ANTHROPOLOGIE * XXX/2 * 1992

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SOCIAL STRATIFICATION AND DIFFERENTIAL ACCESS TO MEAT THROUGH TRACE ELEMENT ANALYSIS

ABSTRACT: Since differential access to food resources, specially meat, can be the consequence of a great social stratification, we migh expect to find some correlation between status and dietary indicators, such as trace elements bone content. The spatial distributions of human remains in two archaeological sites from Spain seem to reflect an intentional use of the available area. The studied sites are the Paleochristian Basilica of Ceuta and the medieval church of L'Esquerda. Zn/Ca site distribution suggests that, in the studied sites, social stratification might have influenced funerary rituals. The use of diet as a social status indicator needs, though, close relationship among archaeological, historical, ecological, and anthropological data.

KEY WORDS: Zinc – Strontium – Bone – Atomic absorbtion – Archaeological organization – Social organization – Spain.

INTRODUCTION

Trace elements in bone may be used for determining the importance of the different food types in the diet. The analysis of Strontium (Sr) and Zinc (Zn) has proved to be a useful indicator of vegetable and meat intake (Buikstra et al. 1989, Schöninger 1989, İşcan 1989, Lambert et al. 1985, Sillen and Kavanagh 1982, Schöninger 1982, Fornaciari and Mallegni 1987, Pérez-Pérez 1990). Since differential access to food resources may be influenced by social status, the study of diet might give information on social organization of past human groups. Differences, though, seem to be slight in modern hunter-gatherer groups, while they can be large in historical, highly stratified populations.

In certain instances, trace elements not directly related to diet, such as Lead (Pb), show social correlates (Aufderheide et al. 1981, 1985). Other elements content in bone, heavily dependent on the nutritional intake, might also be indicators of social status whenever social stratification involves differential access to specific types of food, and if their concentration in bone is not affected by post-depositional factors. In this regard, Sr and Zn seem to be poorly affected by diagenetic processes (Lambert et al. 1985, Pate and Brown 1985) and the site corrected index of Sr to Ca (Observed Ratio, O.R.) (Schöninger1982, Navari et al. 1982) and the index of Zn to Ca (Fornaciari el al. 1984, Fornaciari and Mallegni 1987) may be good indicators of the importance of vegetable and meat consumption. For intragroupal comparisons the corrected O. R. index gives the same relevant information as the not corrected Sr/Ca index.

The purpose of the present paper is to correlate Sr and Zn content in bone with archaeological information regarding social status in two christian sites from Spain. The distribution of the burials around

a religious building had great social importance during christian times, unlike the muslims that did not seem to consider of special relevance the location of the burial within the graveyard.

MATERIAL AND METHODS

Samples of well-preserved compact bone were taken in order to minimize possible diagenetic processes affecting the mineral structure. Only adult individuals were considered. A total of 38 bone samples belonging to two different sites have been studied. Nineteen individuals have been analyzed from the first site, a Paleochristian Basilica excavated in 1990 in Ceuta (North Africa, Spain). Coins and *sigillata* discovered within its walls seem to support IVth or Vth century A. D. dates. The interior area of the building was completely scattered with different burials. Three main types of tombs have been described: 1) *amphora*, 2) *tegulae* and 3) *opus signinum*. Most of the individuals studied were buried in *opus signinum graves*, because these were more resistant than the other types that were less preserved through time. Burial goods are usually good estimators of status. However, there were almost no burial goods in the tombs from these sites, so social status was inferred from the type and location of the tomb. All skeletal remains were found in situ, although most of them were damaged.

The second sample, also consisting of nineteen adult individuals, comes from a medieval site called L'Esquerda (Roda de Ter, Barcelona, Spain). The area was a Frankish settlement during the VIIIth and IXth centuries, occupied for retaining the Muslim invasion towards the north of the peninsula. Four types of tombs were found in this site, corresponding to different time periods: 1 – *Pit grave* (IXth – Xth century A. D.), 2 – *Anthropomorphic* (Xth – XIth century A. D.), 3 – *Slab stone* (XIth – XIIIth century A.D.), and 4 – *Calcic layers* (XIIIth – XIVth century A. D.). Burials are grouped around the Romanic church, and the different types of tombs are all in the same area. Most of the studied individuals were buried in anthropomorphic tombs which were excavated in the rock.

Bone samples, obtained from compact tissue, most frequently at the anterior crest of the tibia, were burned at 500 °C during 2 hours and then 0.5 g of the bone ashes were digested in a hot sand bath (200 °C) during 90 minutes with three 5 ml nitric acid (HNO_3 70 %) aliquotes till dryness. Then the sample was solved in 5 ml of chloridic acid ($HCl\ _2N$) and stored in 50 ml of water solution at 4 °C. Trace elements bone content was determined by Atomic Absorption Spectroscopy (AAS). Concentrations are expressed in mg per g of ash for Sr and Zn, and in mg/g for Calcium. Indexes of Sr/Ca and Zn/Ca were also computed. The observed ratio (O.R.) was calculated as the ratio of the human Sr/Ca to the herbivorous one separately for each site. Interpretation of the indexes obtained follows Fornaciari and Mallegni (1987).

RESULTS

Since all the samples analyzed belonged to adult individuals (both excluding subadult and old individuals) no age variability was expected. The range of variability of the results for both sites (*Tables 1 and 2*) was considerably high. No sex differences were found. Individual results of Zn/Ca and O.R. indexes of the sample from Ceuta are shown in *Table 1*. The mean Zn/Ca index shows medium values, indicating a moderate intake of animal proteins in the diet. The mean O. R. index shows extremely high values, which might be due to a high consumption of marine foods, since they result in an increase of Sr bone content when diet is heavily dependent on them (Schöninger and Peebles 1981, Sillen and Kavanagh 1982). Results of Zn/Ca and O.R. indexes of L'Esquerda are shown in *Table 2*. The mean values observed correspond to a pastoral economy, according to the classification suggested by Fornaciari and Mallegni (1987), with a high consumption of animal-derived proteins and low intake of vegetable foods. The spatial distribution of the Zn/Ca values obtained in the Paleochristian Basilica of Ceuta is shown in *Figure 1* (simplified from Bernal 1989). *Figure 2* (simplifed from Ollich 1982) shows the Zn/Ca values distribution in L'Esquerda.

DISCUSSION

Two possible explanations can be hypothesized for the distribution of the burials within the Basilica of Ceuta. One could be related to the existence of an intentional planning of the total available area, and the other would consider random burial distribution.

TABLE 1. *Individual trace element indexes for the site of Ceuta.*

BURIAL	Zn/Ca	Sr/Ca	O.R.
B-2	0.769	0.466	0.953
B-3	0.267	0.196	0.401
B-5	0.595	0.405	0.828
B-6	0.239	0.512	1.046
B-7	0.285	0.431	0.880
B-10	0.444	0.752	1.537
B-11	0.346	0.422	0.863
B-12	1.227	0.457	0.935
B-13	0.497	0.467	0.973
B-14	0.514	0.729	1.491
B-16	0.679	0.402	0.822
B-26	0.425	0.412	0.841
B-31	0.600	0.563	1.151
B-34	0.441	0.698	1.427
B-37	0.368	0.595	1.216
B-39	0.469	0.375	0.766
B-40	1.140	0.542	1.107
B-41	0.307	0.216	0.441
B-42	0.208	0.529	1.081
Ovis-Capra 1	0.371	0.659	
Ovis-Capra 2	0.258	0.535	
Ovis-Capra 3	0.199	0.338	
Bos 1	0.159	0.444	
Bos 2	0.295	0.501	
Bos 3	0.161	0.459	

TABLE 2. *Individual trace element analysis for the site of L'Esquerda.*

BURIAL	Zn/Ca	Sr/Ca	O.R.
Herbivore	0.65	1.43	1.20
Herbivore	0.57	0.95	0.80
Soil 1	1.59	2.48	2.09
Soil 2	1.35	1.61	1.35
Soil 3	0.99	1.24	1.04
Soil 4	0.91	1.39	1.17
G8 T14	0.49	0.33	0.28
G8 T13	0.37	0.27	0.23
G9 T13	0.41	0.25	0.21
G9 T14	0.53	0.32	0.27
5	0.53	0.22	0.19
7	0.86	0.70	0.59
8	0.35	0.32	0.27
9	0.64	0.43	0.37
11	1.03	1.24	1.04
12	0.84	0.42	0.35
13	0.64	0.37	0.31
17	1.22	1.18	0.99
20	0.86	0.62	0.52
24	0.77	0.74	0.62
F2 T6	0.68	0.47	0.39
5/2	0.59	0.44	0.37
9/2	0.47	0.44	0.37
G1 T6	0.78	0.53	0.44
G8 T9	0.37	0.32	0.27

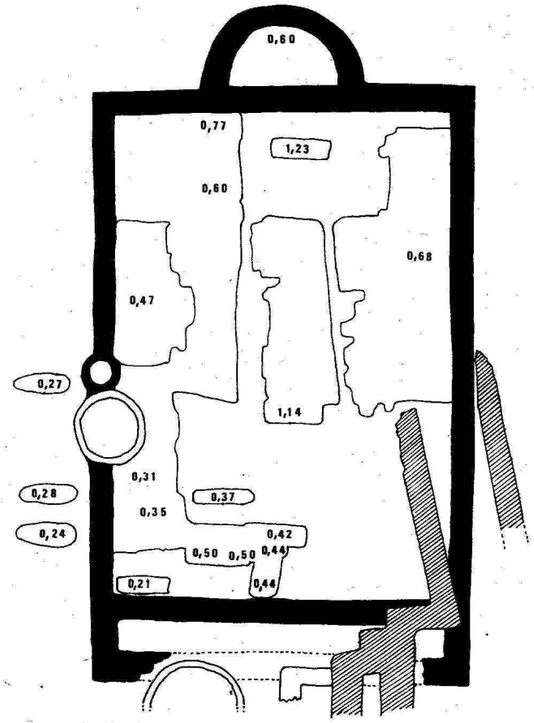

FIGURE 1. *Spatial distribution of Zn/Ca index in the site of Ceuta.*

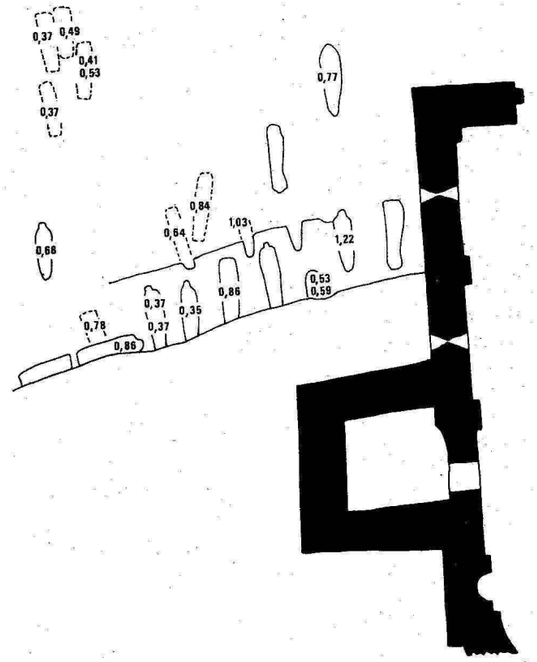

FIGURE 2. *Spatial distribution of Zn/Ca index in the site of L'Esquerda.*

The latter seems false at least for one individual (B-1), which is buried in front of the apse, in a privileged place called *martyria*. An important person of the community, usually a martyr, was usually buried in this place. When representing the Zn/Ca index values for each individual on their own burial place, a distribution pattern can be observed. Higher values are grouped near the apse of the building, and also in the central area, where the larger *opus signinum* tombs are located. The individual at the *martyria*, which was considered the sacrest place of the Basilica, displays the highest value of Zn/Ca. This individual was an 18-year-old female. Medium values are located close to the lateral walls and the entrance area of the Basilica. The lowest indexes are located in the exterior of the precinct, near the north wall. Outside the apse walls, no burials have been discovered.

The distance from each individual to the most important point of the cult, the *martyria*, shows a high correlation with the Zn/Ca index ($r = 0.7395$, $p < 0.01$). Since the different burial types display variable Zn/Ca index values, it can be hypothesized that the observed differences are not related to different occupation time periods of the site.

The O. R. values do not show any clear distribution pattern, probably because marine diet can bring noticeable quantity of Strontium to it (Sillen and Kavanagh 1982). Ceuta was a fishing factory during the Roman period. Remains of a fish factory have been recently discovered near the Basilica. Ceuta is a highly favourable place for capturing large pelagic

fish, especially *Thunnus thunnus*, *Auxis rochei* and *Scomber scombrus*, because the Gibraltar Strait tends to concentrate pelagic migratory fish during their movements from the Atlantic Ocean to the Mediterranean Sea. Some fish vertebrae, and large amounts of shell (especially *Ostrea*, *Spondylus* and *Patella*) have been discovered in archaeological sites of Ceuta.

The site of L'Esquerda is placed in a cold dry area, with low agricultural productivity. The proximity of the Montseny mountains stops the marine humid winds, causing the formation of fog that favours the development of grass and humid forests. Pastoralism was probably the predominant activity during the Middle Ages in this area. The bidimensional distribution of Zn/Ca index in L'Esquerda, shows a trend towards higher index values near the church, and near the line of the crack of the terrain. The distribution pattern is less clear in this case, probably due to differences in the temporal dimension. Pit grave burials, which are in the lowest stratigraphic level, show lower Zn/Ca values than the others. The variation coefficient of the O. R. index in this period (IXth to Xth centuries) is lower than in the following ones (XIth to XIVth centuries), which corresponds to the existence of a homogeneous, highly cohesive group of people in war land. According to Schöninger (1979), a variation coefficient larger than 20% for the Sr/Ca and Zn/Ca indexes can be considered a sign of a heterogeneous sample, with different dietary patterns. Periods of economical growing are related to an increment of social diversification. The latest time periods in L'Esquerda have higher variation coefficients, coinciding with the development of the agriculture practice in the area. In any case, the concentration of high indexes near the fissure of the rock layer, can be related to the presence in that area of the best places to excavate anthropomorphic tombs.

From the results shown, it can be concluded that social statification inferred from an archaeological context may correlate with other anthropological evidence, such as bone trace element content as indicator of diet. Ecological, historical, archaeological and anthropological information is needed, though, when studying social organization of individuals from a site. Diagenetic processes may have altered the bone mineral content in bone if the location of the burial within the site might have been determinant for the preservation of the bone. Nevertheless, since samples were obtained from well-preserved bones, the observed archaeological correlate with Zn content suggests more likely that differences in dietary habits among individuals could have caused the spatial distribution of Zn content in bone.

ACKNOWLEDGMENTS

Trace elements analysis was performed at the Spectroscopy Service of the University of Barcelona.

This research was partially financed by a grant of the "Instituto de Estudios Ceuties".

REFERENCES

AUFDERHEIDE A. C., NEIMAN F. D., WITTMERS L. E., RAPP G., 1981: Lead in Bone II: Skeletal-Lead Content as an Indicator of Lifetime Lead Ingestion and the Social Correlates in an Archaeological Population. *Am. J. Phys. Anth.*, 55: 285 – 291.

AUFDERHEIDE A. C., LAWRENCE J., KELLEY J. O., OUTLAW A. C., OUTLAW M. A., RAPP G., WITTMERS Jr. L. E., 1985: Lead in Bone III: Prediction of Social Correlates from Skeletal Lead Content in Four Colonial American Populations (Catoctin Furnace, College Landing, Governor's Land, and Irene Mound). *Am. J. Phys. Anthrop.*, 66: 353 – 36.

BERNAL D., 1989: La basílica paleocristiana de Ceuta. *Revista de Arqueología*. 101, pp. 8 – 13.

BUIKSTRA J. E., FRANKENBERG S., LAMBERT J. B., XUE L., 1989: Multiple elements: multiple expectations. In: T. Douglas Price (Ed.): *The chemistry of prehistoric human bone*. School of American Research Book. Cambridge University Press.

FORNACIARI G., MALLEGNI F., 1987: Paleonutritional Studies on Skeletal Remains of Ancient Populations from the Mediterranean Area: An Attempt to Interpretation. *Anthrop. Anz.*, 45 (4): 361 – 370.

FORNACIARI G., MENICAGLI E., CECCANTI B., 1984: Indagini Paleonutrizionali e Determinazione del Piombo Osseo Mediante Spettroscopia ad Assorbimento Atomico sui Resti Scheletrici di Epoca Tardo-Romana (IV secolo d.C.) della "Villa dei Gordiani" (Roma). *Archivio per l'Antropologia e la Etnologia* 14: 149 – 176.

İŞCAN M. Y., KESSEL M. H., MARITS S., 1989: Spectrographic analysis of trace elements in archaeological skeletal material from Florida: a preliminary report. *Am. J. Phys. Anthrop.* 79: 483 – 488.

LAMBERT J. B., SIMPSON S. V., SPUZNAR C. B., BUIKSTRA J. E., 1985: Bone diagenesis and dietary analysis. *J. Hum. Evol.* 14: 477 – 482.

NAVARI E., MALLEGNI F., MENICAGLI E., FORNACIARI G., CECCANTI B., 1982: Ricerca degli Elementi Mediante Spettroscopia ad Assorbimento Atomico. Necropoli di Et Romana in Regione San Cassiano di Alba. *Bottega d'Erasmo*. Torino: 70 – 93.

OLLICH I., 1982: Tipologia de les tombes de la necrópolis medieval de L'Esquerda (Osona). *Acta Medievalia*, Annex 1. Dept. Historia Medieval — Inst. Historia Medieval.

PATE D., BROWN K. A., 1985: The Stability of Bone Strontium in the Geochemical Environment. *J. Hum. Evol*, 14: 483 – 491.

PEREZ-PEREZ A., 1990: *Evolución de la dieta en Cataluña y Baleares desde el Paleolítico hasta la Edad Media a partir de restos esqueléticos*, Doctoral Dissertation. University of Barcelona, September 1990.

SCHÖNINGER M. J., 1982: Diet and the evolution of Modern Human Form in the Middle East. *Am. J. Phys. Anth., 58: 37–52.*

SCHÖNINGER M. J., PEEBLES C.S., 1981: Effect of Mollusc Eating on Human Bone Strontium Levels. *J. Arch. Sci.*, 8: 391 – 397.

SCHÖNINGER M. J., 1989: Reconstructing prehistoric diet. In: T. Douglas Price*The chemistry of prehistoric human bone*. (Ed.): School of American Research Book. Cambridge University Press.

SILLEN A., KAVANAGH M., 1982: Strontium and Paleodietary Research: A Review. *Yearbook of Physical Anthropology*, 25: 67 – 90.

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