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SOME ALKALINE EARTH METALS AS PALAEODIETARY INDICATORS AT PORROS SITE (MALLORCA, IRON AGE)

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Abstract: *Strontium is the first chemical element studied as a possible discriminant factor in diet. Its behaviour along food chains is well-known. To date other elements have also been studied as possible paleodietary indicators.*

This study analyses some alkaline earth metals present in bones by a new methodology. The skeletal material chosen for this project belongs to a talayotic necropolis "S'Illot des Porros" (Mallorca) (VI–II bC). S'Illot des Porros is a small island and in fact, the only human evidence to be found there is this necropolis. The inhabited place where this people lived is unknown. The dietary study of these skeletal remains can help in discovering the location.

Key words: *Paleodietary; Alkaline earth metal; Strontium; S'Illot des Porros (Mallorca).*

Introduction

Alkaline earth metals are chemical elements commonly present in soil composition. In the 1950s, Odum (1957) studied the biogeochemical cycle of one of these elements, strontium. During the same decade and as a result of the testing of nuclear weapons, some investigators observed a relatively high concentration of a dangerous radioactive isotope, ^{90}Sr, in the atmosphere, plants and animals (Karlson 1967). These variations in the concentration of strontium along the food chain are higher in the first step and lower in the last. Plants absorb a relatively high strontium concentration of the soil. Herbivore tissue has relatively lower strontium levels than the plants that these animals consume because the digestive tract discriminates againts strontium in favour of calcium. The small amount of strontium is placed principally in bones. Carnivores ingest herbivorous flesh and also discriminate against strontium, thus their bones should contain the lowest strontium content in a given trophic chain. So, we can establish differences along the food chain (Toots & Voorhies 1965). In 1974, Brown incorporates human bones of a mexican population (Huitzo 1100–900 bC) in these studies, to know the diet of that population.

Materials and Methods

The skeletal material chosen for this project belongs to a talayotic necropolis "S'Illot des Porros" (S. VI–II bC). This necropolis is placed in a small island in Alcudia bay (Mallorca, Spain) and the inhabited place where this people lived is unknown (Tarradell 1961). The skeletal remains of this necropolis consist of 230 individuals and other animal remains (Malgosa 1985).

Table 1.
Composition of the faunal sample

Herbivores	12	*Oryctolagus cuniculus*
	9	*Bos taurus*
	6	*Equus*
	22	*Capra, Ovis*
Omnivores	4	*Sus*
Carnívores	1	*Felis*

In this study the sample was taken from femurs of 197 individuals and 59 animal bones (Table 1). The sample was treated by a gravimetric analysis that is conducted on a modification of the Szpunar method (1978) based on an important reduction in the time of the sample preparation and a reduction in the bone weight (Subirà, Malgosa & Carrasco 1987). The reading of levels of trace elements was made by Atomic Absorption Spectrometry (AAS), and Inductively Coupled Plasma Atomic Emission Spectrometry (ICP/AES).

The elements analysed in this study are different alkaline earth metals: barium, strontium and calcium. The amount of calcium is expressed as a percentage while barium and strontium are expressed as ppm and are related to calcium. This is because strontium and barium have a similar chemical behaviour to calcium and replace it in the bone.

The SPSS statistic package was used in the treatment of data. Oneway was applied to analyse the differences in the food chain. Tests for homogeneity of variances was not respected. Then non parametric tests were applied: test of Kruskal–Wallis to analyse the differences in the food chain, and Mann–Whitney test to analyse the differences between two groups. Discriminant analysis was also applied in order to obtain a graph of distribution of groups and peercentage of grouped cases correctly classified.

Results and Discussion

Barium and strontium are chemical elements frequently present in the soil and therefore are present in high levels in herbivores. Barium is generally considered a more discriminant element than strontium. When you analyse Ba/Ca ratio (Table 2) you can observe that herbivores are the group which contains a higher barium level then omnivores, carnivores and finally man. The differences between the levels are significant as Kruskal–Wallis test shows. When you analyse these differences using the Mann–Whitney test, you see that they correspond to the study between man-herbivores and man–omnivores (Table 3). Discriminant analysis shows a 76.17% of grouped cases correctly classified (Fig. 1).

Table 2. **Descriptive statistics and Kruskal–Wallis test results for concentrations of Sr/Ca, Ba/Ca**

		Man	Herbivores	Omnivores	Carnivores	p(K–W)
BA/Ca	$\bar{x}$	0.72255	2.0385	1.9757	0.9318	0.0000*
	SD	0.28	1.03	0.25		
Sr/Ca	$\bar{x}$	7.5960	4.3313	4.1255	3.0033	0.0000*
	SD	0.05	0.02	0.01		
	N	197	54	4	1	

Table 3. **Mann-Whitney test results**

Comparisons		Ba/Ca	Sr/Ca
Man–Herbivores	p	0.0000*	0.0000*
	N	251	251
Man–Omnivores	p	0.0007*	0.0014*
	N	201	201
Man–Carnivores	p	0.2518*	0.09138*
	N	198	198
Herbivores-Carnivores	p	0.1153	0.1015
	N	55	55
Omnivores–Carnivores	p	0.1573	0.1573
	N	5	5
Herbivores–Omnivores	p	0.5807	0.8061
	N	58	58

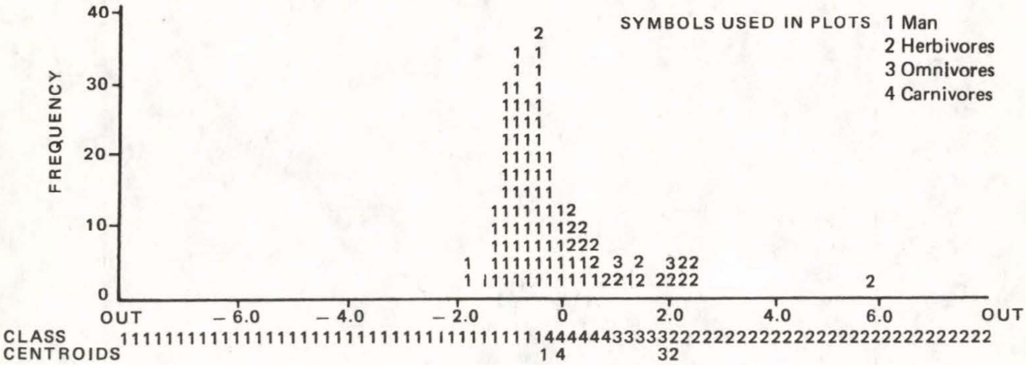
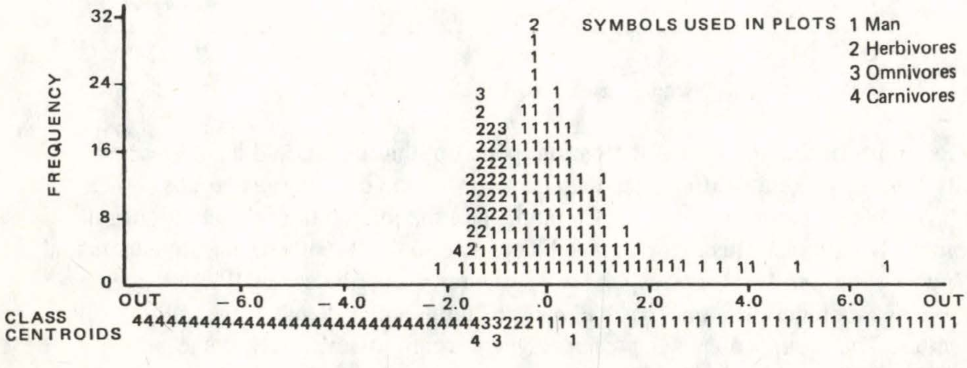


Fig. 1: Discriminant analysis of Ba/Ca ratio

When Sr/Ca ratio is studied, the higher levels belong to man, next to herbivores, to omnivores and finally to carnivores (Table 2). Discriminant analysis show a 70.70% of grouped cases correctly classified (Fig. 2).



In this case Kruskal–Wallis test also indicates significant differences along the trophic chain (Table 2) that correspond to man–omnivores and man–herbivores when the Man–Whitney test is applied (Table 3). These differences coincide with Ba/Ca ratio but unlike it, the higher concentration of strontium belongs to man in this case.

In both elements, the group of carnivores don't present differences between the other groups. This could be due to the small size of the sample only a cat. Also, there is a coincidence in the study of each element; there exist no differences between herbivores–omnivores. This absence can be due to a vegetarian diet for both groups because all the omnivore specimens belong to genus os *Sus* that also consume vegetables. The homogeneity present in omnivores and herbivores datas can be made evident in the discriminant analysis when this is applied to Sr/Ca ratio and Ba/Ca ratio. The percent of grouped cases correctly classified increase to 85.55% (Fig. 3).

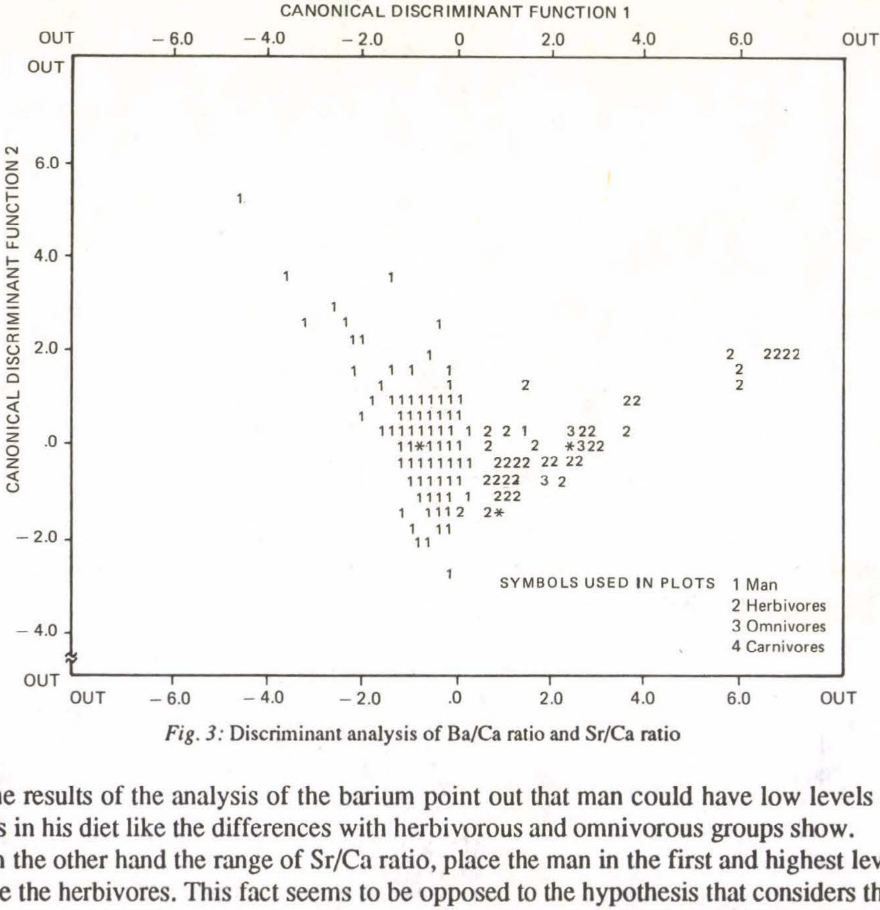


Fig. 3: Discriminant analysis of Ba/Ca ratio and Sr/Ca ratio

The results of the analysis of the barium point out that man could have low levels of plants in his diet like the differences with herbivorous and omnivorous groups show.

On the other hand the range of Sr/Ca ratio, place the man in the first and highest level before the herbivores. This fact seems to be opposed to the hypothesis that considers that the higher strontium levels correspond to herbivores. Nevertheless in 1979, Schoeninger studied two populations, one basically agricultural and the other basically mollusc collectors. The results obtained present higher strontium levels in people who ingest shellfish. Thus in the population of Porros we must consider that the necropolis is located in a small island and therefore it's not unusual that these people are mollusc collectors. In this study, as in the Schoeninger one, the higher strontium levels can be explained by a great amount of molluscs in diet and a low content of plants. This can be corroborated by the low Ba/Ca ratio present in our population.

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