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GROUPING PATTERNS IN IBERIAN ICHTHYOARCHAEOLOGICAL ASSEMBLAGES FROM COASTAL SITES

by

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RESUMEN: La comprensión de la totalidad de las implicaciones proporcionada por una simple lista faunística se potencia con la disponibilidad de técnicas diseñadas para sintetizar los aspectos esenciales de la información obtenida. Este trabajo explora, desde una perspectiva de estadística multivariante, una serie de asociaciones ictioarqueológicas que se han estudiado hasta el momento en la Península Ibérica. Los patrones de agrupamiento resultantes, no sólo demuestran el poder de inferencia paleocultural de estas metodologías sino que posibilitan la mejor comprensión de las faunas mismas.

PALABRAS CLAVE: FAUNA, PECES, YACIMIENTOS ARQUEOLOGICOS, IBERIA, ANALISIS DE CORRESPONDENCIAS, PATRONES DE AGRUPAMIENTO

SUMMARY: To understand the overall implications of a simple faunal list, it is extremely useful to have techniques for synthesizing the essential aspects of the information provided. The present work investigates, from a multivariate statistics approach, the ichthyoarchaeological coastal assemblages thus far studied in the Iberian Peninsula. The grouping patterns which emerge not only demonstrate the paleocultural inference power of the techniques involved but also open the way to a more comprehensive interpretation of the faunas themselves.

KEYWORDS: FAUNA, FISH, ARCHAEOLOGICAL SITES, IBERIA, CORRESPONDENCE ANALYSIS, GROUPING PATTERNS

I. INTRODUCTION

The simultaneous handling of large numbers of variables in the analysis of any group of phenomena greatly restricts the possibilities of reaching objective data interpretations. This fact is further reinforced when the significance of the data is not clear or univocous. Both these peculiarities of epistemological nature are most patent in the study of historical (i.e., non-repeatable) events.

Zooarchaeology, as a branch of Evolutionary Biology, is a historical discipline. It is, therefore, affected by all the analytical constraints which derive from this condition. In this science, moreover, the handling of large numbers of variables, is a constant of every study undertaken. For both these reasons, clear answers are an almost impossible task to accomplish in practice though not in theory.

To solve questions involving the handling of large quantities of data, multivariate statistics have proved of great help (HOPE, 1972; KENDALL, 1980; CUADRAS, 1981) together with a series of specyphic routines in computers (AFFIZI & AZEN, 1972; FRANE, 1978; DIXON, 1985). Though their application in Zooarchaeology is not free of problems, some results thus far obtained are certainly very promising (BERTELSEN, 1988; RINGROSE, 1988).

This study groups a series of iberian archaeological fish assemblages according to their faunal diversity. We wanted to know if there was any kind of pattern, which would allow us to classify them in any coherent way and, if so, what was the nature of this pattern.

Though ichthyoarchaeological research is still very incomplete on the Iberian Peninsula, the number of variables which we have to deal with is not small at all (Table 1). On the other hand, it is interesting to carry out studies of this type when the samples are not still very large. This is so mainly because of two reasons: (1) when the "system" is reduced, its intrinsic variance is ussually smaller, thus being easier to more clearly delimit the patterns which underly it and (2) one can start building up a "reference system" against which new data can be contrasted to revalidate or refute formerly formulated hypothesis as our information on the subject increases. For these reasons we thought it appropiate a study of the nature undertaken.

II. MATERIAL AND METHODS

The data for this analysis was initially constituted by nine ichthyological assemblages recovered on coastal sites of the Iberian Peninsula. Figure 1 depicts the location of each one of these settlements and provides also the cultural periods to which they belong as well as their identification code. Table 1 provides the lists of fish taxa identified in these sites together with their letter code plus the letter code of the sites themselves. We will refer to these site and species codes in the remaining of the paper.

In order to manipulate quantitative variables we have decided to consider, for the taxa under study, the number of remains (NR) with which each contributed to the total NR.

Our matrixes (taxa x site) have been always subjected to the same analytical technique, namely factorial correspondence analysis (CA). The details of these numerical routines have been treated in many recent publications (FOUCART, 1985; MALLO, 1985). CA was chosen instead of principal components analysis (PCA) due to its possibility of simultaneous graphic representation of cases and variables. An stepwise-discriminant analysis was carried out afterwards to select taxa of discriminant value culturally (DIXON, 1985).

SPECIES	ADR	CAP	CZA	CJN	SITES LTK	PPA	SIL	TOS	TBU
O. taurus (OT)	-	1	-	-	-	-	-	-	-
L. nasus (LS)	-	3	-	-	-	-	-	-	-
I. oxyrinchus (IO)	-	-	-	-	4	-	-	-	-
G. galeus (GA)	-	3	1	-	-	-	-	5	-
S. zygaena (SZ)	-	1	-	-	-	-	-	-	-
S. squatina (SQ)	-	-	-	-	-	-	-	1	-
M. helena (MH)	-	3	-	-	-	-	-	-	-
B. belone (BE)	-	-	-	2	-	-	-	-	-
P. pollachius (PO)	-	-	-	13	-	-	-	-	-
M. labrax (ML)	-	-	8	7	-	-	-	1	-
E. guaza (EG)	-	-	-	67	-	-	-	36	-
P. americanus (PA)	-	-	-	-	-	-	-	6	-
Mugil sp. (OM)	-	-	4	-	-	-	-	1	-
P. pagrus (PG)	-	-	4	40	-	-	-	48	-
S. aurata (SU)	-	1	9	32	-	1	-	12	-
D. sargus (DS)	-	-	-	14	-	-	-	-	-
P. erythrinus (PE)	-	1	-	173	-	-	-	14	-
P. bogaraveo (PN)	-	2	-	-	-	-	-	4	-
D. dentex (DD)	-	-	2	-	-	-	-	66	-
Dentex sp. (OD)	-	-	-	14	-	-	-	-	-
Z. faber (ZF)	-	-	-	-	-	-	-	1	-
S. sphyraena (SY)	-	-	-	-	-	-	-	5	-
Labrus sp. (OI)	-	-	-	4	-	-	-	-	-
L. bergylta (LE)	-	-	-	-	-	-	1	-	-
T. mediterraneus (TE)	-	-	-	18	-	-	-	-	-
S. dumerilii (SD)	-	-	-	1	-	-	-	-	-
A. regius (AE)	-	5	1	-	-	-	-	7	-
S. umbra (SB)	-	-	1	-	-	-	-	-	-
S. scombrus (SO)	-	-	-	-	-	-	-	2	-
S. colias (SL)	-	-	-	5	-	-	-	-	-
T. thynnus (TH)	2	6	-	4	-	-	-	3	-
E. alleteratus (ET)	-	-	-	1	-	-	-	-	-
S. sarda (SJ)	-	-	-	-	-	-	-	1	-
Trigla sp. (OR)	-	-	-	9	-	-	-	-	-
A. sturio (AT)	-	-	2	9	-	-	-	-	-
Barbus sp. (OB)	-	-	-	-	-	-	-	1	-
SPARIDAE	-	-	-	273	-	-	-	25	-
S. salar (SS)	-	-	-	-	-	-	-	-	1
S. trutta (SK)	-	-	-	-	-	-	-	-	123
P. flessus (PF)	-	-	-	-	-	-	-	-	1

TABLE 1 - Faunal lists, with NR (number of remains) per species, of the sites studied in this work. ADR = Adra (MORALES, 1976); CAP = Cabezo de San Pedro (DRIESCH, 1973; LEPIKSAAR, 1973a); CZA = Castro do Zambujal (DRIESCH & BOESSNECK, 1976; LEPIKSAAR, 1976); CJN = Cueva de Nerja (BOESSNECK & DRIESCH, 1980); LTK = La Tiñosa (MORALES, 1978); PPA = Papauvas (MORALES, 1985); SIL = S'Illot (UERPMANN, 1971); TOS = Toscanos (LEPIKSAAR, 1973b); TBU = Tito Bustillo (MORALES, 1984).

A first run of the program evidenced the presence of distortional elements. In particular the so-called "Woodman effect" was detected for three sites: TBU, LTK and SIL. These respectively explained, with values which were of 100 for absolute contributions and of 1 for relative contributions, the first three factors of the program. This anomaly is due to the fact that each of these sites only have taxa which never appeared on any of the remaining sites. In the case of TBU these are the salmon (*Salmo salar*), the sea trout (*Salmo trutta trutta*) and the flounder (*Platichthys flesus*), whereas in LTK it is the mako shark (*Isurus oxyrinchus*) and in SIL it is the ballan wrasse (*Labrus bergylta*). To eliminate this type of distortion these sites had to be excluded from the program.

Before commenting on the results of the final data matrix we need to say that this one has not been the only matrix subjected to analysis. Thus, besides our quantitative data matrix of genera and species, we have also run a qualitative matrix (i.e. "presence-absence" matrix) as well as two additional ones -qualitative and quantitative- clumping species and genera into families. In all three cases the results have been almost the same as the ones which we are about to comment. This fact is to be kept in mind throughout the discussion as it stresses the consistency of the results. Detailed discussions of all four programs would, therefore, be redundant in this context.

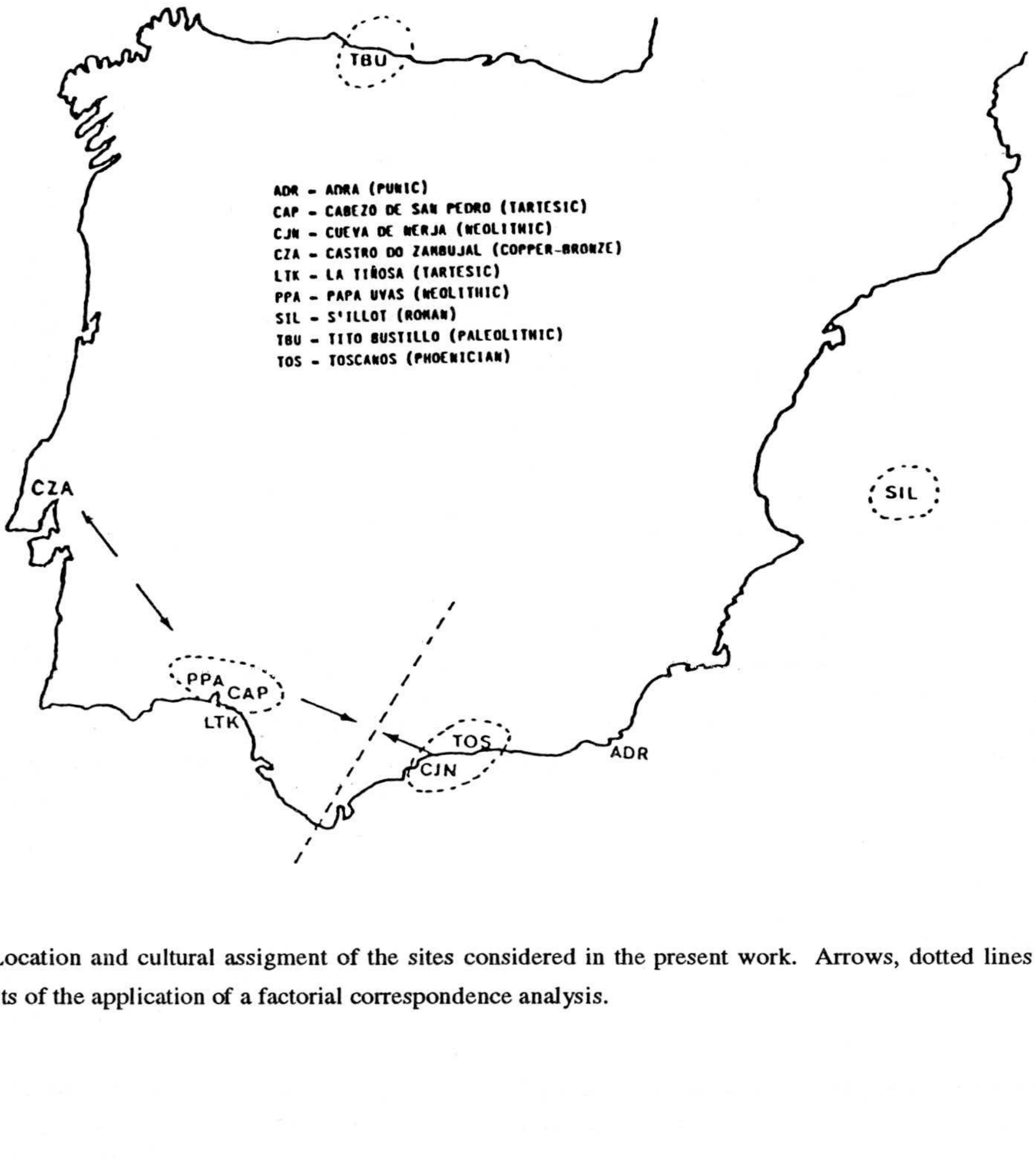

Figure 1 - Location and cultural assigment of the sites considered in the present work. Arrows, dotted lines and groupings reflect the results of the application of a factorial correspondence analysis.

III. RESULTS

Figures 2, 3 and 4 and Tables 2, 3 and 4 present the graphic and numerical results of the program.

A first comment of general nature seems rather evident from the results: these are not only clear but they also seem to be significant. This last point is based on two details:

1) The absence of cases and variables near the origin of the different factors (i.e. axis). In fact, the oppossite seems to hold, namely, the location of cases and variables in places so far away from the origin that their correct representation on the graphs is not possible and we have to place an arrow next

to each one of them. This pattern evidences the power of the program in "explaining" the cases and variables given to it.

2) The extremely high percentage of the total variance which is absorbed by the first three factors (91.3%). This means that with only these three axis one could explain, with a great amount of certainty, the reasons for placing cases and variables in the way they appear on the graphs. This, of course, does not mean that we will find satisfactory explanations automatically but, rather, that the causes behind the display patterns do seem to be significant.

Next we will comment on the specific details of the results for each one of the factors involved.

A) FACTOR I (F1): it nearly absorbs 41% of the total variance generated by the matrix (40’65%). In a decreasing order of importance the species which contribute to its formation are: TH, AE, DD, DS, LS and MH. As for the sites it is CAP the one that contributes most to its formation, followed, with very reduced values now, by CJN and TOS respectively.

F1 explains the position on the graph of GA, PN, AE, OS and PE. Among the sites, it explains the location of CJN and CAP. F1, moreover, confronts TOS and CJN (positive side) with CAP (negative side). Among the taxa, PE and OS (positive half) are confronted to AE, GA and PN (negative half).

B) FACTOR II (F2): this axis absorbs 28’87% of the total amount of variance generated by the system. DD is the only taxon which contributes with a significant amount to the formation of this axis, since TH, LS and MH (these two last ones with identical contributions) exhibit very low values. Among the sites, TOS and CAP (in that same order and, again, confronted) are the ones responsible for the formation of F2.

Through its relative contributions F2 explains, on a decreasing order of importance, the position on the graph of the following taxa: DD, SQ, PA, ZF, SY, SD and OB (all, except DD, with the same value). The sites whose position F2 explains are, again on a decreasing order of importance, TOS, CAP, CJN and ADR (the two last ones to a very small degree).

CAP and ADR (negative half) are confronted with TOS (positive half), and CJN, though a little bit closer to TOS, is placed on the middle of this "gradient". Among taxa it is TH (negative side) the one that confronts itself with DD and almost all the remaining ones (on the positive side).

C) FACTOR III (F3): this axis absorbs 21’71% of the total amount of variance generated by the system. On a decreasing order of importance ML, OM, SJ and SB (the two last ones minimally) are the taxa which contribute to its formation. As for the sites, CZA is really the only one which contributes to its formation as the contribution of TOS is very marginal.

Through its relative contributions, F3 explains the position on the graph of ML, SB, AT, OM, SJ and EG (on a decreasing order of importance) and, among the sites, the locations of CZA, TOS and PPA (these two last ones to a much lesser degree than the first one).

CZA and PPA (negative half) are confronted to TOS (positive half). Among the taxa, SJ and EG (positive half) are confronted to ML, SB, AT and OM (negative half).

ABSOLUTE CONTRIBUTIONS		**RELATIVE CONTRIBUTIONS**	
SPECIES		SPECIES	
14'10	TH	0'918	GA
11'19	AE	0'897	PN
10'37	DD	0'892	AE
9'98	OS	0'760	OS
9'70	LS, MH	0'703	PE
		0'684	BE,PO,DS,OI,TE,SL,ET,OR
SITES		SITES	
53'45	CAP	0'754	CJN
21'00	CJN	0'666	CAP
20'30	TOS		

TABLE 2 - Contribution values for the first factor (F1). Only significant values are given.

ABSOLUTE CONTRIBUTIONS		**RELATIVE CONTRIBUTIONS**	
SPECIES		SPECIES	
31'54	DD	0'614	DD
12'88	TH	0'568	SQ,PA,ZF,SY,SD,SJ,OB
9'09	LS,MH		
SITES		SITES	
43'08	TOS	0'532	TOS
35'56	CAP	0'315	CAP
		0'246	CJN
		0'131	ADR

TABLE 3 - Contribution values for the second factor (F2). Only significant values are given.

ABSOLUTE CONTRIBUTIONS		**RELATIVE CONTRIBUTIONS**	
SPECIES		SPECIES	
35'51	ML	0'920	ML
27'47	OM	0'897	SB
10'29	SJ	0'888	AT
9'21	SB	0'844	OM
		0'639	SJ
		0'554	EG
SITES		SITES	
88'76	CZA	0'868	CZA
12'39	TOS	0'115	TOS
		0'109	PPA

TABLE 4 -Contribution values for the third factor (F3). Only significant values are given.

IV. DISCUSSION

Figure 1 synthezises the essentials of all the information provided by the analysis.

Once the "Woodman-effect" sites (TBU, LTK and SIL) have been removed from the matrix, the results seem to evidence some kind of confrontation of sites on both sides of the Strait of Gibraltar. This, at any rate, does not preclude complementary hypothesis, in particular, that the seggregation seems to be ruling out cultural factors as the causes for the separation, since on both sides of Gibraltar the samples are culturally heterogeneous. This last conclusion has been later reinforced with the results of a stepwise-discriminant analysis. This analysis was carried out in order to detect taxonomic variables (i.e., taxa) potentially useful as cultural indicators but the program was unable to select even a single taxon from the sample provided. We should, therefore, turn towards other non-cultural explanatory phenomena in order to account for the observed grouping patterns.

At this stage we not only need to know the causes involved, wether biological, geographical or other, but also the nature of their interaction. To find out this we need to investigate further details on the specific contributions of the different cases and variables and also the various patterns of confrontations to see if any coherent picture emerges.

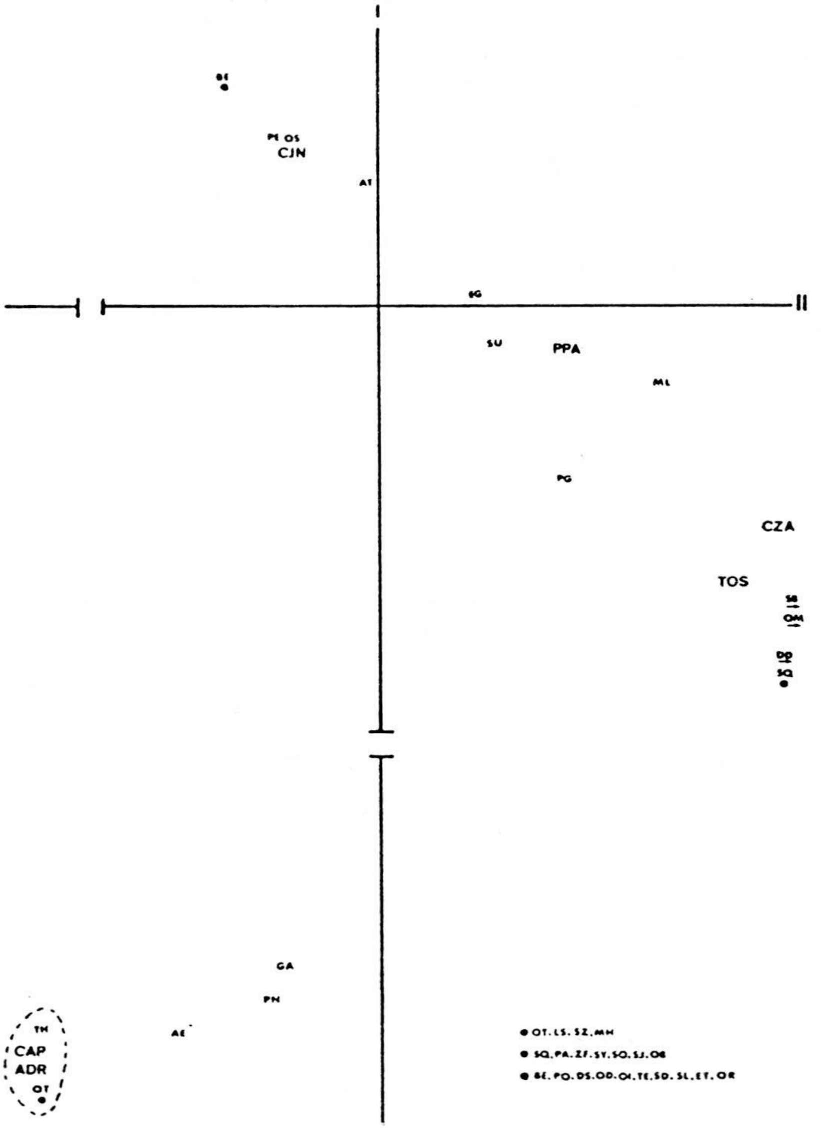

FIGURE 2 - Confrontation of the first two factors (F1 and F2) of t he correspondence analysis. Black dots represent multiple points of taxa (see inset).

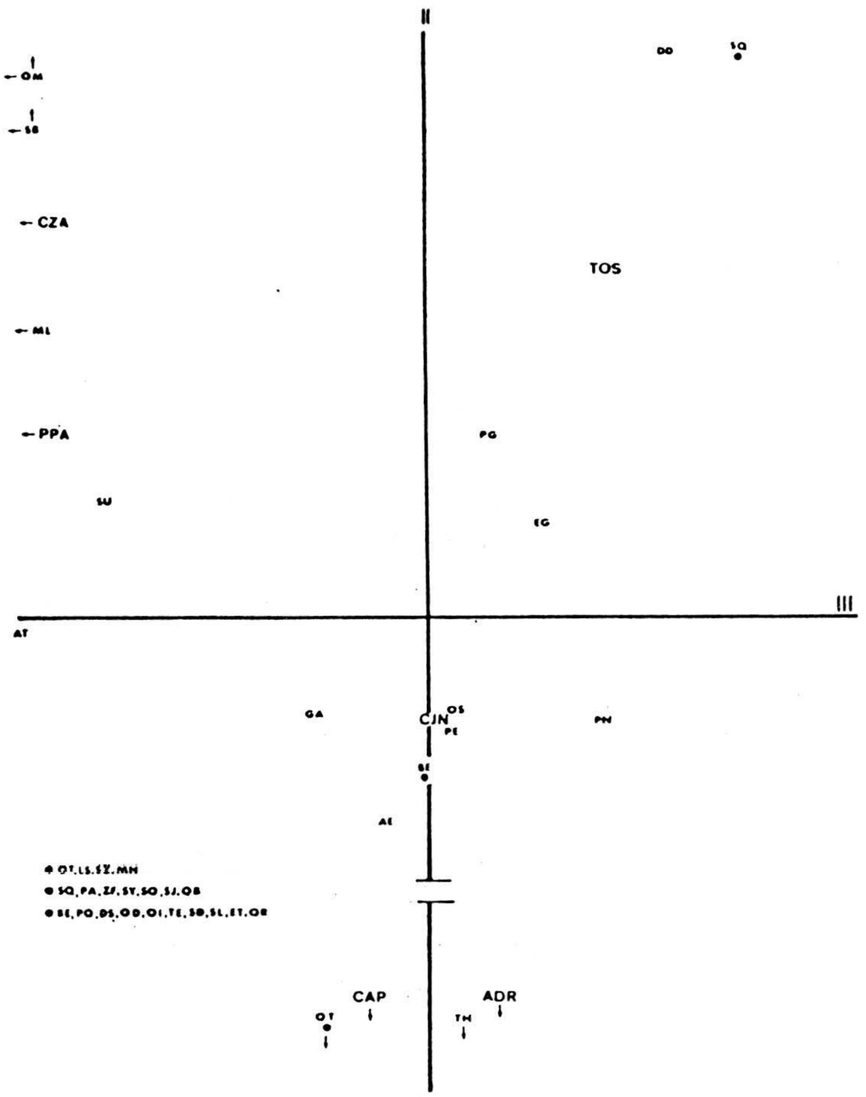

FIGURE 3 - Confrontation of factors II and III (F2 and F3) of the correspondence analysis. Black dots represent multiple points of taxa (see inset).

A pattern which is repeated on F1 and F2 is the confrontation of CAP with the eastern andalusian sites of CJN and TOS. In F1 CAP is confronted to them in isolation but in F2, ADR joins CAP. Since the only species present in ADR is the bluefin tuna (*Thunnus thynnus*), it seems that this species, fairly abundant in CAP, must be responsible to an large extent for the seggregation detected. The hypothesis seems to be further reinforced when we review the contributions of F2 and see how TH is sistematically confronted to the taxa associated with TOS and, to a lesser degree, to those associated with CJN. This is very interesting since TH is present on both TOS and CJN, though accounting for minimum percentages of the total NR (0'58% in CJN and 1'26% in TOS). Thus, after these facts are taken into account, we might presume that it is the relative importance of bluefin tuna within the faunal assemblage what plays a significant role on the observed groupings. If this is so, geographic factors automatically take a secondary role as explanatory causes. Eventually, they could be important, for example, to the extent

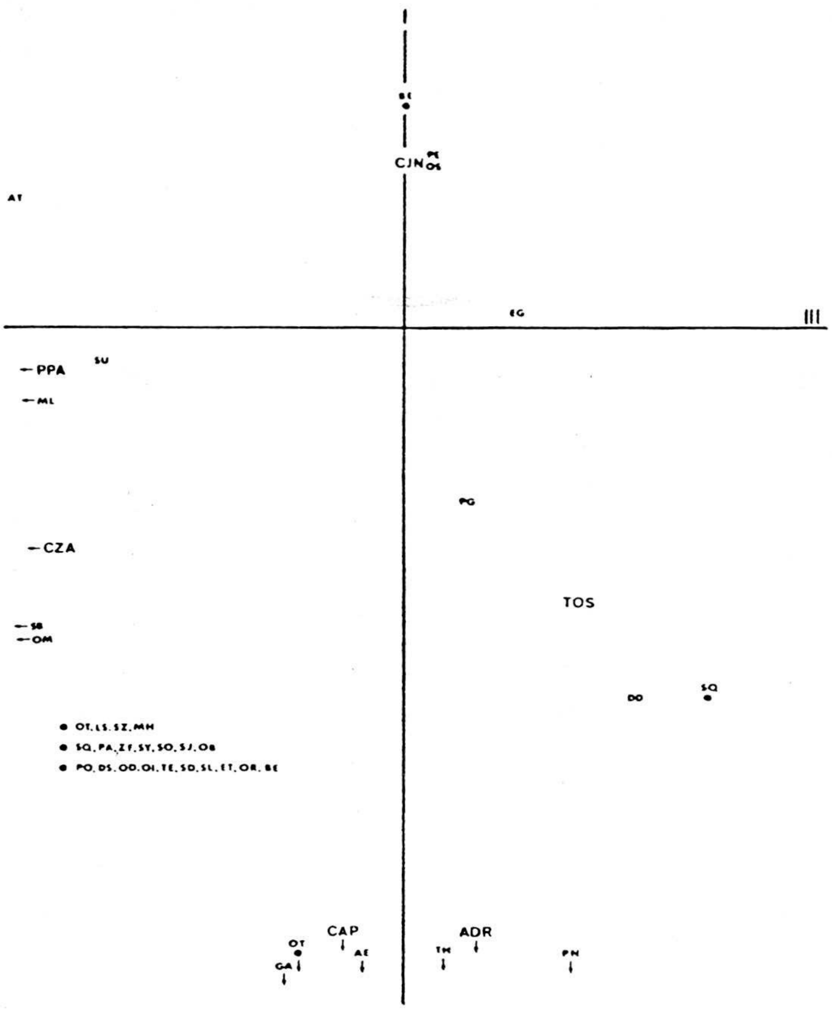

FIGURE 4 - Confrontation of factors I and II (F1 and F3) of the correspondence analysis. Black dots represent multiple points of taxa (see inset).

that geography might influence the types of fish faunas to be found along the coasts. Otherwise, the association of ADR with CAP would make no sense at all.

We suspect that this observation on tuna fish, nevertheless, should be a partial reflection of a more complex phenomenon. After all, if the program seggregates quantitative faunal differences, one must think that these can also be detected by a careful examination of the other ichthyological taxa involved. Are there further consistencies to support this hypothesis? we think so.

Let us consider now the big pelagic sharks. There are not too many identified in the samples but these (OT, LS and SZ) regularly appear associated with the tuna fish and CAP. Their confrontation to other taxa is always weak, probably due to their small NR. These observations are further reinforced by considering other taxa and sites. Thus, we have the site of LTK, not included in the program and very close to CAP, were only the mako shark (IO) appears. Secondly, we see how the benthonic sharks (SQ) appear always on a multiple point close to TOS whereas the semi-benthonic tope (GA) is always located somewhere in between close to species of similar habits (i.e., partial migrants) such as AE (meagre) and PN (red bream). The pattern, thus, appears to be more than just a coincidence. A last piece of information supporting this scheme is the ichthyoarchaeological assemblage of "Calle del Puerto nº 10" (prov. Huelva) also very close to CAP and LTK (ROSELLO y MORALES, in preparation). This tartessian site from the VI century B.C., exhibits, together with a very diversified sparid fauna, all the pelagic shark species mentioned above (OT, IO and SZ) as well as a rather big sample of tuna fish remains plus one species of migratory ray: the eagle ray (*Myliobatis aquila*).

If we consider the remaining of the teleost fishes we will spot further consistencies. Sparidae, for example, a group of mainly littoral species, are always associated with the mediterranean site of CJN. Among these we can even follow the "behaviour" of some species. Thus, within the genus *Pagellus*, the semi-migratory PN is associated with CAP, whereas the more sedentary PE becomes associated with CJN. TOS is also closely associated with another littoral species, namely DD (*Dentex*). The list could be prolonged in excess but at this stage we tend to think that the clustering pattern is clear: the program has spotted one sector of the Iberian coastline (the southwestern atlantic) where the abundance of pelagic and migratory species is particulary high among the ichthyological assemblages. This sector is confronted with others where the abundance of littoral species is almost overwhelming (see arrows in Figure 1). Actually, one eastern andalusian site, ADR, joins the cluster of western andalusian sites due to its faunal similarity with them.

Cultural reasons do not seem to be behind these clusters; the clusters include sites all the way from the neolithic to carthaginian times. Geographic, or, rather, ecological reasons, however, do seem to play a more important role. Thus, the so-called ibero-moroccan bay (the entrance to the Mediterranean from the Atlantic ocean) is a funnel-shaped area just before the Strait of Gibraltar with periodic concentrations of pelagic migrants which spawn in the Mediterranean. Among these the bluefin tuna is the most famous one but other less social migrants such as the hammerhead and basking sharks have also been known since the times of the romans. These species ussually disperse once they have crossed the Strait and are less accesible to local fishing fleets operating from the coastline. In the spanish provinces of Huelva and Cádiz, on the other hand, sophisticated fishing gear called "almadrabas" (series of fixed net complexes with a "death chamber") have been operating for the last two thousand years at least (PONSICH & TARRADELL, 1965) to take advantage of this most valuable renewable resource.

For all these reasons, though benthonic and littoral species might be biologically more significant in archaeoichthyology, pelagic fish assemblages have turned out to be the really discriminant variables of the study undertaken.

There is one last implication derived from this analysis. The capture of pelagic species demands a more sophisticated sailing and fishing gear than the one required to fish littoral faunas. The study of pre- and protohistoric fishing gear is at present one of the great underdeveloped areas of iberian archaeology. Since the development of this gear should be a direct consequence of the availability of a particular ressource, our results can help archaeologists on "where to" and "what" to look for. At the same time, this future archaeological research will greatly help us in validating or refuting the hypothesis advanced in our work.

V. CONCLUSIONS

The results from a series of multivariate analysis applied to a sample of iberian ichthyoarchaeological assemblages from coastal areas of the peninsula, demonstrate, besides specific faunal differences of ecological or geographical nature, the existence of a sector of the spanish coast (the western andalusian) characterized by a much more systematic exploitation of pelagic species. The biological and paleocultural implications of this pattern are to be taken tentatively but do agree, nevertheless, with the data which we have on the periodic concentrations of open-sea migrants from the Atlantic ocean in this area (the ibero-moroccan bay). Further archaeological and ichthyoarchaeological research along these lines is needed in order to substantiate our results.

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