Alentejo, Portugal.* Unpublished Master's Thesis, Dept. of Anthropology, Arizona State University.

GLICK, T. F. (1979) — *Islamic and Christian Spain in the Early Middle Ages.* Princeton University Press, Princeton.

GREEN, R. F. and J. M. SUCHEY (1976) — The Use of Inverse Sine Transformations in the Analysis of Non-Metric Cranial Data. *American Journal of Physical Anthropology,* 45: 61-68.

JAKES, M. (1992) — Paleodemography: Problems and Techniques. in *Skeletal Biology of Past Peoples: Research Methods.* S. R. Saunders and M. A. Katzenberg eds. Wiley-Liss Inc., pp. 189-224.

KECKLER, C. N. W. (n./d.) — Where Did All the Humans Go? Simulating Forager Age-at-Death Distributions with a Biphasic Model of Mortality. Paper presented at the 1994 meetings: Integrating Demography and Archaeology.

MACIAS, S. (1993) — Um Espaço Funerário in *Basílica Paleocristã,* C. Torres and S. Macias eds., Campo Arqueológico de Mértola.

McMILLAN, G. P. (n./d.) — A Preliminary Analysis of the Paleochristian and Islamic Cemeteries of Rossio de Carmo, Mértola, Portugal m.s.

O'CALLAGHAN, J. F. (1975) — *A History of Medieval Spain.* Cornell University Press, Ithaca.

PAINE, R. R. (1989) — Model Life Table Fitting by Maximum Likelihood: AProcedure to Reconstruct Paleodemographic Characteristics from Skeletal Age Distributions. *American Journal of Physical Anthropology,* 79: 51-61

PALMORE, J. A. and R. W. GARDENER (1983) — *Measuring Mortality, Fertility, and Natural Increase.* East-West Center, Honolulu.

WRIGLEY, E. A. (1969) — *Population and History.* McGraw-Hill Book Company, New York.

ROTH, E. A. (1992) — Applications of Demographic Models to Paleodemography. in *Skeletal Biology of Past Peoples: Research Methods.* S. R. Saunders and M. A. Katzenberg eds., Wiley-Liss, Inc., pp. 175-188.

SJOVOLD, T. (1977) — Non-metrical Divergence Between Skeletal Populations. *Ossa,* 4 (Suppl 1): 1-133

SMITH, B. H. (1991) — Standards of Human Tooth Formation and Dental Age Assessment. in *Advances in Dental Anthropology.* M. A. Kelley and C. S. Larson eds., Wiley-Liss, Inc., pp. 143-168.

SOKAL, R. R. and F. J. ROHLF (1981) — *Biometry.* W. H. Freeman and Co.

SUCHEY, J. M., D. V. WISELY, D. KATZ (1986) — Evaluation of the Todd and Mckern-Stewart Methods of Aging the Male *Os Pubis.* In *Forensic Osteology: Advances in hte Identification of Human Remains,* K. Reichs, ed. Thomas, Springfield, Illinois, pp. 33-67.

SUCHEY, J. M., P. A. OWINGS, D. V. WISELY, and T. T. NOGUCHI (1984) — Skeletal Aging of Unidentified Persons. In *Human Identification: Case Studies in Forensic Anthropology,* ed. T. A. Rathbun and J. E. Buikstra. Thomas. Springfield, Illinois, pp. 278-297.

UBELAKER, D. H. (1978) — *Human Skeletal Remains: Excavation, Analysis, Interpretation,* Aldine, Chicago.

Appendix 1

Discrete Trait Representation and Transformations. Islamic Data and Transformations

Trait	Present	%	Variance N	Variance 1 / (n+½)	θ	Divergence PC-ISL	Sum Variance
Bregmatic Ossicle	0	0	0	2	0	1.515261	2.118
Coronal Ossicle	1	1	1	0.667	-0.79	2.327074	0.784
RT. Sup-Orbit Foram Complet	0	0	4	0.222	1.107	0.257844	0.287
LT. Sup-Orbit Foram Complet	2	1	2	0.4	-0.96	1.423923	0.461
RT Front Notch	0	0	3	0.286	1.047	0.073397	0.35
LT Front Notch	0	0	2	0.4	-0.955	0.215452	0.461
RT Front Foram	1	0.33	3	0.286	0.262	0.113951	0.35
LT Front Foram	0	0	2	0.4	0.955	0.105302	0.461
RT Zygo Foram	2	1	2	0.4	0.96	0.00182	0.474
LT Zygo Foram	1	0.5	2	0.4	0	0.101467	0.465
RT Access Zygo Foram	0	0	3	0.286	1.047	0.036016	0.373
LT Access Zygo Foram	0	0	3	0.286	1.047	0.232988	0.355
RT Os Japonicum	0	0	3	0.286	1.047	0.058837	0.366
LT Os Japonicum	0	0	3	0.286	1.047	0.068875	0.355
RT Suture into Infra-orbit	1	0.33	3	0.286	0.262	0.028872	0.373
LT Suture into Infra-or	1	0.33	3	0.286	0.262	0.45434	0.355
RT Zygo-Max Tubercle	1	0.25	4	0.222	0.422	0.059642	0.302
LT Zygo-Max Tubercle	1	0.33	3	0.286	0.262	0.091633	0.355
RT Max Torus	0	0	3	0.286	1.047	0.018103	0.36
LT Max Torus	0	0	4	0.222	1.107	0.041002	0.291
RT Epiteric Bone	0	0	1	0.667	0.785	0.028872	1.067
LT Epiteric Bone	0	0	1	0.667	0.785	0.068539	0.952
RT Fronto-Temp Artic	0	0	1	0.667	0.785	0.103523	0.889
LT Fronto-Temp Artic	0	0	1	0.667	0.785	0.158246	0.821
RT Parietal Notch	0	0	0	2	0	0	2.4
LT Parietal Notch	0	0	0	2	0	0	2.4
RT Parietal Foram	2	1	2	0.4	-0.96	2.065019	0.48
LT Parietal Foram	1	0.5	2	0.4	0	0.024004	0.48
Sagittal ossicle	0	0	1	0.667	0.785	0.009914	0.8
Ossicle at Lambda	0	0	4	0.222	1.107	0.080168	0.317
Os Inca	0	0	5	0.182	1.15	0.009758	0.287
RT Lambdoid Ossicle	2	0.5	4	0.222	0	0.61685	0.327
LT Lambdoid Ossicle	0	0	2	0.4	0.955	0.046328	0.518
RT Ossicle at Asterion	0	0	0	2	0	0.61685	2.667
LT Ossicle at Asterion	0	0	0	2	0	0.61685	2.667
RT Ossicle in Mastoid Sutur	0	0	3	0.286	1.047	0.390335	0.508
LT Ossicle in Mastoid Sut	1	0.5	2	0.4	0	0.285992	0.582
RT Petrosquamous Suture	0	0	3	0.286	1.047	0.025758	0.366
LT Petrosquamous Suture	1	0.25	4	0.222	0.422	0.731921	0.309
RT Mastoid Foramen	2	1	2	0.4	-0.96	0.91263	0.495
LT Mastoid Foramen	2	0.67	3	0.286	-0.96	0.898002	0.419
RT Mastoid Foram Extra-sutu	0	0	2	0.4	0.955	0.730406	0.505
LT Mastoid Foram Extra-sutu	1	0.33	3	0.286	0.262	0.898002	0.419
Palatine Torus	0	0	3	0.286	1.047	0.073397	0.35
RT Accessory Lesser Palatin	0	0	1	0.667	0.785	0.12509	0.754
LT Accessory Lesser Pal	0	0	1	0.667	0.785	0.010263	0.747
Pharyngeal Fossa	0	0	1	0.667	0.785	0.014102	0.747
RT Foramen Ovale Complete	0	0	1	0.667	0.785	0.254382	0.747
LT Formamen Ovale Complete	0	0	1	0.667	0.785	0.001491	0.762
RT Foramen Spinosum Open	0	0	1	0.667	0.785	0.175617	0.741
LT Foramen Spinosum Open	0	0	1	0.667	0.785	0.025197	0.754
RT Double Condylar Facet	1	1	1	0.667	-0.79	4.349914	0.741
LT Double Condylar Facet	0	0	1	0.667	0.785	0.242611	0.754
RT Posterior Condylar Canal	0	0	11	0.087	1.278	0.929535	0.167
LT Posterior Condylar Canal	0	0	1	0.667	0.785	0.169212	0.762
RT Hypoglossal Canal Double	0	0	1	0.667	0.785	0.242611	0.754
LT Hypoglossal Canal Double	0	0	1	0.667	0.785	0.229557	0.762
RT Mandibular Torus	0	0	9	0.105	1.249	0.008149	0.159
LT Mandibular Torus	0	0	9	0.105	1.249	0.005894	0.166
RT Ment Foram Double	1	0.08	12	0.08	0.887	0.018722	0.131
LT Ment Foram Double	0	0	11	0.087	1.278	0.072392	0.141
RT Accessory Mandib Foramen	0	0	7	0.133	1.209	0.040213	0.187
LT Accessory Mandib Foramen	0	0	6	0.154	1.183	0.061183	0.223
RT Mylo-hyloid Bridge	0	0	6	0.154	1.183	0.138961	0.211
LT Mylo-Hyloid Bridge	0	0	6	0.154	1.183	0.05128	0.218

Appendix 2

Discrete Trait Representation and Transformations. Paleochristian Data and Transformations

Trait	Present	%	Variance N	Variance 1 / (n+½)	θ
Bregmatic Ossicle	0	0	8	0.117647	1.230959
Coronal Ossicle	1	1.125	8	0.117647	0.740077
RT. Sup-Orbit Foram Complete	3	0.2	15	0.064516	0.599365
LT. Sup-Orbit Foram Com	6	0.38	16	0.060606	0.237966
RT Front Notch	0	0	15	0.064516	1.318116
LT Front Notch	4	0.25	16	0.060606	0.491148
RT Front Foram	3	0.2	15	0.064516	0.599365
LT Front Foram	3	0.19	16	0.060606	0.630814
RT Zygo Foram	12	0.92	13	0.074074	-0.91265
LT Zygo Foram	10	0.67	15	0.064516	-0.31854
RT Access Zygo Foram	1	0.1	11	0.086957	0.857419
LT Access Zygo Foram	3	0.21	14	0.068966	0.56451
RT Os Japonicum	0	0	12	0.08	1.289761
LT Os Japonicum	0	0	14	0.068966	1.309639
RT Suture into Infra-orbit	3	0.27	11	0.086957	0.431718
LT Suture into Infra-or	1	0.07	14	0.068966	0.935847
RT Zygo-Max Tubercle	2	0.16	12	0.08	0.666646
LT Zygo-Max Tubercle	3	0.21	14	0.068966	0.56451
RT Max Torus	1	0.08	13	0.074074	0.91265
LT Max Torus	0	0	14	0.068966	1.309639
RT Epiteric Bone	0	0	2	0.4	0.955317
LT Epiteric Bone	0	0	3	0.285714	1.047198
RT Fronto-Temp Artic	0	0	4	0.222222	1.107149
LT Fronto-Temp Artic	0	0	6	0.153846	1.1832
RT Parietal Notch	1	0.5	2	0.4	0
LT Parietal Notch	1	0.5	2	0.4	0
RT Parietal Foram	3	0.25	12	0.08	0.481701
LT Parietal Foram	5	0.42	12	0.08	0.154934
Sagittal Ossicle	1	0.14	7	0.133333	0.68583
Ossicle at Lambda	1	0.11	10	0.095238	0.824008
Os Inca	0	0	9	0.105263	1.249046
RT Lambdoid Ossicle	1	0.11	9	0.105263	0.785398
LT Lambdoid Ossicle	1	0.125	8	0.117647	0.740077
RT Ossicle at Asterion	0	0	1	0.666667	0.785398
LT ossicle at Asterion	0	0	1	0.666667	0.785398
RT Ossicle in Mastoid Sutur	1	0.25	4	0.222222	0.42243
LT Ossicle in Mastoid Sut	1	0.2	5	0.181818	0.534782
RT Petrosquamous Suture	1	0.08	12	0.08	0.886704
LT Petrosquamous Suture	0	0	11	0.086957	1.277954
RT Mastoid Foramen	5	0.5	10	0.095238	0
LT Mastoid Foramen	1	0.14	7	0.133333	0.68583
RT Mastoid Foram Extra-sutur	4	0.44	9	0.105263	0.100679
LT Mastoid Foram Extra-sutur	6	0.86	7	0.133333	-0.68583
Palatine Torus	0	0	15	0.064516	1.318116
RT Accessory Lesser Palatine	3	0.27	11	0.086957	0.431718
LT Accessory Lesser Pal	1	0.08	12	0.08	0.886704
Pharyngeal Fossa	2	0.17	12	0.08	0.666646
RT Foramen Ovale Complete	0	0	12	0.08	1.289761
LT Formamen Ovale Complete	1	0.1	10	0.095238	0.824008
RT Foramen Spinosum Open	4	0.31	13	0.074074	0.366331
LT Foramen Spinosum Open	2	0.18	11	0.086957	0.626663
RT Double Condylar Facet	0	0	13	0.074074	1.300247
LT Double Condylar Facet	0	0	11	0.086957	1.277954
RT Posterior Condylar Canal	4	0.33	12	0.08	0.31383
LT Posterior Condylar Canal	3	0.3	10	0.095238	.374044
RT Hypoglossal Canal Double	0	0	11	0.086957	1.277954
LT Hypoglossal Canal Double	0	0	10	0.095238	1.264519
RT Mandibular Torus	0	0	18	0.054054	1.339319
LT Mandibular Torus	0	0	16	0.060606	1.325818
RT Ment Foram Double	1	0.05	19	0.051282	1.023532
LT Ment Foram Double	1	0.06	18	0.054054	1.008896
RT Accessory Mandib Foramen	1	0.06	18	0.054054	1.008896
LT Accessory Mandib Foramen	1	0.07	14	0.068966	0.935847
RT Mylo-hyloid Bridge	2	0.12	17	0.057143	0.810425
LT Mylo-Hyloid Br	1	0.07	15	0.064516	0.956749