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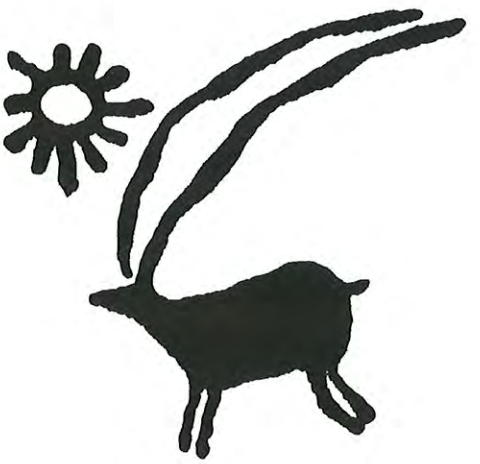
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The importance of domestic mammals during the La Tène Period in Romania

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ABSTRACT: Mammal remains of the La Tène Period in Romania are described in terms of their frequencies based on the number of identified specimens and in terms of the morphology and size of the animals consumed. The species discussed are cattle, sheep, goat, pig, dog, and horse. Wild species are considered as a single group, and are not discussed in detail. A summary of previous and recent studies in the area shows that regional and sub-regional variation characterizes the assemblages.

KEY WORDS: ROMANIA, LA TÈNE, ANIMAL HUSBANDRY

RESUMEN: Restos de mamíferos del periodo La Tène en Rumanía se describen en términos de sus frecuencias basadas en el número de especímenes identificados como así también en términos de la morfología y el tamaño de los animales consumidos. Las especies en discusión son: vaca, oveja, cabra, cerdo, perro y caballo. Las especies salvajes se consideran como un solo grupo y no serán discutidas en detalle. Un esquema de previos y recientes estudios en el área muestra que las variaciones regionales y subregionales caracterizan el conjunto.

PALABRAS CLAVE: RUMANÍA, LA TÈNE, GANADERÍA

INTRODUCTION

This study concerns the Geto-Dacian culture, which occupied the Carpatho-Danubian basin, in the territory named Dacia. The study will mainly focus on subsistence as reflected by archaeozoological analyses for the La Tène period in the modern territory of Romania. Previous archaeozoological syntheses for the La Tène period (Udrescu, 1985a, 1985b; Haimovici, 1987) discuss the fauna discovered in the southern and eastern parts of the country. The goals of this paper are: (a) to present archaeozoological data for the La Tène period from all regions of the country, i.e. to summarize the data presented by previous studies, as well as to include previously unpublished results; and (b) to provide a source of comparison for archaeozoological studies in other parts of Europe.

The Geto-Dacians belonged to the north-Thracian branch of the Thracian tribes living east of the North Balkan Peninsula. The Geto-Dacians' separation into the north branch of the Thracian tribes took place at the beginning of the Iron Age. In Romanian historiography, "Geto-Dacians" refers

to all of the North-Thracian tribes from the Carpatho-Danubian region. The names "geți" (Γεταz, *Getae*) and "daci" (Δάκοz, Δάκαz, *Daci*) were used by Greek and Latin writers to differentiate the tribes of the Lower Danube (geți) from those located in the central and west parts (daci) of the Carpatho-Danubian space (Crișan, 1993). The most ancient references of the Greek and Latin writers to the Carpatho-Danubian territories were made by Hecataeus of Miletus, Herodotos, and Thycidides, and they report on events that took place by the end of the 6th century B.C. Subsequent written sources concur that these two names refers to the same population, which lived north of the Balkans and between the Carpathian mountains, the Middle Danube, and the west shore of the Black Sea.

The Geto-Dacians had a state organization as early as the 1st century B.C., which was characterized by a tributary type of exploitation. The society was divided into nobles (*pileati*) who, along with the priests, lived on the *acropole*, and ordinary people (*comati*) who inhabited the rural settlements (Crișan, 1993). The Geto-Dacians were in contact with other populations such as Bastarns, Scythians, and Celts, but the main external influences were the Greeks, beginning with the 7th century B.C., and the Romans in 106 A.D. After the Roman conquest the Geto-Dacians were assimilated and took the name of Daco-Romans. This population lies at the origin of the modern Romanians.

The Geto-Dacians' settlements were economic, political, military, and ritual establishments. They represent proto-urban agglomerations similar to the Celtic *oppidum.* Their function was analogous to that of the Mediterranean towns, but the Geto-Dacian settlements do not meet the same criteria of public utility (Crișan, 1993). In the Geto-Dacian language ("daco-moesica") the settlements were called *dava.* The *oppidum* type of civilization begins in Dacia in the 4th century B.C. and reaches its apogee between the middle of the 2nd century B.C. and the beginning of the 2nd century A.D. During those times the Geto-Dacians settlements had a formal level of organization consisting of a fortified zone (*acropole*), situated on a strategic point/promontory, and the surrounding civil settlement in the open area (Crișan, 1993).

Geto-Dacian Iron Age

The terms "Hallstatt" and "La Tène" have been used for a long time as synonyms for the first and second Iron Age periods. These concepts are of Central European origin, and they do not entirely fit to the Carpatho-Danubian region. However, for the purpose of eliminating confusions, Romanian research has continued to use Hallstatt and La Tène as synonyms for the two Iron Age periods; the "La Tène" term has the same meaning as the analogous cultural phenomenon in Central and Western Europe, which was that of receiving and interpreting Greek and Hellenistic influences by the indigenous populations.

The Romanian La Tène is divided in three general phases: the ancient phase (c. 450-300 B.C.), the middle phase (c. 300-200 B.C.) and the late phase (c. 200 B.C.-106 A.D.). This latter one corresponds to the period of maximum development of the Geto-Dacian culture, and it is subdivided into several sub-phases.

Environment

Romania has a transitional type of temperate-continental climate, specific to Central Europe, with four clearly defined seasons. Local differences are caused by altitude and by slight oceanic (to the west), Mediterranean (to the south-west), and continental (to the east) influences. The Central Transylvanian Basin is separated from the Plain of Moldavia to the east by the Carpathian Mountains, and from the Walachian (Romanian) Plain to the south by the Transylvanian Alps. Varied forms of relief, which were suitable for agriculture and animal husbandry, are geographically represented in this vast region. There are three major, well-differentiated relief steps: the highest is represented by the Carpathian Mountains, the middle by the Sub-Carpathians, the hills and the tablelands, and the lower by the plains, the river meadows, and the Danube Delta. The most characteristic feature of the topographic components is their distribution in the form of an amphitheatre. The mountains form an arch in the central part and cover 31% of the country's area, the hills and tableland occupy 36%, and the plains take up to 33%. The mountains encircle Transylvania, the Transylvanian tablelands. A belt of hills and elevations, which rise no higher than 1000 m, dominate the relief in this area. The Sub-Carpathians to the east and south of the mountains have lower altitudes, between 100 and 500 m. To the east and south lie the two plateaus, Moldova and Dobrogea tablelands, with altitudes of 400 to 600 m. The plains, formerly sea

and lake bottoms, cover the southern and western parts of the country and are low and extremely flat. Between the Carpathians and the Danube lies the Romanian Plain, and to the west stretches the Western Plain, which is crossed by many rivers. The multi-tiered relief structures the climate, the soil, the vegetation and the fauna and implicitly the human settlements. The network of rivers is radial-shaped, with 98% of the rivers springing from the Carpathian Mountains and being collected through tributaries by the Danube. The Danube flows into the Black Sea through three arms, which form a delta. The forests, which in ancient times and during the Middle Ages used to cover almost the entire area of Romania (except for its southeast), gradually were cleared for farming land. Today forest accounts for 26.2% of the country's area, consisting of beech, common oak and evergreen oak, coniferous trees, hornbeam, elm, lime and other species. Alpine pastures cover extensive areas at altitudes higher than 1800 m and are used mainly for sheep breeding.

During ancient times, agriculture and animal husbandry were constantly practiced, their economic importance differing according to regional forms of relief and environment.

ARCHAEOZOOLOGICAL STUDIES

Archaeozoological studies in Romania have addressed archaeological questions mainly related to subsistence practices such as animals present and/or consumed in each site, proportion of wild species *versus* domestic fauna, and animal use. They have also addressed questions such as variability, differentiation, or diminution of the characteristics related to the domestication processes, through morphological and statistical studies. They have tried to bring insight to the knowledge of the endemic types that lies at the origin of the modern races of domestic animals. They also emphasized some of the aspects of animal microevolution. In essence, these approaches were mainly concerned with the biological aspects of faunal remains from archaeological sites, and less with the anthropological ones (i.e. human behavior) (Reitz & Wing, 1999).

Bone assemblages from excavated settlements and cemeteries, as well as from some high status tombs, have been studied. The La Tène settlements yielded large samples of bones, mostly from animals that had been butchered and consumed. The fauna discovered in cemeteries came from animals that had been sacrificed and buried. The regions of the country that have yielded suitable fauna for archaeozoological analysis are: Moldova, Muntenia, Oltenia, Dobrogea, Transylvania, and Banat (Figure 1). The settlements studied are as follows: Lozna (Haimovici, 1987), Lunca Ciurei (Haimovici, 1987), Bîtca Doamnei (Haimovici, 1987), Brad (Haimovici, 1987), Răcătău (Haimovici, 1989), Florești (Haimovici, 1987), Piatra Șoimului (Haimovici, 1993) in Moldova; Grădiștea (Udrescu, 1992; Tarcan-Hrișcu *et al.*, 1996; Hrișcu *et al.*, 1997), Căscioarele (Hrișcu *et al.*, 1996), Cîrlomănești (Udrescu, 1977), Radovanu (Udrescu, 1985a), Popești (Udrescu, 1985a), Piscu Crăsani (Udrescu, 1985a), Zimnicea - settlement and necropolis - (Haimovici, 1972, 1983), Vlădiceasca 1 (Udrescu, 1989), Vlădiceasca 2 (Ionescu, 1976), Cătunu (Haimovici, 1987), Peretu (Bolomey, cited in Haimovici, 1987) in Muntenia; Mărgărițești (Udrescu, cited in Haimovici, 1987) in Oltenia; Agighiol (Bolomey, 1968) in Dobrogea; Pecica (Haimovici, 1978) in Transylvania; Stenca Liubcovei (El Susi, 1985) and Divici (El Susi, 1996) in Banat.

There are some limitations to this study that concern with several variables. First, not all the data for the settlements in Moldova were available, so data from a synthesis (Haimovici, 1987) were mainly used here. Information on sampling intensity and recovery methods was not usually recorded. Some of the samples do not display significantly comparable frequencies, due to their small size, like Pecica and Vlădicesca 2. On the other hand, Căscioarele, which has also yielded a small sample, displays a similar pattern to the larger assemblages in the same region. These settlements were included in the analysis even if there still may be coincidence in the results obtained. The Geto-Dacian settlements usually yield well-preserved bones in high quantities, and the contextual information and stratigraphy are generally clear. An exception to the rule was the fauna recovered at Căscioarele where the five settlements excavated in this area have yielded only 403 faunal remains.

Chronologically, the settlements in Moldova are dated to a longer time span (400 B.C.-100 A.D.) and are located in different geographic units, such as the sub-Carpathian area, and plains. The settlements in Muntenia are generally dated to 200-100 B.C. and are located in plains, where the climate is today drier than in Moldova.

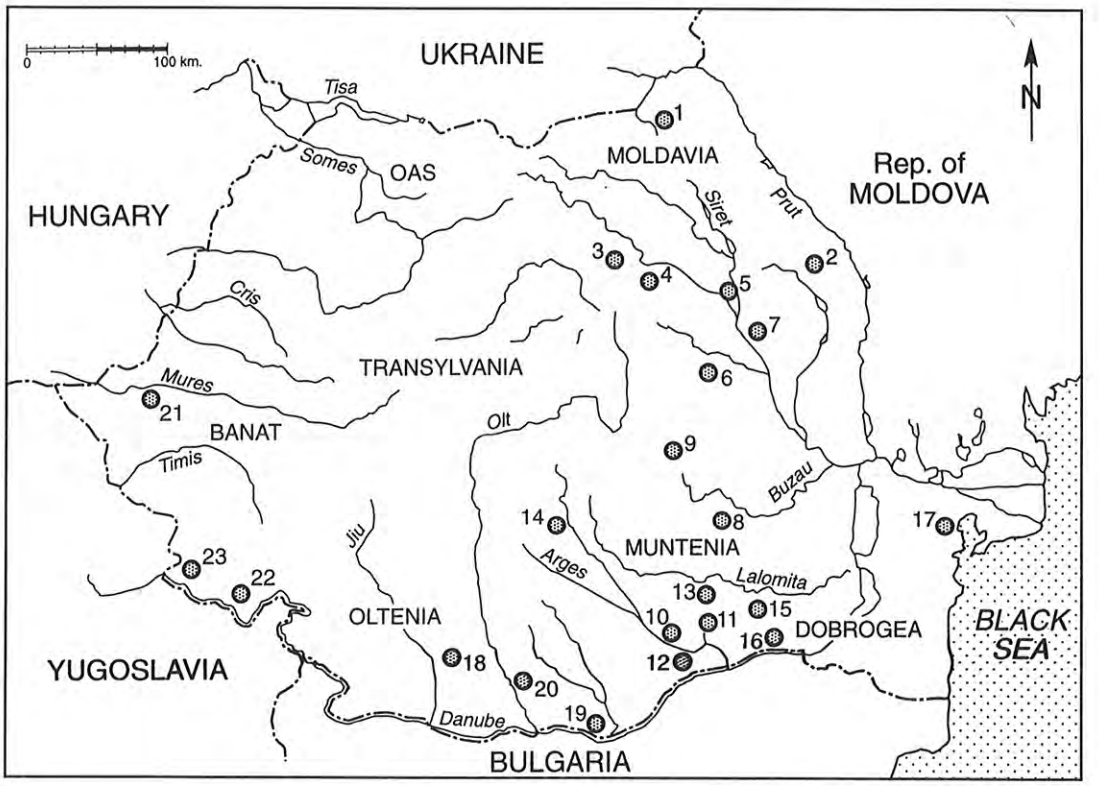


FIGURE 1

Map of Romania showing the Geto-Dacian sites that have been zooarchaeologically analyzed. Legend: 1. Lozna Hlibicioc; 2. Lunca Ciurei; 3. Bîtca Doamnei; 4. Piatra Șoimului; 5. Brad; 6. Florești; 7. Răcătău; 8. Grădiștea; 9. Cîrlomănești; 10. Radovanu; 11. Vlădiceasca 1; 12. Popești; 13. Piscu Crăsani; 14. Căunu; 15. Vlădiceasca 2; 16. Căscioarele; 17. Agighiol; 18. Mărgărițești; 19. Zimnicea; 20. Peretu; 21. Pecica; 22. Stenca Liubcovei; 23. Divici.

1. ASSEMBLAGE VARIABILITY: Among the animal resources, domestic birds and mammals constitute the majority; however, because the number of remains attributed to domestic birds (hen and goose) is small, they were not included in this study. Animal husbandry was an important subsistence activity during La Tène in Romania, but wild mammal remains are still present, even if only in smaller amounts. As Table 1 shows, the percentage of domestic mammals and wild mammals vary from one region to another, as well as from one site to another. In Moldova, the percentages of domestic mammals range between 78% at Piatra Șoimului and 96% at Răcătău. In Muntenia, the percentages of domestic mammals are slightly higher: from 86% at Vlădiceasca 2 and 99% at Căscioarele. In Banat and Transylvania the percentages are the lowest. The minimum value is 67% at Pecica, and the maximum 71% at Divici. The wild mammal species were better represented in Banat and Transylvania, with values of about 30 %. Thus, the main regions of the country show differences and similarities, as well as local variability in terms of the importance of animal husbandry, the maximum values being recorded in Muntenia. The differences from one region to another, as shown by the data, may be related to different regional adaptations to the local environment. It is possible that Muntenia was a more favorable land for animal husbandry due to its lower plains and drier climate, in comparison to Moldova, Banat, and Transylvania where more hilly regions prevailed.

The domestic mammals identified in the La Tène settlements in Romania, as well as their frequencies based on NISP (specimen count or number of identified specimens), are shown in Table 1.

	Total mammals	Domestic mammals		Wild mammals		Cattle		Sheep/Goat		Pig		Horse		Dog	
Region/ Site	NISP	NISP	%	NISP	%	NISP	%	NISP	%	NISP	%	NISP	%	NISP	%
Moldova															
Piatra Soimului	929	725	78.04	204	21.96	403	43.38	126	13.56	174	18.73	18	1.94	4	0.43
Racatau	1848	1771	95.83	77	4.17	734	39.72	350	18.94	609	32.95	71	3.84	7	0.38
Muntenia															
Cascioarele	211	208	98.57	3	1.43	84	39.81	63	29.86	44	20.85	10	4.74	7	3.32
Vladiceasca 1	1905	1644	86.29	261	13.71	817	42.89	410	21.52	258	13.54	69	3.62	90	4.72
Vladiceasca 2	584	501	85.78	83	14.22	305	52.23	52	8.90	66	11.30	57	9.76	21	3.60
Piscu Crasani	7008	6642	94.77	366	5.23	2245	32.03	2119	30.24	1753	25.01	381	5.44	144	2.05
Popesti	1894	1839	97.09	55	2.91	719	37.96	535	28.25	436	23.02	111	5.86	38	2.01
Radovanu	4874	4596	94.29	278	5.72	1801	36.95	1109	22.75	1374	28.19	246	5.05	66	1.35
Cirlomanesti	2818	2713	96.27	105	3.73	762	27.04	1167	41.41	697	24.73	74	2.63	13	0.46
Gradistea	2257	2028	89.85	229	10.15	919	40.72	511	22.64	440	19.49	135	5.98	23	1.02
Banat + Transylvania															
Stenca Liubcovei	916	650	70.96	266	29.04	253	27.62	161	17.58	227	24.78	5	0.55	4	0.44
Divici	1584	1126	71.08	458	28.92	137	8.65	136	8.59	843	53.22	8	0.51	2	0.13
Pecica	410	276	67.31	134	32.69	72	17.56	35	8.54	96	23.41	34	8.29	39	9.51
Total	27238	24719		2519		9251		6674		7017		1219		458	
Note: the percentages were calculated on the basis of Total NISP															

TABLE 1

The relative importance of domestic and wild species.

They consist of cattle (*Bos taurus)*, sheep (*Ovis aries)*, goat (*Capra hircus)*, pig (*Sus domesticus)*, horse (*Equus caballus)*, and dog (*Canis familiaris)*. Cattle dominate the two assemblages in Moldova with an average of 41.55%. Pig comes on the second place (25.84%), while sheep/goat on the third (16.25%). In Muntenia, the average value for cattle is of 38.7%, while sheep/goat has a higher average value (25.7%) than pig (20.77%). In Banat and Transylvania the average value of pig increases substantially, reaching 33.81%.

The remains of horse and dog are generally less frequent (see Table 1), and their relative frequencies also differ between sites and regions. The average values for the entire country are 4.47% for horse, and 2.26% for dog. For the two settlements in Moldova the average value for horse is 2.89%. In Muntenia, the percentages seem to be higher, with a minimum value of 2.63% at Cîrlomănești and a maximum value of 9.76% at Vlădiceasca 2. As for Banat, the percentages are extremely low, e.g. 0.55% at Stenca Liubcovei, and 0.51% at Divici. The more humid environment in this area was probably not favorable for keeping horses. The percentage of horse is higher at Pecica in Transylvania (8.29%) due to the small size of the assemblage. Dog has even lower frequencies, with values comprised between 0.38% (Răcătău) and 4.72% (Vlădiceasca 1), and a very high value is recorded for the settlement at Pecica (9.51%). In Muntenia the percentages are higher than in Moldova, with an average value of 2.32%. This phenomenon may be related to the higher percentage of caprovines in this region. The high percentages of dog and horse at Pecica and Vladicëasca 2 are responsible for lower percentage of cattle, sheep/goat, and pig. These samples are small in comparison to the others, and it is possible that the data obtained are not revealing. On the other hand, the settlement of Cascioarele, which has an even smaller sample than the other two mentioned above, displays a pattern that is similar to that obtained for most of the settlements in Muntenia. Further excavations in these areas are required in order to confirm the pattern obtained.

In order to account for the regional and local variability among the domestic species, a chi-square test of independence using Systat was applied. Table 2 presents the standardized residuals obtained for each species and site. The resi-

duals represent the difference between the observed and expected frequencies. Negative values show that the observed frequency was lower than the expected one, and positive values show that the observed frequency exceeded the expected one. Standardized residuals outside the limits of approximately ± 2 show that the difference from expectation is significant. The calculated chi-square value in Table 2 is significant at $p \leq 0.0005$, confirming that the variables (i.e. species and sites) are not independent. This means that the differences between sites and regions have a real basis, and probably are not the result of sampling.

In order to obtain a clearer pattern of association, the chi-square test was complemented by a correspondence analysis. The first two factors account for more than 80% of the variability (see Table 3), and the variable coordinates are presented in Table 4. The coordinates of these factors were plotted in Figure 2 in order to show correspondences between sites and assemblages. The plot shows two patterns of association. The first pattern shows the proportional representation of species in the assemblages. According to Factor 1, there seems to be a strong association between cattle, sheep/goat, horse, and dog, and a separation of this grouping from pigs. This distinct separation of the two groups mentioned above may suggest that Factor 1 may indicate mobility and/or herding behavior. The distribution of species on Factor 2 shows less separation than on Factor 1, but there is still a distinction between sheep/goat on one extreme and dog on the other extreme, with horses, cattle, and pigs in the middle. At present this distribution cannot be easily explained.

The second pattern of association shows the sites' position in relation to the species. Factor 1 indicates that most of the sites are positively associated with sheep/goat, cattle, horse, and dog, and only a few with pig. All of the sites have high percentages of cattle; variability seems to depend on the relationship between percentages of sheep/goat *versus* pig. The majority of sites have higher percentages of the former whereas a few sites have higher percentages of the latter. Divici, on the other hand, has a high percentage of pig remains. This settlement is located in the west Danube Valley, and the swampy and forested environment in this area seems to have been more favorable for pigs than for cattle and caprovines. The distribution of sites along Factor 2 is again fairly compact, but the fact that Cîrlomănești is associated with sheep/goat and Divici is associated with pigs may mean that factor 2 is indicating some influence of altitude or environmental zone. The settlement of Cîrlomănești is located in the sub-Carpathian area, at an altitude of 200m, while Divici is located at lower altitude.

A similar analysis was conducted by adding the wild species and performing the necessary percentage calculations. The chi-square value obtained is significant (see Table 5). The first two factors of variation account for more than 80% of the variability (see Table 3), and the variable coordinates (see Table 4) are plotted in Figure 3. Factor 1 tends to oppose wild animals from domestic ones, particularly cattle, sheep/goat, and horse. The distribution of assemblages along Factor 1 shows a majority exhibiting high proportions of cattle, sheep/goat, and horse. However, a substantial minority exhibits increased proportions of pig and wild animals. The distribution of sites and species on Factor 2 seems to mirror their distribution along Factor 1 in Figure 2. This distribution is assumed to result from the same underlying causes.

The general patterns observed on Figure 2 are the opposition between pig and the other domestic animals, as well as the opposition between sheep/goat and dog, which may suggest that dogs were not used for herding flocks and that that may have had another usage. Possible other options include hunting, food, and pets. As noted earlier the separation of pigs from other domesticates may rest on the degree of mobility or tendency of herding.

The larger picture in Figure 3 shows the relationships between all mammals, rather than simply the domestic ones. The strong clustering of large domesticates and the majority of sites, as noted above, indicate a heavy reliance on these taxa in the most cases. However, there is an interesting minority of assemblages that exhibit an increased emphasis on dogs, pigs and wild animals. Assemblages in the upper right quadrant show increased emphasis on dogs and/or wild animals, possibly suggesting heavier reliance on hunting. The lower right quadrant shows only one assemblage (Divici) with an emphasis on pig and wild animals. The adaptation suggested by this mixed emphasis is infrequent.

It seems that in Muntenia the majority of sites were more oriented toward animal husbandry than hunting, although some showed an increased emphasis on hunting. In Banat and Transylvania hunting and raising pigs seems to be an important part

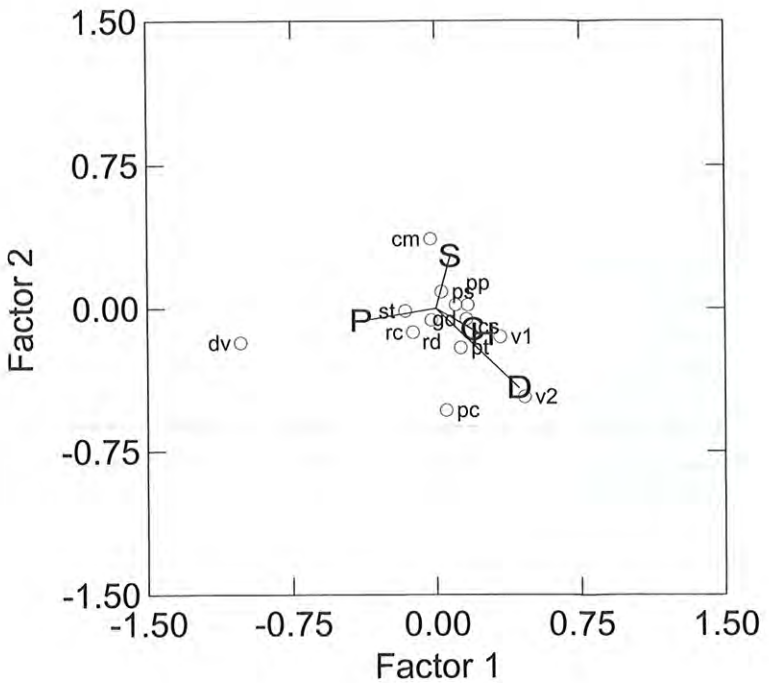


FIGURE 2

Plot of domestic species and sites. Legend: C = cattle; D = dog; H = horse; P = pig; S = sheep/goat; cs = Căscioarele; cm = Cîrlomăneşti; dv = Divici; gd = Grădiştea; pc = Pecica; pt = Piatra Şoimului; ps = Piscu Crăsani; pp = Popeşti; rc = Răcătău; rd = Radovanu; st = Stenca Liubcovei; v1 = Vlădiceasca 1; v2 = Vlădiceasca 2.

of the adaptive strategy. It may be that these areas had better wild game resources, or it may be that the area was less suitable for domestic animals. However, in rare cases wild animals and pigs were important components of the adaptive strategy. Cattle, horses, and dogs are symbols of wealth, and differences in social status may also account for regional variability.

2. MORPHOLOGICAL AND BIOMETRICAL CHARACTERISTICS:

• Cattle (*Bos taurus)*

The morphological characteristics of the few cranium fragments available show the presence of two cattle morphotypes, *primigenius* (i.e. broad and straight frontal ridge, flat and even front) and *brachyceros* (i.e. narrow and wavy frontal ridge hollowed in the middle, narrow and relatively long front). Most of the horn cores are short and thin, characteristic of the *brachyceros* type, and some, very rare, have the features of the *primigenius* type, i.e. they are long and thick. Some of these morphological characteristics were resulting from sexual dimorphism and castration. Today, Spanish cattle kept for bullfights and Scottish cattle may be considered as representatives of the *primigenius* type. As for the *brachyceros* type, the cattle of the brown group are the best-known representatives (Bökönyi, 1974). The Geto-Dacians' cattle were morphologically heterogeneous and, according to Haimovici (1987), they seem to be more similar in terms of form and size to those from the north-Pontic regions, and especially to those from the fortress of Olbia.

A special characteristic of the cattle found in some of the Geto-Dacian settlements is the presence of hornless individuals. Arerander (1896, cited in Bökönyi, 1974) described the *akeratos* type, and he suggested that these cattle become more numerous to the north, due to the cold. Nine

Site/Species	Cattle	Sheep/Goat	Pig	Horse	Dog
Cascioarele	0.698	0.795	-1.958	-0.08	1.603
Cirlomanesti	-7.950	15.533	-2.636	-5.169	-5.256
Divici	-13.854	-9.824	29.273	-6.378	-4.13
Gradistea	5.809	-1.898	-5.655	3.499	-2.378
Pecica	-3.079	-4.672	1.994	5.527	14.985
Piatra Soimului	7.994	-5.156	-2.217	-2.969	-2.574
Piscu Crasani	-4.829	7.004	-3.051	2.954	1.887
Popesti	1.173	1.383	-3.766	2.133	0.673
Racatau	2.766	-6.143	4.739	-1.748	-4.506
Radovanu	1.952	-4.24	1.919	1.285	-2.076
Stenca Liubcovei	0.624	-1.283	3.128	-4.779	-2.318
Vladiceasca 1	8.133	-1.909	-9.66	-1.341	10.788
Vladiceasca 2	8.581	-7.279	-6.391	6.497	3.846
Chi-square = 2849.720 Degrees of freedom = 48 Probability = 0.000					

TABLE 2
Standard residuals for domestic species.

	Domestic		Domestic + Wild	
Factor	Eigenvalue	Percent	Eigenvalue	Percent
1	0.064	55.880	0.100	58.580
2	0.031	26.470	0.041	24.170
3	0.016	14.040	0.016	9.660
4	0.004	3.610	0.011	6.280
5			0.002	1.310

TABLE 3
Factors of variability.

hornless individuals have been found in the Geto-Dacian settlements from Romania. According to Haimovici & Beleniuc (1983) and Haimovici (1987) this apparently high representation of hornless individuals seems to support the presence of a hornless breed instead of a non-transmissible variation. Haimovici (1987) also argues that this type, probably raised by the Geto-Dacians, coexisted with the horned type, and was not genetically bundled with the larger hornless type raised by the Scythians from the North-Pontic regions. Today, some breeds of hornless cattle are kept in Scotland, Scandinavia and Northern Russia (Haimovici, 1967). Greek historians, such as Herodotos and Strabo, also mention the hornless type of cattle, in the 5th century B.C. They suggest that hornlessness is either due to the low temperatures in the Nordic regions or even to a removal of the horns because of their sensitivity to freezing. Claudius Aelianus notes the presence of this breed in Moesia, and he argues that this phenomenon has no external cause and that these individuals appear only sporadically

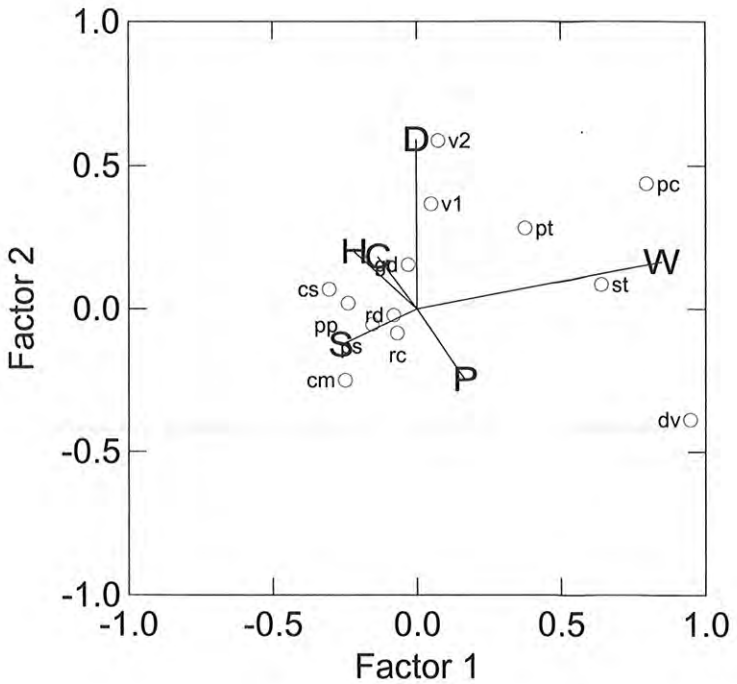


FIGURE 3

Plot of domestic species, wild species and sites. Legend: C = cattle; D = dog; H = horse; P = pig; S = sheep/goat; W = wild; cs = Căscioarele; cm = Cîrlomănești; dv = Divici; gd = Grădiștea; pc = Pecica; pt = Piatra Șoimului; ps = Piscu Crăsani; pp = Popești; rc = Răcătău; rd = Radovanu; st = Stenca Liubcovei; v1 = Vlădicească 1; v2 = Vlădicească 2.

amongst the cattle population (Haimovici, 1987). According to Rütimeyer (1865) and David (1897), the hornless cattle are not an independent type but a variant of other types. This opinion is well supported by the fact that hornless individuals can be bred through selection.

The withers height estimated on the basis of the metapodials (Table 6) shows great variability within the cattle population. The lowest withers height value is 98.6 cm at Zimnicea, while the highest is 125.7 cm at Popești. The mean value for the entire country is 112.5 cm (Zalkin coefficient). In Moldova, the average is 113.1 cm, while in Muntenia 112.8 cm. The average withers height for Europe in general, is 111 cm (Audoin-Rouzeau, 1991a).

• Sheep/Goat (*Ovis aries/Capra hircus*)

The skeletons of these two species are similar in many aspects and, except for the metapodials, horns, phalanges, and some parts of the cranium, could not be separated easily. For this reason many remains are included within the *Ovis-Capra* group. Both sheep and goat were found in the Geto-Dacian settlements. Usually sheep are more numerous than goats (Udrescu, 1985a; Haimovici, 1987). Even if the cranial remains were fragmentary they could reveal some of the morphological characteristic for both species. As Haimovici (1987) notes, male goats had very strong horn cores, twisted and turning outwards, which are characteristic of the "prisca" type. The she-goats had a straighter line on their horn cores and were only slightly twisted. The twisted horns became more frequent beginning in Neolithic times (Bökönyi, 1974).

As for sheep, the cranial fragments show moderate sized horns in males, triangular in section at their base. Females are generally hornless or they have very short horns, usually resembling goats. Horns with typical morphological characteristics resulting from castration have not been found

	Domestic		Domestic + Wild	
Species	Factor 1	Factor 2	Factor 1	Factor 2
Cattle	0.189	-0.111	-0.136	0.181
Sheep/Goat	0.075	0.273	-0.265	-0.126
Pig	-0.391	-0.065	0.168	-0.249
Horse	0.241	-0.139	-0.218	0.199
Dog	0.430	-0.419	-0.002	0.590
Wild			0.849	0.163
Sites				
Cascioarele	0.166	0.018	-0.305	0.069
Cirlomanesti	-0.026	0.364	-0.250	-0.250
Divici	-1.016	-0.179	0.948	-0.388
Gradistea	0.159	-0.056	-0.030	0.154
Pecica	0.052	-0.535	0.798	0.437
Piatra Soimului	0.128	-0.206	0.376	0.282
Piscu Crasani	0.030	0.087	-0.156	-0.054
Popesti	0.103	0.019	-0.240	0.020
Racatau	-0.118	-0.125	-0.069	-0.085
Radovanu	-0.023	-0.061	-0.081	-0.022
Stenca Liubcove	-0.158	-0.013	0.642	0.085
Vladiceasca 1	0.334	-0.150	0.050	0.366
Vladiceasca 2	0.459	-0.466	0.075	0.587

TABLE 4
Variable coordinates.

Site/Species	Cattle	Sheep/Goa	Pig	Horse	Dog	Wild
Cascioarele	1.457	1.453	-1.405	0.181	1.833	-3.738
Cirlomanesti	-6.306	17.609	-1.075	-4.641	-4.995	-9.639
Divici	-17.288	-12.996	21.531	-7.469	-4.773	25.738
Gradistea	5.506	-2.123	-5.866	3.382	-2.427	1.403
Pecica	-5.699	-6.632	-0.936	3.654	12.228	15.604
Piatra Soimului	4.925	-6.910	-4.223	-3.656	-2.940	12.740
Piscu Crasani	-2.771	9.010	-1.233	3.804	2.410	-11.081
Popesti	2.986	2.947	-2.351	2.850	1.090	-9.079
Racatau	4.245	-5.112	6.092	-1.287	-4.319	-7.183
Radovanu	3.579	-2.963	3.340	1.189	-1.762	-8.137
Stenca Luibcovei	-3.294	-4.426	-0.584	-5.622	-2.905	19.697
Vladiceasca 1	6.683	-2.930	-10.507	-1.761	10.242	6.391
Vladiceasca 2	7.573	-7.737	-6.885	6.037	3.568	3.945

Chi-square = 4640.402
Degrees of freedom = 60
Probability = 0.000

TABLE 5
Standard residuals for domestic and wild species.

Site/Region	Chronology	Site type	Species							
			Bos taurus		Ovis aries		Capra hircus		Equus caballus	
			Var	X	Var	X	Var	X	Var	X
Moldova										
Lozna	III-II B.C.	S	111.4-124.4	115.3	-	-	-	-	-	-
Lunca										
Ciurei	III-II B.C.	S	-	121.7	-	63.1	-	-	-	140.7
Bitca										
Doamnei	II B.C.-I A.D.	S	-	110	-	-	-	-	-	-
Piatra										
Soimului	I B.C.-I A.D.	S	105.1-107.0	105.8	51.8-59.8	57.1	54		-	-
Brad	IV B.C.-I A.D.	S	103.4-126.0	111.6	50.0-73.5	60.6	60.9-66.2	62.7	126.3-144.8	133.8
Racatau		S	-	110	-	62	-	67.2	-	133
Floresti	I B.C.-I A.D.	S	-	110	-	-	-	-	-	-
Muntenia										
Gradistea	II-I B.C.	S	103.4-124.0	110.1	56.3-61.1	59.2	62.7-67.3	65	-	130.1
Cascioarele	IV-I B.C.	S	105.6-121	113.6	-	68.7	-	-	-	-
Cirlomanesti	II-I B.C.	S	103.5-125.1	113.9	52.0-67.9	60.5	60.8-68.4	63.3	-	-
Radovanu	II-I B.C.	S	104.1-124.6	113.6	52.6-63.9	59.7	64.7-68.4	66.1	128.2-132.7	130.9
Popesti	II-I B.C.	S	104.6-125.7	115.8	53.8-65.2	58.2	62.1-65.0	63.3	130.8-138.0	135
Piscu										
Crasani	II-I B.C.	S	103.2-130.1	114.7	50.9-70.2	60.2	58.6-71.9	65.6	125.0-137.0	132.6
Zimnicea	IV-I B.C.	S	98.6-122.4	110.2	51.4-64.1	58	58.7-67.2	62.6	128.2-141.7	132.8
Margaritesti	III-I B.C.	S	109.8-117.1	114.6	-	-	-	-	136.5-139.1	137.8
Vladiceasca 1	II-I B.C.	S	107.0-130.4	116.7	53.6-65.2	57.4	69.6-73.0	71.3	134.9-139.9	137.4
Vladiceasca 2	III-I B.C.	S	101.4-108.4	104.9	67.1-73.8	70.4	-	-	138.3-140.2	-
Catunu	II-I B.C.	S	-	-	-	-	-	-	130.3-140.3	135.3
Zimnicea	IV-II B.C.	N	-	-	-	-	-	-	129.5-145.6	136.7
Peretu	IV-III B.C.	T	-	-	-	-	-	-	-	131.6
Dobrogea										
Agighiol	IV B.C.	T	-	-	-	-	-	-	132.4-145.9	139.1
Banat										
Stenca										
Liubcovei	III B.C. - I A.D.	S	-	-	-	62.7	59.8-64.4	61.62	-	-
Transylvania										
Pecica	La Tene	S	103.6-110.4	106.9	-	-	-	-	-	-
S= settlement; N= necropolis; T= tomb										

TABLE 6
Withers height values for the main domestic species.

(Haimovici, 1987). The earliest hornless sheep seem to have emerged around 7500 B.C. in South West Asia and spread into South East and Central Europe in the middle Neolithic. They become common from the Bronze Age onwards, and today they are most frequent in both sexes of domestic sheep (Bökönyi, 1974). Chaix (1977) argues that the first hornless sheep date from Early Bronze Age. The analyses in Hungary show that the earliest hornless sheep was found in Southern Hungary around 5000 B.C (Bökönyi, 1974).

At Răcătău (Haimovici, 1985), a fragment of a male cranium was found with four horns: two anterior and two posterior. The author suggests the magic or ritual functionality of this piece, arguing that this phenomenon was extremely rare and that the primitive populations were not accustomed to it. Four-hornedness is an anomaly characteristic of domestic ruminants, and some authors believe that it is caused by domestication (Bökönyi, 1974). Krysiak (1937) notes that multi-hornedness occurs more frequently in caprovinae and rarely in bovinae kept under similar conditions, and he suggests that this may be independent of the domestication process.

The average sheep withers height value is 61.5 cm, with the lowest value at Piscu Crasani and the highest at Cîrlomănești (see Table 6). During Iron Age in Europe the mean withers height was of 60.3 cm, ranging between 55 and 65 cm (Audoin-

Rouzeau, 1991b). According to Bökönyi (1974), in Eastern Europe the average withers height for sheep was 60 cm. During the Bronze Age in Romania sheep were bigger than in the Neolithic or Iron Age, and their withers height was almost 65 cm (Haimovici, 1968). The average goat withers height value in Romanian La Tène is 64.87 cm, ranging from 58.6 cm at Piscu Crăsani to 73 cm at Vlădiceasca 1 (see Table 6).

• Pig (*Sus domesticus*)

The pig assemblages are generally highly fragmented, making morphological analysis difficult. During La Tène in Romania, as well as elsewhere in contemporary Europe, the pig still had the long snout characteristic of its wild ancestor. Pig size was also generally small, withers height reaching only 70 cm. The calculation of the withers height is theoretical because it usually reflects the tall withers, which is a characteristic that has been inherited from the wild swine, and not the real size of the animal. Therefore, pig withers height is not expected to account for a better husbandry practice. Withers height is by itself an approximate value of a biological parameter and represents one of the aspects of the variation within the domestic forms (Udrescu *et al.*, 1999). It is, however, generally agreed that the metrical data are most important for a biometrical analysis. Therefore, the differences between the dimensional variations should be interpreted with prudence because of the disparities in withers height that appear when measuring different bones (Weinstock, 1993; Forest, 1998). The withers height obtained from the measurements taken on metapodials show lower values than those obtained on other bones, with 7% in average (Forest, 1998). In a recent attempt to subsume both zootechnical and archaeozoological data, Forest (1998) asserts that pig withers height value is imprecise and that this value does not prove to be efficient for an accurate analysis of inter-specific variations. The measurements taken on dentition and long bones show that during the Bronze Age in Romania pig was more massive than the *palustris* type from the Neolithic and was similar in size to that from the Oriental regions (Haimovici, 1968). During La Tène, the withers height began to decrease again. A similar size pig was found in the Celtic settlements from Bavaria (Boessneck *et al.*, 1971). The decrease in size may be a consequence of the expansion of agriculture, to the detriment of forest areas, to which pig is well adapted.

• Horse (*Equus caballus*)

Horse was an important species for the Geto-Dacians and it was probably the only species that was given special care. They were buried in the necropolis from Zimnicea (400-200 c. B.C.). They were also found in high status tombs, at Peretu (400-300 B.C.) and Agighiol (400 B.C.).

Bökönyi (1968), in his study of Iron Age horses, distinguished two groups of horses in Europe. The first group (Oriental) encompassed medium sized horses from the eastern part of Central Europe and from Eastern Europe, with broad foreheads, long skulls and short facial parts. Their mean withers height value is 136-137 cm, and it ranges from 121.9 to 149.4 cm. This group included Scythian and Russian horses of South Russia, the Kurgan horses of Altai, the Hallstatt horses from Slovenia, the Thracian horses from Bulgaria and the early Iron Age horses from Romania. The second group (Occidental) was comprised of smaller size horses, with a mean withers height of 126-126 cm, and a range of 109.9 and 149.4 cm. These horses had narrower foreheads and relatively long facial parts. The group was represented by the Hallstatt horses from Austria and Germany, as well as by the Celtic horses from Germany and Switzerland. Eastern (steppe) horses had thicker bone extremities than the western (mountain and forest) group.

The exhumation of 12 individuals, each of them buried in a separate pit, at the necropolis from Zimnicea in Muntenia, was of major importance in describing the morphological characteristics of the Geto-Dacians horses. According to Haimovici (1983), the Geto-Dacians horses were divided in two groups. The first one included the "ordinary" horses that had a large head, with the facial part and the snout moderately long. Its limbs were well proportioned, and the distal part large. They had a small overall size, but were larger than the Occidental group. This type of horse was probably used for traction and agriculture and maybe even for riding. Even though these horses were mainly found in settlements, one individual was found in the high status tomb from Agighiol in Dobrogea (Bolomey, 1968); its withers height was 132.4 cm. The second group, so-called "elite", was represen-

ted by larger individuals, which were probably used only by the aristocratic class. Their withers height was about 140 cm or even higher, but they did not reach the 150 cm size of the Scythian or Kurgan horses (Haimovici, 1983). According to Haimovici (1983), the "elite" horses had long limbs due to the elongation of the proximal part of their legs (while modern riding horses have the distal part very long), and this has substantially contributed to increase their withers height. Their withers were tall and their croup relatively low. Their head was smaller in comparison to the "ordinary" type, their neck was long and their limbs were longer and more slender. The "elite" type was, however, rare. Its presence is also confirmed by the artistic representation on the silver helmet found in the princely tomb from Agighiol, which displayed a horse with long limbs, low croup, tall withers, medium size head, and short mane. The above-mentioned groups are not exclusive, because intermediate forms are present and reflect the heterogeneous character of the horses kept by the Geto-Dacians. As for the origin of the "elite" horses, both Haimovici and Bolomey agree that they were not imported from the Scythians and that these tall size individuals could be obtained by improving the local stock of animals because by the end of the Bronze Age in Romania an indigenous stock of tall horses, around 140 cm, was present (Haimovici, 1987). Through breeding, high quality forage and use of castration, this indigenous stock could have resulted in the tallest size individuals during the Iron Age. According to Haimovici (1983), the high frequency of castrate animals found among the horse fauna, and the fact that castrating individuals younger than two years of age can improve the withers height by 4 to 6 cm supports this hypothesis. The average withers height value obtained for Romania is of 134.7 cm, with a minimum of 125 cm at Piscu Crăsani, and a maximum of 145.6 cm for one of the horses found at the necropolis of Zimnicea (see Table 6). The mean withers height in Europe during Iron Age is 127.89 cm, ranging between 121 and 132.9 cm (Audoin-Rouzeau, 1991c).

Bökönyi (1974) notes that the Hellenistic kingdom and Rome imported tall horses from the Scythians to improve their military power. However, since trade between these states and Dacia is well documented for the Iron Age, it seems more efficient to import these specimens from the closer source.

• Dog (*Canis familiaris*)

Morphological features seem to show the beginning of different dog breeds during the La Tène period. However, the number of complete skulls is extremely low, and a conclusion in this respect is premature. The basal length of the cranium calculated with the Dahr coefficient, and the withers height values, generally show the presence of all sizes of dogs, from small to large. The preponderant category is that of medium size dogs, with a basal length between 160-180 mm and withers height between 50-60 cm (Haimovici, 1987). The average withers height values vary between 48.4 and 66.3 cm in the Geto-Dacian region (Udrescu, 1990). At Radovanu, the average withers height value was 59.5 cm, while at Piscu Crăsani it was 57.4 cm. At Grădiștea the average withers height value was 52.3 cm, while at Pecica, the basal length obtained for two individuals was 156 and 187 mm. A question related to the size of dogs during La Tène is whether the small sized dogs were present before the Roman conquest. One small individual with a cranial basal length of only 131.5 mm was found at Piscu Crăsani. An even smaller individual was found at Stenca Liubcovei where a basal length of 127.1 mm was obtained. Small individuals were also found in the high status tomb from Peretu. Dwarf dogs, of 23-25 cm withers height, are mainly known from the Roman period (Bökönyi, 1974), and some individuals have been found in the Celtic *oppidum* at Manching (Boessneck *et al.*, 1971). Thus, small size dogs are present during the Geto-Dacian period, but they seem to have been rare.

As for the use of this species for food, the presence of burnt bones amongst culinary refuse seems to favor this possibility (Hriscu *et al.*, 2000). Bökönyi (1974) notes that "The brain seems to have been a favorite delicacy for prehistoric man, for Neolithic and Bronze Age dog skulls have often been found whose brain case was opened with a cut along the medial plane or by cutting off the os occipitale; sometimes holes were made on the side of the skull so that the brain could be removed". At Manching, dog was eaten (Boessneck *et al.*, 1971) and in Gaul (600-100 B.C.), there is no doubt that dog meat was eaten and that dog was butchered (Meniel, 1987). In Germany slaughtering of dogs for meat was forbidden only in 1986 (Geppert, 1990). In Romania, the low percentage of dog remains shows that, even if the species was eaten, this happened only occasionally.

Primarily, dogs were used for hunting, companionship, to tend flocks and to guard dwellings.

3. BUTCHERY: The study of butchery has continued to be an important topic because of its major contribution in distinguishing several aspects of human-animal interactions. Butchering animal carcasses is a significant taphonomic factor in the formation of humanly created assemblages. It is important to deduce not only how humans reduce animal carcasses into consumable parts but also how those behaviors are reflected archaeologically. Butchery analyses provide information about the resources exploited by people and the manner in which these resources were exploited. Butchery is also related to transport processes and can reveal practices such as abandonment, transport, and different uses of the bones. The type of butchery mark can also reveal interesting information about the butchery stages such as kill-butchery stage, secondary butchery stage, and final butchery-consumption stage, and thus, to the type of site. According to Binford (1978: 48), "butchering is not a single act but a series of acts beginning when the animal is killed and continuing at varying junctures until the animal is totally consumed and discarded." Lyman (1987) has termed the activities involved in butchering as *butchering process* or *butchery technique* and the result of the process as *butchering pattern.*

Few analyses on butchery processes and patterns have been done in Romania; however, some analyses for the settlements in Muntenia (Udrescu, 1985b) show different types of cut marks that seem to suggest two types of cutting tools on some of the remains. Some cuts were fine, probably from filleting and meat detachment, and some cuts were heavy, probably from dismemberment. The fine type of cut marks is most frequently encountered, but the second type constantly appears on all bones. Besides these sorts of traces, many breakages done with cutting tools and other heavy tools have been noted. These breakages were probably done in order to extract the marrow inside the bones and probably to facilitate carcass portioning. The breakages were more frequent on humerus, radius, femur and tibia; these bones were found more fragmented than other parts of the body that have a low-meat quality (e.g. metapodials).

The head was detached from the body by repeated chopping in the atlas/axis region, a pattern seen consistently in all analyzed settlements. Most of the assemblages have preserved the odontoid process and a part of the vertebral centrum, and this operation was most evident in cattle.

There is no evidence for the methods of slaughter. It is possible that this was done in the most vulnerable zones of the body, instead of heavy blows on the head. Several blows for cattle and only one for sheep and goats achieved the detachment of the horns. For these species, as well as for pigs, the head was split in half for extracting the brain. The mandible was detached from the cranium by several blows about 3.5-5 cm below the condyle and the coronoid apophysis. The articular part of the mandible usually remained attached to the articulation and could be found during excavations. As part of this process, the tongue was probably detached as well. The detachment of the head from the body, of the mandible from the cranium, or of the tongue were probably accompanied by the removal of the horns and of the brain (Udrescu, 1985a, 1985b; Udrescu *et al,* 1999).

SOCIAL ORGANIZATION

One analysis of Romanian data was intended to provide information regarding social organization as deduced from the fauna found on the *acropole* at Răcătău (Hrișcu & Bejenaru, 1998). Most Romanian studies are concerned with high status tombs that belonged to tribal aristocracy members (e.g. Agighiol, Peretu). The study of the fauna from the *acropole* at Răcătău analyzes two houses and the sanctuary area, and provides comparative data with those obtained for the habitation site analyzed by Haimovici (1989). The small sample obtained from *acropole* and sanctuary area (1047 NISP) did not reveal significant information concerning the sacerdotal and/or aristocratic group that probably lived there. Dog remains were absent in the sanctuary area. The distribution of other species does not differ significantly from that obtained by Haimovici for the habitation site. Also, the distribution of skeletal elements does not bring insight into a specific "attitude" related to a "sacred" activity. It is possible that the animals were slaughtered outside the sanctuary area, that only small parts of the body were deposited, and that the part of the body selected to be deposited was not as significant as the selection of the animal to be sacrificed.

CONCLUSIONS

Animal husbandry was of great importance during La Tène in Romania. The domestic mammals raised by the Geto-Dacians were cattle, sheep, goats, pigs, horses, and dogs. The frequencies obtained for each species vary from one site to another, as well as from one region to another, mainly due to local environmental factors. Cattle were generally the most frequent species, similar to the general situation in Central and Eastern Europe in prehistoric times. This species was better adapted to the environment and more likely to be found because of the presence of its wild ancestor in the area, and it also had a multiple use (primary products, secondary products, and traction) in comparison to other domesticates. Most of the sites show more or less variation of the main domesticates. Some sites have increased emphasis on hunting, suggesting a larger contribution of the wild species to the diet while, in rare instances, there is notable reliance on raising pigs and hunting. Horse and dog remains have generally low representation among the domestic fauna. However, the horse had a special place if we consider the revolution it created in transport, trade and the development of warfare. Horse was also significant in people's imagination about the afterlife. This phenomenon is especially reflected by the practice of burying it. Dogs were of varied sizes, were apparently used in hunting, and were occasionally eaten.

Generally, the main domestic animals were of small size, primitive, with low productivity rates. It is possible that the cooler and more humid climate during the Iron Age contributed to their decrease in size, and/or the Geto-Dacians did not use rational techniques in order to improve the size and productivity of their domestic animals. Only horse was given special care and that led to the emergence of tall size individuals.

The patterns revealed in the present analysis raise some interesting questions for future research. Do these patterns show simply adaptations to local environmental conditions? What effect, if any, of the social environments is reflected in these assemblages? For example, does the differentiation seen amongst these assemblages reflect specialized production within a centralized economic system? Do these pattern reflect intensification of production in order to fulfill social obligations? What demographic models might account for the observed patterning? Are we looking at a number of different populations, each with its own adaptations, or are we looking at specialization within a single population? Further research will contribute to the interpretation of the data presented here.

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Des festins à l'entrée du temple? Sacrifices et consommation des animaux à l'époque géométrique dans le sanctuaire d'Apollon à Erétrie, Grèce

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RÉSUMÉ: Le site d'Erétrie (île d'Eubée, Grèce) a été occupé dès la fin du Néolithique, puis à l'Age du Bronze, aux périodes géométrique, archaïque, classique, hellénistique et paléo-chrétienne. Le contexte de l'étude archéozoologique dont il est ici question se réduit chronologiquement à la période géométrique et spatialement à un sondage au sud-est du temple d'Apollon Daphnéphoros, où des foyers ont été mis au jour. Les résultats de cette étude sont comparés à ceux obtenus pour les vestiges contemporains d'une aire sacrificielle fouillée au nord-est du même temple. L'analyse des restes osseux en relation avec les foyers au sud-est du temple montre que des carcasses de caprinés et dans un moindre mesure d'autres animaux domestiques, ont certainement été débités, cuisinés et probablement consommés à cet endroit. Par opposition, les vestiges découverts autour de l'autel de sacrifice sont des éléments anatomiques et spécifiques représentatifs d'offrandes. La fonction de ces deux zones fouillées semble donc à la fois différente et complémentaire.

MOTS-CLÉ: ARCHÉOZOOLOGIE, GRÈCE, ÉPOQUE GÉOMÉTRIQUE, CONSOMMATION D'ANIMAUX, SACRIFICES

ABSTRACT: The archaeological site of Eretria (Euboia, Greece) has been occupated since the late Neolithic period, then into Bronce Age, and Geometric, Archaïc, Classical, Hellenistic and Paleo-christian Periods.The context of the archaeozoological study which is discussed here is limited to Geometric Period and to a pit situated in the South-east of the sanctuary of Apollo Daphnephoros, where some fire-pits have been discovered. The archaeozoological results are compared to those obtained for a sacrificial and contemporary context excavated in the North-east of the sanctuary. The study of the bone remains related to the fire-pits shows that the carcass of caprines and some other domestic species were prepared, cooked and perhaps consumed at this site. On the contrary, the remains discovered around the sacrificial altar are typical offerings. The function of those two excavated pits seems both different and complementary.

KEY WORDS: ARCHAEOZOOLOGY, GREECE, GEOMETRIC PERIOD, ANIMAL CONSUMPTION, SACRIFICES

RESUMEN: El sitio de Eretría (isla de Eubea, Grecia) fué ocupado desde el final del Neolítico, luego en la Edad de Bronce, y durante los periodos Geométrico, Arcaico, Clásico, Helenístico y Paleocristiano. El contexto del análisis arqueozoológico que presentamos en este trabajo se reduce cronológicamente al periodo Geométrico y espacialmente a un "sondeo" ubicado en el sur-este del Templo de Apolo Dafnéforos, lugar en el cual se encontraron varios fogones. Los resultados de este análisis son comparados luego con los obtenidos de los vestigios óseos de un área de sacificios excavada en el noreste del mismo templo. El estudio de los restos óseos ligados a los fogones en el sur-este del templo muestran cuerpos de caprinos, y en menor cantidad de otros animales domésticos, que fueron probablemente descuartizados, cocidos y consumidos en este lugar. Por el contrario, los vestigios descubiertos alrededor del área de sacificios son elementos anatómicos específicos y representativos de ofrendas. La función de las dos áreas excavadas parece ser así a la vez diferente y complementaria.

PALABRAS CLAVE: ARQUEOZOOLOGÍA, GRECIA, PERIODO GEOMÉTRICO, CONSUMO DE ANIMALES, SACRIFICIOS

INTRODUCTION: SITE, MATÉRIEL ET OBJECTIFS

Erétrie se situe sur la côte ouest de l'île d'Eubée. Elle fait face à la Béotie et à l'Attique. Le site est séparé du continent par le Golfe euboïque. Il s'étend dans une riche plaine alluviale formée par un delta entre le bord de mer et l'acropole, colline rocheuse située à moins d'un kilomètre de la côte. Il est bordé par deux montagnes, le Voudochi au nord-ouest et l'Olympos au nord-est.

Le début de la chronologie érétrienne semble remonter à la fin du Néolithique, qui est attesté par de la céramique provenant d'une occupation de cette période dans la plaine. Des établissements de l'Age du Bronze lui succèdent, avec la présence de matériel de l'Helladique ancien et moyen dans la plaine et de l'Helladique moyen et récent sur l'acropole (Müller, 1985).

Mais la ville elle-même ne fut fondée qu'à la période géométrique, après un possible et épisodique vide d'occupation entre l'Helladique récent et l'arrivée de nouvelles populations au VIIIe s. av. J.-C. (Krause, 1985). Les premiers sanctuaires furent érigés à cette époque (Bérard, 1985; Krause, 1985): le temple d'Apollon Daphnéphoros (2e moitié du VIIIe s.) et, à une cinquantaine de mètres au nord-est, le sanctuaire d'une divinité féminine, peut-être Artémis (Krause, 1985), associé à une aire de sacrifices (Huber, à paraître). Le matériel osseux dont l'étude[1] est présentée ci-dessous provient de deux secteurs situés à proximité du temple d'Apollon Daphnéphoros et du second sanctuaire mentionné (Artémis?) (Figure 1).

SANCTUAIRE D'APOLLON DAPHNÉPHOROS

Le premier secteur se trouve à l'angle sud-est du temple d'Apollon Daphnéphoros, dont trois phases successives sont conservées. Deux sondages ont été effectués près de l'entrée du temple d'époque géométrique (Figure 1: 2) et à proximité de l'autel (Figure 1: 12) contemporain, à l'emplacement où les couches n'avaient pas été perturbées par des constructions au XIXe s. et lors des premières fouilles archéologiques[2]. Le premier sondage (81.11) a été ouvert par A. Altherr-Charon en 1981 à l'est de l'autel 12 (Altherr-Charon & Amstad, 1982) et le deuxième (91.7) par S. Huber en 1991 et 1992 (Huber, 1992, 1993).

Une importante stratigraphie a permis de mettre en évidence de nombreuses couches d'occupation en relation avec le sanctuaire, se succédant entre le début de l'époque géométrique et le VIe s. av. J.-C. Dans la couche géométrique, plusieurs phases de foyers associées à des sols d'occupation et intercalées par des remplissages ont été repérées (Huber, 1993). Au total, presque 1700 restes osseux ont été décrits par l'auteur en 1995 pour l'ensemble de la stratigraphie (Chenal-Velarde, 1995). Cependant, l'époque géométrique nous intéressant ici, nous nous attacherons uniquement à la couche lui correspondant, en prenant soin de respecter la répartition entre remplissages, sols et foyers et en détaillant chaque fois l'appartenance des os à chacune de ces unités.

SANCTUAIRE ATTRIBUÉ À UNE DIVINITÉ FÉMININE (ARTÉMIS?)

Le deuxième secteur étudié, au nord-est du temple, correspond à une aire sacrificielle fouillée par A. Altherr-Charon entre 1978 et 1981, puis par S. Huber en 1990. Les recherches menées dans cette zone ont permis de dégager des ensembles archéologiques s'échelonnant entre la fin du IXe s. et la fin du IVe s. av. J.-C. (Huber, 1991). En plus de divers vestiges architecturaux, dont une structure cylindrique interprétée comme autel de sacrifices, de nombreux restes de matériel votif (principalement céramique) et de grandes proportions de fragments osseux ont été récoltés dans cette zone de fouilles. Ce matériel osseux, provenant de l'ensemble de la stratigraphie (du géométrique à la période hellénistique), a été étudié par Jacqueline Studer et l'auteur en 1994 (Studer & Chenal-Velarde, 1994), sur la demande de S. Huber. Près de 2000 vestiges

[1] L'auteur tient à exprimer sa gratitude à Mme Sandrine Huber, qui a bien voulu lui confier cette étude, à l'Ecole suisse d'archéologie en Grèce et particulièrement à son directeur, M. Pierre Ducrey, pour leur soutien, enfin au Service archéologique grec et à l'Ephorie des antiquités préhistoriques et classiques d'Eubée, qui lui ont libéralement accordé les autorisations nécessaires.

[2] Les vestiges d'époque géométrique mis au jour dans le Sanctuaire d'Apollon Daphnéphoros feront l'objet d'une publication préparée par C. Bérard, S. Huber et S. Verdan.

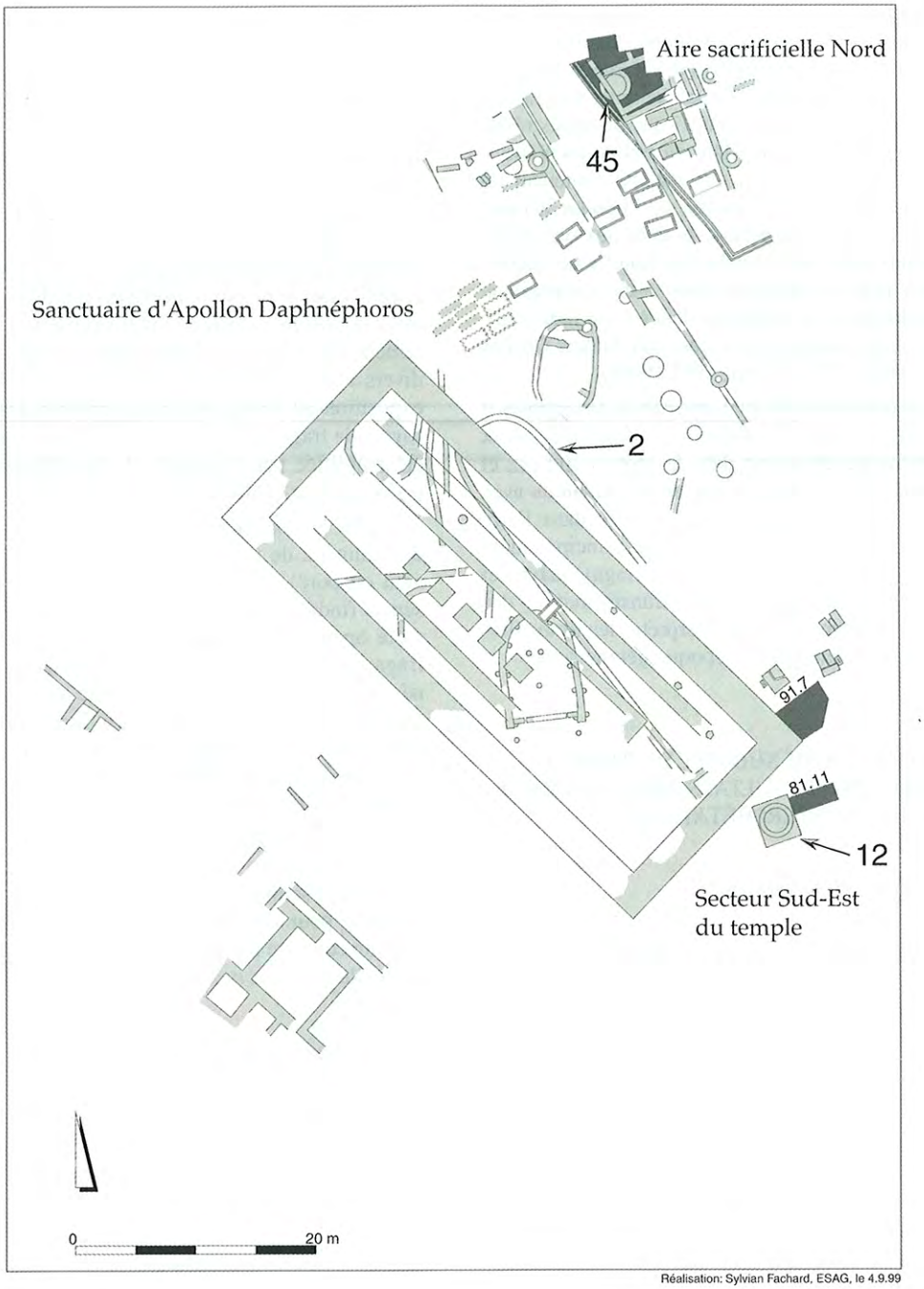


FIGURE 1

Le temple d'Apollon Daphnéphoros et la situation des deux zones de fouilles étudiées: le sondage au sud-est (91.7) et l'aire de sacrifices au nord est (92.2). Sont entre autres représentés le temple d'époque géométrique (2), un autel (12) et une aire de sacrifice (45) contemporains (dessin ESAG).

osseux ont été décrits à cette occasion. La publication de l'étude archéozoologique détaillée de cet ensemble est en cours (Chenal-Velarde & Studer, à paraître a; Studer & Chenal-Velarde, à paraître). Nous n'en utiliserons donc ici que quelques résultats ponctuels. L'autel, daté du milieu du VIIIe s. av. J.-C., est associé à une couche contenant du matériel céramique et osseux de l'époque géométrique. C'est à cette période et donc aux ossements contenus dans cette couche que nous nous intéresserons pour la présente étude archéozoologique, étant donné qu'ils correspondent à la période d'utilisation de l'autel de sacrifices (voir Altherr-Charon & Amstad, 1982 ; Huber, 1991, 1998).

Les objectifs sont ici d'une part la description et les interprétations relatives au matériel osseux géométrique découvert dans le secteur sud-est, et d'autre part la comparaison de ces résultats avec ceux obtenus pour la même période dans l'aire sacrificielle. Nous étudierons donc principalement les problèmes de répartition, de fragmentation et de facteurs anthropiques de transformation des ossements, dans le but d'interpréter les trouvailles des deux secteurs pour l'époque géométrique.

LE SECTEUR AU SUD-EST DU TEMPLE D'APOLLON: RÉSULTATS ARCHÉOZOOLOGIQUES ET INTERPRÉTATIONS

Remarques préliminaires

Nous devons tout d'abord rappeler que la limitation de l'étude à un secteur de fouille relativement réduit oblige à ne considérer le matériel issu de ces recherches de terrain que comme un échantillon. Les totaux donnés ci-dessous auront ainsi plutôt une valeur comparative entre les espèces, les parties anatomiques, et avec l'aire sacrificielle. Pour les mêmes raisons, nous n'aborderons pas ici d'analyse ostéométrique, l'échantillon mesurable étant beaucoup trop faible. Enfin, avant toute description des ossements, il est préalablement nécessaire d'indiquer que les mollusques (marins et terrestres) n'ont pas été inclus. Ils feront l'objet d'une étude ultérieure.

La forte fragmentation des restes osseux dans ce secteur a rendu leur détermination relativement difficile. Ainsi, le poids moyen de chaque fragment peut être estimé à moins de 1 gramme (0.9 exactement), ce qui explique le nombre important d'esquilles qui n'ont pu être attribuées à une espèce et/ou à une partie anatomique. En ne considérant que les ossements déterminés, la fragmentation est plus caractéristique des conditions de conservation dans chacune des trois couches: dans le remplissage, le poids moyen des fragments s'élève à 3.8 g, alors que sur le sol il est de 2.4 g et seulement de 1 g dans les foyers. Ces constatations sont significatives des conditions de dépôt et de traitement post-dépositionnel des os. Ainsi, dans le remplissage, le recouvrement plus rapide du matériel a permis de réduire le fractionnement, contrairement aux sols où le piétinement et l'exposition à divers autres facteurs de destruction (carnivores, exposition au soleil, etc) l'a augmenté. Dans les foyers, la fragmentation des restes a probablement été amplifiée par l'intensité de la chaleur, qui a provoqué leur éclatement.

Parmi les os indéterminés, ceux représentant des animaux de taille moyenne (taille petit ruminant ou porc) ont été considérés dans un groupe séparé (indéterminés de taille moyenne). Ce choix a été opéré à cause de la très grande quantité de fragments appartenant probablement à des caprinés (moutons et chèvres), mais ne pouvant leur être attribués avec certitude. Ainsi, le nombre d'indéterminés de taille moyenne pourra être utilisé plus loin de manière à réajuster celui des restes de caprinés, sous-estimé à cause de la fragmentation.

La détermination du nombre d'individus sur un secteur de fouilles aussi restreint que celui étudié ici ne nous semble pas utile. Il serait valable uniquement pour une surface plus représentative ou dans un contexte fermé, ce qui n'est pas le cas dans la fouille qui nous occupe.

Spectre faunique de la couche géométrique

Le spectre faunique dévoilé par la Tableau 1 révèle une absence totale d'espèces sauvages parmi les restes déterminés, qu'elles soient issues de la chasse ou de la pêche.

• Les caprinés (mouton et chèvre):

Les caprinés sont de loin les animaux domestiques les plus représentés. Ils totalisent à eux seuls plus de 80 % des restes déterminés. Malheureusement, seuls deux restes ont pu être identifiés comme ayant appartenu au mouton (*Ovis aries*): il s'agit de deux fragments de cheville osseuse d'animaux adultes. Aucune chèvre n'a été reconnue,

	Total		Remplissage		Sols		Foyers	
	NR	Poids	NR	Poids	NR	Poids	NR	Poids
mouton (*Ovis aries*)	2	21.0	1	20.0	0	0	1	1.0
caprinés	79	125.0	40	69.7	9	22.0	30	33.3
porc (*Sus domesticus*)	10	48.7	8	46.5	1	2.0	1	0.2
boeuf (*Bos taurus*)	3	53.2	3	53.2	0	0	0	0
chien (*Canis familiaris*)	5	21.3	3	20.9	0	0	2	0.4
équidés	1	2.2	1	2.2	0	0	0	0
total déterminés	100	271.4	56	212.5	10	24.0	34	34.7
indéterminés taille moyenne	428	333.3	257	210.4	25	33.8	146	89.1
indéterminés	212	78.1	58	33.8	24	11.0	130	33.3
total	740	682.8	371	456.7	59	68.8	310	157.3

TABLEAU 1

Répartition des vestiges osseux du secteur sud-est par espèce, en nombre de restes (NR) et en poids (en grammes), pour la couche géométrique.

mais cela ne signifie pas pour autant que cette espèce ne figure pas parmi les ossements de caprinés.

Cependant, les "indéterminés de taille moyenne" devant permettre de se faire une idée plus correcte des quantités réelles de restes de caprinés, nous pouvons admettre que les proportions de ces derniers sont supérieures à 81%. La fréquence des ossements de caprinés est équivalente dans les trois couches: elle avoisine pour chacune d'entre elles 80 % des restes déterminés.

L'âge des individus n'a pu être attribué qu'à partir de très peu d'ossements. Il n'est donc pas possible d'en déduire une courbe d'abattage des membres de la population de caprinés. Pourtant, une 4e prémolaire inférieure non usée atteste d'un individu de moins de 2 ans, alors que deux troisièmes molaires inférieures droites, toutes deux bien usées, ont appartenu à deux bêtes dont la mort est probablement survenue à au moins 8 ans (Habermehl, 1975).

• Le porc (*Sus domesticus*):

Nettement moins bien représenté que les caprinés (10 % des restes déterminés), le cochon domestique a néanmoins été consommé.

Une canine supérieure et une inférieure attestent d'au moins une femelle adulte, et une mandibule portant une dent déciduale et une première molaire appartenaient à un individu d'environ 6-8 mois (Habermehl, 1975).

Un fragment de tibia provenant d'un foyer ne portait aucune trace de feu. Cet élément est probablement intrusif et son dépôt dans le foyer est certainement postérieur à l'utilisation de la structure.

• Le boeuf (*Bos taurus*):

Encore plus rare que le porc dans ce secteur, le boeuf ne représente que 3% des restes déterminés. Il est de plus complètement absent des sols occupés à l'époque géométrique et ne figure que dans le remplissage des couches.

• Le chien (*Canis familiaris*):

Totalisant 5% des restes déterminés, le chien est représenté par des éléments variés du squelette: une mandibule sans dents, une vertèbre cervicale et un métacarpien dans le remplissage, et deux prémolaires dans un foyer. Ces deux derniers éléments, une deuxième et une troisième prémolaires inférieures gauches, appartenaient sans aucun doute au même individu, âgé d'au moins 6 mois. Leur situation dans un foyer est pour le moins étonnante, et peut-être due au hasard, mais il est intéressant de remarquer qu'elles ont apparemment séjourné dans le feu, puisque leurs racines ont été blanchies par les flammes.

• Les équidés (cheval et âne, *Equus* sp.):

L'unique vestige d'équidé identifié est un fragment de diaphyse de métapode, dont l'espèce pré-

cise n'a pu être déterminée. Ce reste provenant du remplissage ne portait en outre aucune trace prouvant la consommation de l'animal.

Répartition par parties anatomiques

Dans le but d'observer d'éventuelles différences de représentation des os du squelette pour les espèces identifiées, les vestiges de chacun de ces os ont été comptabilisés par espèce. Cependant, certains ossements ont été regroupés par partie du corps: la tête, comprenant le crâne, les demi-mandibules et les dents, la colonne vertébrale et les côtes, la ceinture scapulaire et la ceinture pelvienne comprenant respectivement les deux omoplates et les deux demi-bassins, et les extrémités de membres, comprenant les carpiens, les tarsiens et les phalanges. De même, les espèces les moins représentées ont été regroupées, parallèlement aux caprinés, car leur nombre de restes respectif est trop faible pour en tirer des conclusions.

Le Tableau 2 montre dès la première approche que toutes les parties du squelette sont présentes parmi les vestiges.

Si certaines sont plus abondantes que d'autres, les causes en sont peut-être des facteurs de conservation différentielle ou la représentativité dans le squelette. Ainsi, les restes de métapodes (métacarpiens et métatarsiens indifférenciés) paraissent très nombreux par rapport aux autres éléments du squelette, car il y en a deux fois plus (2 métacarpes et 2 métatarses) que chacun des os longs, ils sont plus résistants, et enfin ils sont plus faciles à identifier sur de petits fragments.

De même, les vestiges correspondant à la tête semblent sur-représentés par rapport aux autres. Cependant, il s'agit, pour la plupart, de dents, beaucoup moins sensibles que les os aux facteurs taphonomiques ou anthropiques (boucherie). Elles multiplient d'autant plus le nombre de restes qu'elles sont nombreuses chez chaque espèce.

Ces détails éclaircis, nous pouvons confirmer que toutes les parties anatomiques sont représentées de manière équilibrée. Cela signifie qu'aucune pièce bouchère n'a été choisie spécifiquement pour être exploitée dans cette zone de l'entrée du temple.

Traitement de la viande et des os

– DESCRIPTION: Parfois la fragmentation des ossements et le plus souvent les traces laissées par des outils tranchants sur la matière osseuse permettent, au moins en partie, de retrouver les gestes du boucher.

	Espèces indifférenciées			Caprinés
	Remplissage NR	Sols NR	Foyers NR	Sols + foyers NR
tête (crâne + dents)	38	5	12	13
colonne + côtes	15	2	8	0
ceinture scapulaire	1	0	1	0
ceinture pelvienne	1	0	2	1
humérus	3	0	4	0
radius + ulna	10	0	3	1
fémur	3	0	1	1
tibia + fibula	10	4	4	4
métapodes	17	2	14	16
extrémités membres	2	1	5	4
fragments d'os longs	220	31	133	–

TABLEAU 2

Représentation des parties anatomiques de la totalité des espèces sur l'ensemble des couches correspondant à la période géométrique et des caprinés sur les surfaces occupées.

Malheureusement, dans l'échantillon considéré, seuls 2 ossements comportent des traces laissées par un instrument: il s'agit d'un fragment de diaphyse de fémur d'"indéterminé de taille moyenne" et d'un fragment proximal de diaphyse de tibia de capriné, tous deux provenant du remplissage. Le premier porte une trace d'incision et une autre, plus profonde, de coups sur la face postérieure de l'os qui caractérisent la volonté de briser le fémur; le second, plus intéressant puisqu'identifié plus précisément, montre 2 petites incisions sur la face antérieure du tibia. Ceci résulte probablement de la désarticulation entre le tibia et le fémur.

Les traces relatives au traitement anthropique postérieur à la découpe bouchère (cuisson et consommation) sont plus nombreuses: il s'agit des traces de brûlure, dont le détail est donné dans la Tableau 3.

Sur un total de 740 vestiges osseux décrits dans le secteur étudié, 235, soit 32%, comportent des traces de feu. Plus des 2/3 des os brûlés proviennent des foyers, alors qu'aucun n'a été repéré sur les sols. Sur les os comptabilisés dans les foyers (310), plus de la moitié (55%) sont brûlés. Même si les remplissages nous intéressent moins dans le sens où ils ne représentent pas d'occupation, il faut néanmoins noter qu'ils contiennent 17% des restes portant des traces de feu.

La supériorité du nombre de fragments calcinés témoigne d'un séjour prolongé dans les foyers.

La répartition anatomique des restes brûlés présents dans les foyers confirme que chaque partie anatomique a été utilisée. En dehors des 2 prémolaires de chien décrites précédemment et d'un fragment de mandibule d'espèce indéterminée, tous les éléments anatomiques brûlés déterminés ont appartenu à des caprinés (12 restes) ou à des "indéterminés de taille moyenne" (72 restes).

– ESSAI D'INTERPRÉTATION: La présence d'une forte proportion d'os brûlés dans les foyers peut être interprétée de plusieurs manières. Les os calcinés, c'est-à-dire brûlés intensément (en fonction de la température et surtout de la durée d'exposition) (Shipman *et al.*, 1984), ont pu être repoussés dans les structures de combustion, volontairement ou non. Aucune partie anatomique n'ayant été préférentiellement exposée au feu et la fragmentation ne paraissant pas être uniquement due à la chaleur, il est en effet peu probable que les vestiges brûlés découverts dans les foyers résultent du dépôt de pièces de boucherie destinées à être incinérés comme offrande. Il semble plutôt qu'ils soient le résultat du rejet des déchets de consommation de morceaux de viande peut-être préalablement grillés sur les foyers. Cette hypothèse reste à confirmer par l'extension de l'étude à un échantillon plus vaste.

Parallèlement, la présence des os non brûlés dans les foyers et sur les sols peut être significative d'un déplacement spatial ou stratigraphique des vestiges, les causes, naturelles ou artificielles, pouvant être multiples. Ces restes non brûlés ne seraient alors pas en place et leur dépôt pourrait être postérieur au fonctionnement des foyers, sans quoi ils porteraient également des traces de crémation.

DIFFÉRENCES ET RELATIONS ENTRE LE SECTEUR AU SUD-EST DU TEMPLE ET L'AIRE SACRIFICIELLE

Comme il a été préalablement noté plus haut, l'étude archéozoologique de l'aire sacrificielle fera l'objet d'autres publications (Chenal-Velarde & Studer, à paraître a; Studer & Chenal-Velarde, à paraître). Nous n'en utiliserons donc ici que quel-

	Remplissage NR	Sols NR	Foyers NR	Total NR
peu brulé	3	0	0	3
noir (carbonisé)	8	0	19	27
blanc (calciné)	30	0	26	56
noir et blanc	22	0	127	149
total	63	0	172	235

TABLEAU 3

Répartition de la totalité des os brûlés (indéterminés compris) dans l'ensemble du sondage.

ques données, avec l'objectif de présenter et d'essayer d'interpréter les différences observées entre les deux secteurs.

Comparaisons des résultats globaux

A partir des totaux d'ossements décrits dans les deux secteurs, des comparaisons ont été effectuées sur la base de l'identification des espèces, des parties anatomiques et des spécificités d'origine anthropique.

– SUR LE SPECTRE FAUNIQUE (Figure 2): Dans l'aire sacrificielle, pour la période géométrique, 377 restes osseux ont été décrits. Sur ce total, 93% ont été identifiés comme ayant appartenu à des caprinés, chèvres et moutons non discriminés (Studer & Chenal-Velarde, à paraître).

Dans le sondage au sud-est du temple, nous avons vu précédemment que le total des os décrits s'élève à 740. Les caprinés représentent 11% du total et les "indéterminés de taille moyenne" 58%. Les mêmes proportions sont obtenues en ne retenant que les sols d'occupation et les foyers.

Ainsi, les ovins et les caprins sont nettement mieux représentés en nombre de restes dans l'aire sacrificielle, même en tenant compte du fort pourcentage que totalisent les "indéterminés de taille moyenne" dans le secteur sud-est, qui pourrait augmenter celui des caprinés jusqu'à 69% du total des restes (caprinés et "indéterminés de taille moyenne").

– SUR LA REPRÉSENTATION DES PARTIES ANATOMIQUES (Figure 3): Dans l'aire sacrificielle, 93% des restes de caprinés ont été identifiés comme fragments de fémur, ainsi que quelques rotules. De plus, nous pouvons supposer que la majorité, si ce n'est la totalité, des esquilles de diaphyses d'os longs d'"indéterminés de taille moyenne" sont également des vestiges de fémur de caprinés (Studer & Chenal-Velarde, à paraître). Seuls 20 fragments d'os de chèvre ou de mouton appartiennent à d'autres parties anatomiques, dont une vertèbre caudale. Il y a donc une quasi-exclusivité de la représentation de la partie centrale du gigot autour de l'autel de sacrifices, et peut-être de la queue.

Dans le secteur au sud-est du temple, sur 509 restes de caprinés et d'"indéterminés de taille moyenne", 4 fragments de fémur, dont un seul identifié comme ayant appartenu à un mouton ou à une chèvre, ont été reconnus. 374 fragments de diaphyse d'os long ont été répertoriés, en raison de

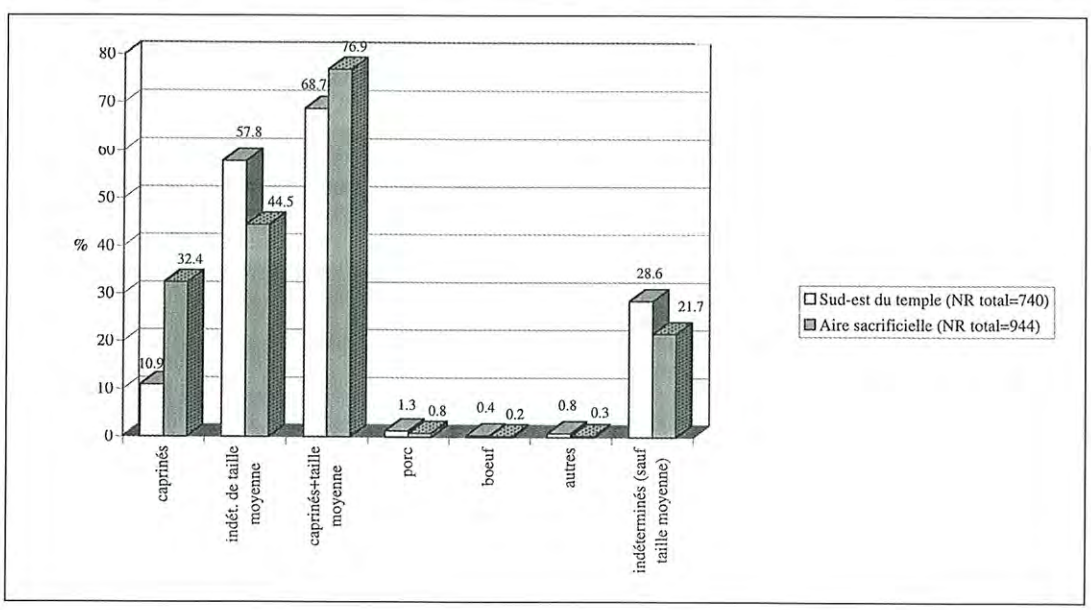


FIGURE 2

Comparaison des spectres fauniques de chacune des zones étudiées en pourcentages du nombre de restes total.

l'important taux de fragmentation, mais, contrairement à ceux de l'aire sacrificielle, ils ne peuvent pas être considérés comme des restes de fémur. En effet, d'une part cet os est sous-représenté dans ce secteur, et d'autre part toutes les parties du squelette ont été identifiées dans cet échantillon osseux (membres et extrémités de membres, crâne et dents, colonne vertébrale et côtes) (voir Tableau 2): ces fragments de diaphyse peuvent donc être les vestiges de n'importe quel os long des membres.

Ces comparaisons font apparaître une nette différence de la représentation des parties anatomiques entre les secteurs étudiés: elles permettent de mettre en évidence une probable exploitation de la totalité de la carcasse dans le sondage sud-est, alors que dans la zone sacrificielle, la présence quasi-exclusive de fémurs de caprinés montre qu'un choix précis a été effectué.

– SUR LES OSSEMENTS BRÛLÉS (Figure 4): Les 284 restes de fémur et patellas de caprinés, ainsi qu'une vertèbre caudale, provenant de l'aire sacrificielle, sont tous brûlés, et pour la plupart calcinés. De même, 89% des restes de diaphyses d'os longs d'"indéterminés de taille moyenne" portent des traces de brûlure.

A l'opposé, seulement 32% du total des fragments décrits dans le secteur sud-est ont été brûlés, et, lorsqu'ils l'ont été, plutôt légèrement.

Ces résultats mettent en évidence des différences caractéristiques du type d'exploitation des parties animales, systématiquement brûlées et en grande partie calcinées dans l'aire sacrificielle, nettement moins brûlées, tant en quantité qu'en intensité (les os étant plutôt carbonisés) dans le secteur sud-est.

Essais d'interprétation: différences et relations entre les deux secteurs étudiés

Les comparaisons archéozoologiques effectuées entre le sondage sud-est et l'aire sacrificielle ont mis en évidence:

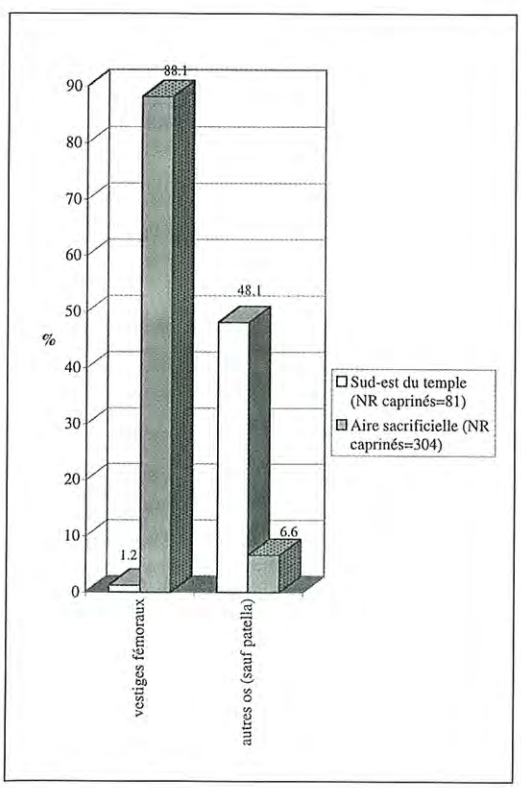


FIGURE 3

Comparaison de la représentation des parties anatomiques (fémurs et autres) entre les zones étudiées, en pourcentages du nombre de restes de caprinés.

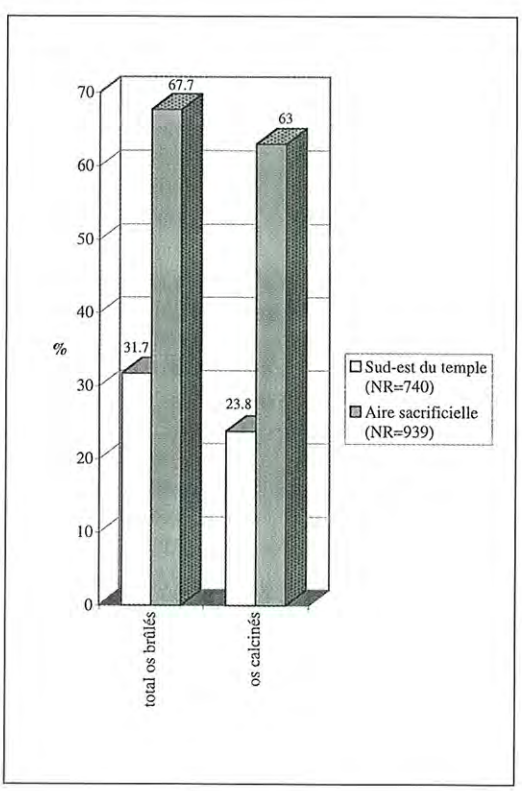


FIGURE 4

Comparaison des proportions d'ossements brûlés et calcinés entre les zones étudiées, en pourcentages du nombre de restes total.

– une exploitation très largement majoritaire des caprinés, aussi bien en relation avec l'autel de sacrifices qu'avec les foyers placés à l'entrée du temple,

– une différence de représentativité des éléments anatomiques, tous présents en quantités équilibrées au sud-est du temple alors que le fémur est quasi-exclusif dans l'aire sacrificielle,

– une différence de la quantité des os brûlés, beaucoup plus nombreux dans l'aire sacrificielle, et de l'intensité de ces brûlures (les os étaient en majorité calcinés dans l'aire sacrificielle et carbonisés dans le secteur sud-est).

Les proportions très importantes de restes de fémurs de caprinés brûlés, principalement calcinés, récoltées dans l'aire de sacrifices peuvent être interprétées comme étant les vestiges d'offrandes de l'os de la cuisse à une divinité (Chenal-Velarde & Studer, à paraître a, b).

Dans le secteur sud-est, le pourcentage beaucoup plus réduit de restes osseux brûlés parallèlement à une quantité proportionnellement importante de fragments carbonisés par rapport au total d'os brûlés, attestent d'activités différentes en relation avec les foyers. La présence de tous les éléments du squelette, non brûlés ou ayant été exposés au feu peu de temps, montrent que ces structures n'avaient pas pour fonction l'incinération de parties anatomiques particulières. Au contraire, il semble que les morceaux des carcasses de caprinés aient été simplement grillés sur ces foyers et peut-être consommés à cet endroit. Les fragments calcinés découverts dans cette zone peuvent être considérés comme des déchets rejetés ou tombés par hasard dans les foyers, où ils se seraient consumés beaucoup plus longtemps. Ce secteur, correspondant à l'entrée du temple d'Apollon à l'époque géométrique, peut donc par hypothèse, jusqu'à ce qu'une extension de l'étude archéozoologique le confirme, être considéré comme une zone réservée à la cuisson et peut-être à la consommation de carcasses de caprinés, les foyers et les vestiges osseux attestant de ces activités.

CONCLUSIONS

Les comparaisons effectuées entre l'aire sacrificielle et le sondage au sud-est du temple d'Apollon pour la période géométrique ont permis de mettre en évidence une différence spatiale des activités liées à l'exploitation des ovins et des caprins.

Les résultats archéozoologiques obtenus pour le sondage au sud-est du temple appuient l'hypothèse selon laquelle des carcasses d'animaux domestiques, presque exclusivement des caprinés, y ont subit un traitement intentionnel. Bien qu'il soit difficile de tirer des conclusions en présence d'un échantillon aussi réduit de restes osseux, nous pouvons proposer une hypothèse selon laquelle les foyers découverts lors des fouilles ont fonctionné en relation avec la cuisson et la consommation de morceaux de carcasse de caprinés, dont aucune partie anatomique n'a été choisie préférentiellement.

Les relations ayant pu exister entre l'aire sacrificielle et le secteur comprenant les foyers sont difficiles à établir, principalement parce que nous n'avons pas de corrélations chronologiques précises. Cependant, pourquoi ne pas penser que les animaux immolés sur l'autel de sacrifice aient pu ensuite être grillés et consommés devant le temple?.

Une extension de l'étude à une aire de fouilles plus étendue, peut-être à l'est et au sud du temple, permettra, en amplifiant le corpus de données, de préciser et de confirmer les résultats obtenus jusque là.

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Les caractères ostéoscopiques chez les Mammifères actuels et fossiles. Histoire de la méthode et apport à la connaissance des populations

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ABSTRACT: Zooarchaeology and, to a lesser extent, zoology still make little use of osteoscopic (discrete) characters in intraspecific analyses. In this paper, the history of the method is reviewed, starting with the earliest descriptions of human discrete characters which later shift to observations on animals and culminate with recent zoological studies that compare the results produced by the study of discrete characters with alternative approaches. Through out this review, we intend to show the interest of the method for a knowledge of modern and fossil animal populations.

KEY WORDS: ZOOARCHAEOLOGY, ZOOLOGY, OSTEOSCOPIC (DISCRETE) CHARACTERS, MAMMALS

RESUMEN: La zooarqueología y, en menor medida la zoología continúan haciendo un uso bastante limitado de los caracteres discretos (osteotópicos) en los análisis intraespecíficos. En este trabajo se hace un repaso a estos métodos de estudio, comenzando con las primeras descripciones de caracteres discretos en humanos, que posteriormente pasan a serlo de animales y culminan en recientes estudios zoológicos que comparan los resultados producidos por el estudio de los caracteres discretos con otros producidos a través de técnicas alternativas. A lo largo de este repaso nuestro principal interés consiste en evidenciar las potencialidades del método para un mejor conocimiento de las poblaciones animales tanto fósiles como modernas.

PALABRAS CLAVE: ZOOARQUEOLOGÍA, ZOOLOGÍA, CARACTERES OSTEOTÓPICOS (DISCRETOS), MAMÍFEROS

INTRODUCTION

L'utilisation des caractères ostéoscopiques (ou caractères discrets) pour comparer des populations animales actuelles et pour documenter leur histoire est rare; elle est pratiquement inexistante pour les populations fossiles. Pourtant les recherches réalisées en anthropologie, et plus particulièrement en paléo-anthropologie, ont montré leur apport dans des approches de ce type. Elles ont également mis en évidence les nombreuses difficultés et interrogations soulevées par leur application.

Devant les potentialités offertes et les biais méthodologiques encourus, il a semblé indispensable de révéler l'importance des caractères ostéoscopiques en tant que marqueurs populationnels, en présentant cette approche de manière détaillée. Les grandes étapes de l'histoire de la méthode sont ainsi retracées depuis les premières descriptions de caractère jusqu'à leur utilisation actuelle, en insistant pour chaque période sur les avancées et les obstacles rencontrés. Le débat sur la signification biologique de ces caractères est ensuite évoqué en même temps que les problèmes de terminologie qui lui sont inhérents. Le lien entre les caractères

discrets et un déterminisme génétique et/ou mésologique, ainsi que la question de leur héritabilité, ont en effet retenu l'attention dès les premières comparaisons de populations dans les années 50, et demeurent d'actualité; les arguments proposés en faveur d'une transmission génétique ou d'une influence de l'environnement sont donc présentés. Enfin, un bilan des recherches menées sur les Mammifères est réalisé; les espèces sélectionnées, les caractères identifiés et les informations que cette méthode peut apporter les concernant sont ainsi développés. Ce premier inventaire est évidemment non exhaustif. Il ne s'agit en aucun cas d'un recensement général de l'ensemble des caractères que la littérature biologique et zoologique est susceptible de contenir. Les études de populations qui cherchent à comparer des groupes y sont privilégiées, plutôt que celles utilisant les caractères ostéoscopiques comme des éléments de diagnose entre famille, genre ou espèce. L'objectif de cet inventaire est la constitution d'un catalogue pouvant être utilisé dans des études ultérieures portant sur d'autres espèces, actuelles et/ou fossiles. Il a été préliminaire à un travail réalisé sur des populations actuelles et fossiles de lapin (*Oryctolagus cuniculus*; Callou, 2000), dont les principaux apports seront présentés en conclusion.

HISTOIRE DE LA MÉTHODE

Les premières descriptions de caractères discrets datent de la fin du siècle dernier et se rapportent exclusivement à l'Homme. Chambellan (1883), en décrivant des os suturaires, semble être le premier à avoir employé ces caractères en anthropologie. Russell (1900), en rassemblant des caractères observés sur des crânes de différents groupes américains, serait quant à lui le premier à y avoir eu recours pour comparer des populations. A la même époque, Le Double entreprit un inventaire complet des variations ostéoscopiques du crâne (Le Double, 1903), de la face (Le Double, 1906), mais également de la colonne vertébrale (Le Double, 1912). Quelques années plus tard, Wood-Jones (1930-31, 1933-34) reprit ces données pour comparer des populations humaines. Ces recherches demeurèrent toutefois essentiellement descriptives jusqu'aux travaux de Laughlin & Jorgensen (1956) et Brothwell (1958), qui exploitèrent les caractères discrets, non pas de manière uniquement qualitative mais aussi quantitative, en comparant les différences de fréquences entre les populations. Brothwell (1958) souligna pourtant les difficultés que cette approche posait, difficultés liées à la méconnaissance de la transmission des caractères et aux modifications que ceux-ci pouvaient subir dans des environnements variés.

A partir des années 50, les caractères discrets furent appliqués aux animaux. Deux séries d'articles intitulées " Genetical studies on the skeleton of the mouse " et " Genetical differentiation involving morphological characters in an inbred strain of mice " furent consacrées aux caractères discrets chez la souris *Mus musculus*, à leur variabilité et à leur héritabilité, soit en laboratoire (Grüneberg, 1950, 1951, 1952, 1955; Truslove, 1952, 1961; Searle, 1954a, 1954b, 1964; Deol, 1955; Carpenter *et al.*, 1957; Deol *et al.*, 1957; Deol & Truslove, 1957; Grewal, 1962a), soit en milieu naturel (Weber, 1950; Deol, 1958; Harland, 1958; Grewal, 1962b; Berry, 1963, 1964, 1967, 1968; Berry & Searle, 1963; Berry & Jakobson, 1975). Ces études cherchaient à analyser le mode de transmission des caractères discrets et l'importance du déterminisme génétique et familial par rapport à l'influence de l'environnement. Il faut noter que, de la même manière que pour l'Homme, les recherches sur la souris privilégiaient les caractères crâniens au détriment de ceux du squelette post-crânien, quelques variations observées sur la colonne vertébrale et le squelette appendiculaire faisant néanmoins l'objet d'une brève description, souvent très subjective (Grüneberg, 1950; Weber, 1950; Stein, 1957).

A la suite de ces études sur les souris et sur quelques autres rongeurs (Berry & Searle, 1963), Berry & Berry (1967) développèrent une approche similaire pour les caractères discrets humains, partant du postulat que les différences de fréquences entre diverses populations étaient le reflet des différences génétiques entre ces populations. Ils étudièrent ainsi trente variables sur 585 crânes d'individus adultes issus de huit localités différentes et, dans une des localités (Egypte), appartenant à six périodes chronologiques distinctes (de l'époque pré-dynastique à l'ère chrétienne). Cet article connut un succès considérable par son caractère novateur et par ses conclusions très optimistes. Les caractères discrets étaient en effet présentés comme d'observation et d'utilisation aisées, peu liés au sexe ou à l'âge des individus et non corrélés entre eux. Ils étaient surtout décrits comme représentant mieux les différences génétiques entre les populations que les variables métriques.

Les analyses utilisant les caractères discrets se multiplièrent ainsi à la fin des années 60 et au début des années 70, effectuées à la fois par des généticiens et par des anthropologues (Anderson, 1968; Hertzog, 1968; Berry & Berry, 1972; Ossenberg, 1970, 1971, 1976; Kellock & Parsons, 1970a, 1970b; Gaherty, 1971; Pietrusewsky, 1971; Corruccini, 1974; consulter la liste bibliographique établie par Finnegan & Faust, 1974); en 1968, Anderson comptabilisait plus de 1500 articles se rapportant uniquement à l'Homme. Parallèlement à ces recherches, quelques auteurs, nettement moins nombreux que les précédents, continuèrent de s'intéresser à des populations animales autres que celles de souris (Grewal & Dasgupta, 1967; Berry, 1969a, 1969b, 1975; Rees, 1969a, 1969b; Hilborn, 1974; Berry & Rose, 1975). Certains chercheurs s'interrogèrent pourtant sur le bien fondé des constatations émises par Berry & Berry (1967). Si l'utilisation des caractères discrets pour distinguer des populations n'était pas remise en cause, il en allait autrement de la facilité d'observation des variables (Molto, 1979), ainsi que de la partialité de l'observateur (Corruccini, 1974). De plus, certains caractères apparaissaient liés à l'âge ou au sexe (Ossenberg, 1969; Berry, 1975), et leur héritabilité se révélait non comparable à celle des données métriques (Sjøvold, 1984).

Corruccini (1974) préconisa l'utilisation conjointe de méthodes fondées sur des variables métriques et discrètes. Son étude fut très critiquée, non sur la méthode et sur les solutions qu'il proposait, mais sur le matériel ostéologique employé pour parvenir à ses résultats (Sjøvold, 1977). Corruccini, puis Carpenter (1976), choisirent en effet un ensemble de crânes, d'origine et d'appartenances variées, formant la collection Terry de la Smithsonian Institution (Washington DC), et la considérèrent comme étant le reflet d'une population naturelle. A la suite de ces articles, la question de la représentativité des échantillons fut donc soulevée, sans pour autant être résolue. Actuellement encore, selon Crubézy (1991), certains auteurs assimileraient les squelettes découverts en contexte sépulcral à des échantillons provenant d'un tirage aléatoire au sein d'une population; or, il semble au contraire que la présence des individus et l'organisation des ensembles funéraires (sépultures collectives ou nécropoles) ne soient pas entièrement dues au hasard.

Aux problèmes de fiabilité des échantillons, s'est rapidement ajouté celui du traitement des données. Les données métriques ont effectivement pu profiter assez tôt du développement des analyses multivariées, tandis que les caractères discrets étaient toujours traités par des comparaisons de fréquence entre populations. La méthode la plus employée fut celle de C.A.B. Smith modifiée par Grewal (1962b) – MMD ou Mesure Moyenne de Divergence[1] – qui s'apparente plus en réalité à un test statistique qu'à une réelle distance biologique. Elle consiste à convertir le pourcentage d'incidence d'un caractère en une valeur angulaire. L'avantage de la méthode réside dans la simplicité des calculs, mais entraîne des difficultés lorsque l'on souhaite l'appliquer à des assemblages fossiles ou à des échantillons de dimensions et de compositions variées, un nombre identique de variables devant être utilisé pour chaque population (Sjøvold, 1973). De plus, elle ne permet de comparer les populations que deux à deux, et le poids respectif de chaque caractère dans le résultat final est loin d'être négligeable (Crubézy, 1991). Des approches multivariées furent donc tentées dès la fin des années 60 mais, comme elles s'appuyaient sur des présupposés génétiques, elles étaient contestables (Ullrich, 1969) et furent pour cette raison rapidement abandonnées. A défaut d'une autre méthode de calcul, la Mesure Moyenne de Divergence continua donc d'être appliquée. Elle l'est encore en complément des méthodes multidimensionnelles (analyses factorielles et classification hiérarchique; Crubézy, 1991; Braga, 1995). Cependant, dans le cadre d'une analyse visant à mettre en évidence les différences et les rapprochements entre des populations et à faire apparaître les liens entre les caractères qui interviennent, une Analyse Factorielle des Correspondances semble plus appropriée (Callou, 2000).

Ces diverses difficultés (échantillonnages et traitement des données) provoquèrent de nombreuses critiques à l'encontre de la méthode (Rösing, 1982). Toutefois, les arguments portaient surtout sur la méconnaissance de leur héritabilité. Trois tendances se sont alors mises en place: une première, nettement dominante, jugeant les risques d'erreur dans l'interprétation trop grands a préféré renoncer à cette approche; une seconde s'est au contraire attachée à comprendre l'étiologie de ces caractères en analysant des situations parfaitement

[1] Cette méthode est en fait proche du concept de distance généralisée défini par Mahalanobis (1930, cité par Sjøvold, 1977). Elle s'est également appelée Estimation Moyenne de Divergence après ajustement des calculs (Sjøvold, 1973).

connues et/ou contrôlées; enfin, une troisième persiste à appliquer ces caractères pour la comparaison des populations, estimant que leur cause n'est pas plus connue que celle des variables métriques.

Depuis le début des années 90, la recherche sur les caractères discrets a pris un nouvel essor. En anthropologie, elle s'est orientée selon trois directions : 1°) l'analyse et la recherche de caractères discrets dans des situations connues (recherche de cas familiaux), 2°) la recherche de liaisons entre caractères discrets et facteurs d'environnement et 3°) l'analyse de sépultures et de nécropoles anciennes (identification de sous-groupes, et reconstitution des liens de parenté) (Crubézy, 1995). En cladistique, zoologie et biologie végétale, les caractères discrets servent à l'analyse des filiations, l'aboutissement étant la reconstitution d'arbres phylogénétiques (Pogue & Mickevich, 1990; Stevens, 1991; Thiele, 1993; Braga, 1995). En biologie, leur utilisation s'intègre à des études pluridisciplinaires mêlant différentes approches dont des analyses génétiques (Vigne *et al.*, 1994). En archéozoologie enfin, les potentialités offertes par l'analyse de ces caractères sont de plus en plus perçues, mais ont été à ce jour encore très peu exploitées (O'Connor, 1984, 1988, 1990; Albarella & Davis, 1996; Callou, 2000).

TERMINOLOGIE

De nombreux vocables ou adjectifs existent pour qualifier l'ensemble des caractères (ostéoscopiques, discrets, qualitatifs, discontinus, quasi-continus ou épigénétiques) ... de la même manière qu'il existe de nombreuses possibilités de présenter et de décrire un même caractère.

Caractères ostéoscopiques, discrets, qualitatifs, non-métriques, discontinus, quasi-continus ou épigénétiques? Difficultés terminologiques et conceptuelles

Plus que des problèmes de terminologie, la multiplicité des termes trouvés dans la littérature pour caractériser ces caractères souligne la difficulté de leur attribuer une origine, un mode de fonctionnement et d'évolution. Cependant, la différence de définition pour un même terme entre différents auteurs et la confusion qui règne même chez certains auteurs sont loin également d'être négligeables[2]; cette gêne a certainement pour origine la complexité inhérente aux caractères.

Les caractères discrets diffèrent des caractères ostéométriques par leur variation discontinue. Ils se définissent comme étant des variations morphologiques mineures, non pathologiques.

Le qualificatif "discret", souvent utilisé pour désigner ces caractères, n'a aucune valeur biologique mais se réfère au type d'information que ceux-ci apportent (Rösing, 1982). Le caractère peut s'exprimer de plusieurs manières, notamment par sa présence ou son absence.

La limite entre caractères discrets et anomalies du développement n'a pas toujours été clairement perçue et il n'est pas rare de trouver la description de ces caractères dans des chapitres consacrés aux pathologies. Des variations dentaires (présence ou absence de la troisième molaire inférieure ou supérieure, par exemple) ou squelettiques (polydactylie, présence d'un foramen mentonnier surnuméraire, etc) sont, dans l'ouvrage de Baker & Brothwell (1980) intitulé "Animal diseases in archaeology", décrits dans les chapitres consacrés aux "Abnormalities of skeletal development" et "Oral pathology". Il est vrai que, dans certains cas, cette limite est très ténue. Certains caractères, classés entre le normal et le pathologique, pourraient même être héréditaires comme c'est le cas de l'amincissement pariétal et dysplasique du crâne humain (Hauser & De Stefano, 1989). Si cette différence n'est pas encore aujourd'hui toujours clairement établie, les caractères concernés ne sont plus traités comme des caractères discrets "vrais" et font l'objet d'un traitement particulier (comparaison de fréquences uniquement), n'intervenant plus ainsi dans les analyses de populations.

Une autre frontière souvent mal définie est celle séparant les variables "discrètes" des variables métriques. Les caractères discrets **diffèrent** des caractères métriques mais ils n'en sont pas pour autant distincts. La terminologie utilisée pour caractériser ces deux types de variations se fonde pourtant fréquemment sur cette opposition: caractères qualitatifs *versus* quantitatifs, caractères discrets *versus* continus ou encore caractères disjoints *versus* non disjoints (Thiele, 1993). Certains

[2] Stevens (1991), par exemple, parle à la fois de caractères "quantitatifs continus" et de caractères "quantitatifs discrets".

caractères qualitatifs peuvent néanmoins être exprimés quantitativement (Stevens, 1991) et ces deux acceptions se réfèrent plus au mode d'expression des caractères qu'à leur nature intrinsèque: "quantitative and qualitative are modes of expression of data, while continuous or discrete refer to properties of the set of numbers that express the data; both these pairs of terms have been confused with overlapping and non-overlapping" (Thiele, 1993). L'expression "caractères non-métriques" utilisée parfois (Berry, 1968; Sjøvold, 1977) ne convient par conséquent pas pour décrire ces caractères.

Les différentes formulations citées précédemment renvoient davantage à l'expression des caractères qu'à leur cause; il en existe néanmoins se rapportant à ce second aspect.

Selon Berry & Searle (1963), la manifestation d'un caractère serait développemental à l'origine et sa présence, ou son absence, chez des individus constituerait une part de la variation existant à l'intérieur d'une espèce. Pour décrire la nature de cette variation, Grüneberg (1952) proposa le terme de variation quasi-continue et Berry & Searle (1963), le terme de polymorphisme épigénétique afin de la distinguer du vrai polymorphisme. Le terme "épigénétique" a été abandonné en raison de l'origine des caractères qui y était sous-entendue et qui n'était pourtant pas démontrée (Crubézy, 1991). En revanche, certains caractères sont encore actuellement présentés comme étant quasi-continus.

Les discussions, développements et modèles proposés autour du concept de "caractères quasi-continus à effet seuil" sont très nombreux. Les critères justifiant le classement d'un caractère dans cette catégorie sont toutefois très variables suivant les auteurs et mènent à des conclusions différentes, parfois contradictoires[3]. Les principaux arguments de ces démonstrations sont la représentation et la fréquence des caractères, leur uni- ou bilatéralité, leur lien avec le sexe et/ou leur évolution au cours de la croissance, mais aussi le lien existant entre ces éléments et les données génétiques ou de milieu.

Le caractère sur lequel se fonde ce modèle, et qui reste certainement à ce jour le plus étudié, est celui de l'agénésie de la troisième molaire chez la souris (Grüneberg, 1951, 1952; Grewal, 1962a). D'après Saunders (1989), "the absence of the tooth is a discontinuous character arising from an underlying continuous distribution, the size of the tooth rudiment", la taille du germe dentaire étant déterminée par la constitution génétique de l'individu, influencée par celle de la mère mais également par l'environnement maternel et des facteurs pré- et postnataux; une variation continue sous-jacente existerait donc, d'où le terme "quasi-continu" proposé.

En fait, pour les auteurs ayant travaillé sur le modèle de "caractères quasi-continus à effet seuil", tout revient à penser que "la susceptibilité de l'individu à présenter un caractère serait sous la dépendance de plusieurs gènes, situés sur des sites chromosomiques différents et sous celle de facteurs du milieu. Le caractère apparaîtrait dès que la susceptibilité atteindrait un seuil critique" (Crubézy, 1991). Les recherches menées par Crubézy (1991) sur la nécropole de Missiminia au Soudan, montrent les deux tendances: certains caractères semblent correspondre au modèle quasi-continu tandis que d'autres paraissent au contraire le réfuter. L'auteur conclut que cette expression doit être réservée aux caractères qui, lorsqu'ils sont présents, peuvent présenter un degré de développement différent d'un individu à un autre; ce qui revient à montrer qu'il existe des cas intermédiaires pour certains d'entre eux.

A l'exception des termes "épigénétiques" et "non métriques" abandonnés pour les raisons déjà évoquées, il est donc délicat de qualifier ces variations morphologiques mineures sans avoir expliqué au préalable leur déterminisme. Le débat sur les causes et manifestations des caractères est loin d'être achevé, même si la confrontation avec les données génétiques permet d'envisager une avancée dans cette direction. Il n' a donc pas paru souhaitable dans ce contexte d'employer des expressions pouvant présumer des unes ou des autres; les termes quasi-continus et discontinus ne seront donc pas employés.

Le qualificatif "discret" pourrait convenir à condition que les caractères présentent une distribution de fréquence nettement bimodale, traduisant la présence ou l'absence, ou bien des morphotypes n'admettant pas de cas intermédiaires. Il

[3] Consulter à ce sujet le chapitre intitulé "caractères discrets ou quasi-continus" (Crubézy 1991), dans lequel l'auteur donne des exemples de critères utilisés par certains chercheurs pour démontrer la réalité des caractères quasi-continus.

devient inapproprié lorsque l'on veut traiter des formes, classées selon plusieurs modalités: forme de la protubérance occipitale externe, de la bulle tympanique ou de la crête tibiale du lapin, par exemple (Vigne *et al.*, 1994). Pour cette raison, l'expression "caractères ostéoscopiques" a été privilégiée dans les analyses des ossements de lapin, qui regroupent à la fois des caractères ostéoscopiques stricts et des caractères discrets (Callou, 2000). L'expression "caractères discrets" est néanmoins maintenue lors des citations de travaux antérieurs dans lesquels celle-ci est utilisée (d'où le titre des chapitres suivants).

Problème de dénomination: quel nom pour un caractère?

Outre la confusion existant dans la nomenclature générale, la dénomination des caractères est elle-même problématique. Il n'est pas rare en effet de découvrir des caractères dont la localisation et la description sont très similaires mais qui sont nommés différemment. Il existe même des exemples pour lesquels un même nom peut désigner des caractères différents (Hauser & De Stefano, 1989).

Si cette absence de cohérence peut trouver une explication dans le cas d'un caractère décrit chez des espèces différentes[4], elle paraît plus surprenante pour les caractères crâniens chez l'Homme. Deux facteurs doivent sans doute être incriminés:

Une méconnaissance de certains chercheurs pour le travail d'autres chercheurs, mené pourtant sur le même sujet;

des difficultés d'adaptation de caractères, connus le plus souvent sous leur dénomination anglaise.

Plusieurs auteurs se sont intéressés à cette question (Correnti *et al.*, 1979; Cesnys & Pavilonis, 1982; Hauser & De Stefano, 1989); malheureusement les listes qu'ils proposent ne comportent pas toujours les mêmes termes et ne sont donc pas totalement compatibles.

Pour remédier à cette absence d'unité terminologique, Cesnys & Pavilonis (1982) avaient envisagé un ensemble de solutions dont la première était de suivre une nomenclature internationale sur le principe de la *Parisiana Nomina Anatomica*. Les autres propositions étaient variées mais se fondaient en grande partie sur le principe de la topographie anatomique. Ils suggéraient également que des caractères de même nature soient nommés de manière identique, avec des termes courts, que les éponymes soient rejetés et trouvaient ridicule de nommer des caractères absents.

Il n'est évidemment pas envisageable de transposer *stricto sensu* les noms définis chez l'Homme aux animaux et ce bien que les premiers caractères sur la souris aient été identifiés par homologie avec les caractères humains.

Les caractères ostéoscopiques (discrets) identifiés sur les animaux actuels et fossiles sont nommés selon la terminologie vernaculaire indiquée dans "l'Anatomie comparée des mammifères domestiques" (Barone, 1986), ouvrage de référence en anatomie des Mammifères et en archéozoologie (Tableau 1). Des figures complètent cet inventaire pour aider à leur reconnaissance et éviter les ambiguïtés (Figures 1 à 9).

Classification des caractères

Une classification générale des caractères discrets est difficile à établir en raison des nombreuses exceptions possibles. La plupart peuvent s'insérer toutefois dans les quatre grandes catégories définies par Ossenberg (1969), fondées sur la nature et l'étiologie des caractères:

1°) Les *caractères hypostotics*[5] correspondent à une ossification ou à une synostose incomplète de sutures normalement totalement synostosées chez l'adulte. Ils correspondent également à un arrêt du développement ou à la persistance d'un stade fœtal, ou immature ("néoténie").

2°) Les *caractères hyperostotics* sont le résultat d'une ossification excessive ou, chez l'adulte, de l'ossification d'éléments anatomiques habituellement non ossifiés, tels que les ligaments ou les car-

[4] Les exemples de caractères identiques mais exprimés différemment selon les espèces sont nombreux; certains sont signalés par une accolade dans le Tableau 1. On citera à titre d'exemple les foramens maxillaires I et II présents chez la souris, tandis qu'un seul foramen maxillaire existe chez le cerf de Virginie.

[5] Conformément aux recommandations de Crubézy (1991), la dénomination des caractères est donnée dans leur formulation anglaise. Les termes "*hypostotics*" et "*hyperostotics*" ne possèdent pas en effet d'équivalent en français et il existe, en adaptant ces termes, un risque de confusion avec l'adjectif "hyperostosique".

Parties anat.	*Caractères*	*Références bibliographiques*	*Espèces*															
			Mus	Apo	Min	Per	Rex	Rno	Rra	Mag	Mar	Mca	Lem	Sci	Cav	Ory	Vul	Hal	Cer
Caractères crâniens																			
Calvarium	Nasal courbé (fig. 1)	Searle, 1954 ; Berry et Searle, 1963	x					x											
	Foramen nasal (fig. 4)	Sjøvold, 1977															x		
	Fusions des nasaux	Berry et Searle, 1963	x			x	x	x					x	x	x				
	Suture fronto-nasale (fig. 1, 5)	Rees, 1969 ; Callou, 2000														x			x
	Fusion nasal-turbinal	Berry et Searle, 1963	x		x		x	x						x	x				
	Foramen préorbitaire double (fig. 1)	Berry, 1963 et 1969 ; Berry et Searle, 1963 ; Berry et Rose, 1975	x	x	x	x	x	x	x	x	x		x	x	x				
	Foramen préorbitaire	Hilborn, 1974										x							
	Foramen basiorbitaire supplémentaire (fig. 4)	Berry, 1969																x	
	Position du foramen basiorbitaire (fig. 4)	Berry, 1969																x	
	Foramen optique, foramen antérieur supplémentaire (fig. 3)	Callou, 2000														x			
	Foramen optique supplémentaire	Berry et Rose, 1975									x								
	Foramen optique, foramen antéro-ventral supplémentaire (fig. 3)	Callou, 2000														x			
	Fusion lacrymal-maxillaire	Deol, 1955	x																
	Interfrontal (fig. 1)	Berry, 1963 ; Berry et Searle, 1963 ; Berry et Rose, 1975	x								x				x				
	Frontaux séparés (fig. 1)	Berry, 1963 et 1969 ; Berry et Searle, 1963 ; Berry et Rose, 1975	x	x							x								
	Fusion des frontaux (fig. 1)	Berry, 1963 ; Berry et Searle, 1963	x			x	x	x	x	x			x	x	x				
	Fusion interfrontal-frontal	Deol et Truslove, 1957	x																
	Pli synclinal sur l'os frontal (fig. 1)	Callou, 2000														x			
	Canal frontal (fig. 4)	Sjøvold, 1977															x		
	Fontanelle (fig. 1)	Berry, 1963 ; Berry et Searle, 1963	x																
	Foramen frontal double/supplémentaire (fig. 1, 4)	Berry, 1963 et 1969 ; Berry et Searle, 1963 ; Sjøvold, 1977	x	x		x	x	x	x	x			x	x	x		x		
	Fusion turbinal-prémaxillaire	Deol, 1955	x																
	Foramens ethmoïdales séparés (fig. 4)	Sjøvold, 1977															x		
	Suture prémaxillaire-frontal (fig. 4)	Sjøvold, 1977															x		
	Crête sagittale (fig. 4)	Sjøvold, 1977															x		
	Os wormien (fig. 1)	Callou, 2000														x			
	Crête externe sur la ligne temporale (fig. 3)	Callou, 2000														x			
	Foramen maxillaire I double (fig. 2)	Berry, 1963 et 1969 ; Berry et Searle, 1963 ; Berry et Rose, 1975	x	x	x	x	x	x	x	x	x		x	x					
	Foramen maxillaire (fig. 5)	Rees, 1969 ; Hilborn, 1974										x							x
	Foramen maxillaire II (fig. 2)	Berry, 1963 et 1969 ; Berry et Rose, 1975	x	x							x								
	Foramen maxillaire postérieur double	Berry et Rose, 1975									x								
	Foramen supraorbitaire divisé (fig. 5)	Rees, 1969																	x
	Articulation prémaxillaire-nasal (fig. 4, 5)	Berry, 1969 ; Rees, 1969																x	x
	Forme de la suture palatine transverse (fig. 2)	Callou, 2000														x			
	Os palatin supplémentaire (fig. 4)	Berry, 1969																x	
	Torus palatin (fig. 4)	Berry, 1969																x	
	Foramen palatin majeur double (fig. 2, 4)	Berry, 1963 et 1969a et b ; Berry et Searle, 1963 ; Berry et Rose, 1975 ; Sjøvold, 1977 ; Callou, 2000	x	x	x		x	x	x	x	x		x		x	x	x	x	
	Foramen palatin mineur antérieur (fig. 2)	Berry, 1963 et 1969	x	x															
	Foramen palatin mineur (fig. 5)	Rees, 1969																	x
	Foramen palatin mineur postérieur (fig. 2)	Berry, 1963 et 1969	x	x															
	Foramen palatin mineur incomplet (fig. 4)	Berry, 1969																x	
	Foramen palatin mineur supplémentaire (fig. 2, 4)	Sjøvold, 1977 ; Callou, 2000														x	x		
	Bord postérieur du palatin ou "Alae palatinae" (fig. 2)	Deol, 1955	x																
	Epine nasale caudale (fig. 2, 4)	Berry, 1969 ; Callou, 2000														x		x	

Parties anat.	*Caractères*	*Références bibliographiques*	*Espèces*																
			Mus	Apo	Min	Per	Rex	Rno	Rra	Mag	Mar	Mca	Lem	Sci	Cav	Ory	Vul	Hal	Cer
Calvarium (suite)	Interpariétal (présence/absence) (fig. 1)	Berry et Rose, 1975 ; Callou, 2000									x					x			
	Interpariétal double (fig. 1)	Callou, 2000														x			
	Fusion interpariétal-occipital (fig. 1)	Deol et Truslove, 1957 ; Berry et Searle, 1963	x			x				x				x	x				
	Fusion squamosal-frontal	Berry et Searle, 1963	x		x		x	x	x	x			x	x	x				
	Fusion squamosal-pariétal	Searle, 1954 ; Berry et Searle, 1963	x							x				x	x				
	Foramen postsquamosal (fig. 5)	Rees, 1969																	x
	Foramen squamosal	Berry et Rose, 1975									x								
	Fusion périotique-occipital	Searle, 1954 ; Berry et Searle, 1963	x				x			x									
	Forme de la protubérance occipitale externe (fig. 1)	Callou, 2000														x			
	Foramen pariétal (fig. 5)	Rees, 1969																	x
	Foramen ovale double (fig. 3, 4)	Berry, 1963 et 1969 ; Berry et Searle, 1963 ; Sjøvold, 1977	x		x	x	x		x	x			x				x	x	
	Foramen ovale supplémentaire	Berry, 1969		x															
	Foramen infra-ovale double (fig. 2)	Berry, 1963	x																
	Foramen ovale ouvert postérieurement (fig. 3, 4)	Deol, 1955; Berry et Searle, 1963 ; Berry, 1969a et b	x	x	x			x							x			x	
	Foramen supraglénoïdien (fig. 5)	Rees, 1969																	x
	Foramen mastoïdien	Rees, 1969																	x
	Processus ptérygoïdien (fig. 2)	Berry, 1963 et 1969 ; Berry et Searle, 1963 ; Berry et Rose, 1975	x	x	x	x	x	x	x		x		x						
	Suture ptérygo-palatine (fig. 5)	Rees, 1969																	x
	Foramen ptérygoïdien double (fig. 2)	Berry, 1963 et 1969	x	x															
	Foramen sphénoïdien moyen = canal crânio-pharyngien (fig. 2, 3, 4, 5)	Berry, 1963 et 1969a et b ; Berry et Searle, 1963 ; Hilborn, 1974 ; Berry et Rose, 1975 ; Sjøvold, 1977 ; Callou, 2000	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	
	Canal crânio-pharyngien multiple (fig. 2)	Callou, 2000														x			
	Foramen sphénoïdien lateral ventral (fig. 2, 4)	Berry, 1963 et 1969 ; Rees, 1969 ; Berry et Rose, 1975 ; Sjøvold, 1977	x	x							x						x		x
	Foramen condylaire dorsal (fig. 4)	Berry, 1969																x	
	Canal condylaire double (fig. 4)	Sjøvold, 1977															x		
	Canal condylaire ouvert ventralement (fig. 4)	Sjøvold, 1977															x		
	Canal hypoglosse-condylaire (fig. 4)	Sjøvold, 1977															x		
	Foramen condylaire ventral (fig. 4)	Sjøvold, 1977															x		
	Foramen zygomatique (fig. 5)	Rees, 1969																	x
	Crête inframaxillaire	Deol, 1955 ; Berry, 1969	x	x															
	Fusion basisphénoïde-présphénoïde (fig. 2)	Deol et Truslove, 1957 ; Berry et Searle, 1963	x			x	x	x	x	x			x	x	x				
	Fusion basisphénoïde-basioccipital	Berry et Searle, 1963	x			x	x	x	x	x				x	x				
	Présphénoïde, sutures préoptiques (fig. 2)	Berry, 1963 et 1969; Berry et Searle, 1963 ; Berry et Rose, 1975	x	x	x				x	x	x				x				
	Présphénoïde, racines métoptiques anormales (fig. 2)	Berry, 1963 et 1969 ; Berry et Searle, 1963 ; Berry et Rose, 1975	x	x		x	x	x		x	x								
	Absence du canal du nerf hypoglosse (fig. 3)	Callou, 2000														x			
	Foramen hypoglosse double (fig. 3, 4)	Deol, 1955; Berry et Searle, 1963 ; Berry, 1963, 1969 ; Berry et Rose, 1975 ; Sjøvold, 1977	x	x	x	x	x	x	x	x	x		x	x	x		x	x	
	Foramen(s) surnuméraire(s) au canal hypoglosse (fig. 3)	Callou, 2000														x			
	Fenestra flocculi (fig. 3)	Berry et Searle, 1963	x		x	x													
	Absence M3 (fig. 2)	Berry, 1963 ; Callou, 2000	x													x			
Mandibule	Foramen mandibulaire double (fig. 3, 4)	Berry 1963 et 1969a et b ; Berry et Rose, 1975	x	x							x							x	
	Foramen mentonnier antérieur supplémentaire (fig. 3, 4, 5)	Deol, 1955 ; Berry et Searle, 1963 ; Berry, 1969a et b ; Berry et Rose, 1975 ; Sjøvold, 1977	x	x		x		x		x	x		x	x			x	x	
	Foramen mentonnier postérieur supplémentaire (fig. 4)	Rees, 1969 ; Sjøvold, 1977															x		x
	Perforation de l'éminence incisive (fig. 3)	Deol, 1955	x																
	Absence de P2 (fig. 5)	Rees, 1969																	x

Parties anat.	*Caractères*	*Références bibliographiques*	*Espèces*																
			Mus	Apo	Min	Per	Rex	Rno	Rra	Mag	Mar	Mca	Lem	Sci	Cav	Ory	Vul	Hal	Cer
Mandibule (suite)	Absence de M3 (fig. 3, 4)	Berry 1963; Berry et Searle, 1963 ; Sjøvold, 1977	x														x		
	Développement de l'hypoconulide de la M3 (fig. 5)	Rees, 1969																	x
	Crête mylo-hyoïdienne (fig. 5)	Rees, 1969																	x
Caractères post-crâniens																			
Scapula	Foramen scapulaire supplémentaire (fig. 6)	Berry, 1963 ; Berry et Searle, 1963	x		x	x	x	x	x	x			x	x					
	Forme du bord dorsal (fig. 6)	Stein, 1957	x																
	Forme de l'acromion (fig. 6)	Stein, 1957	x																
	Longueur de l'épine scapulaire	Stein, 1957	x																
Clavicule	Forme de l'extrémité acromiale	Stein, 1957	x																
Humérus	Forme de la crête humérale (fig. 6)	Stein, 1957	x																
	Fosse olécrânienne perforée (fig. 6)	Berry, 1963 ; Berry et Searle, 1963	x		x	x	x	x	x	x			x	x	x				
	Foramen supracondylaire incomplet (fig. 6)	Berry et Searle, 1963												x					
Radius	Position de la tubérosité radiale (fig. 6)	Stein, 1957	x																
Ulna	Massivité du processus oléocrâne (fig. 6)	Stein, 1957	x																
Coxal	Foramen acétabulaire perforant (fig. 7)	Stein, 1957 ; Berry et Searle, 1963	x			x	x	x	x										
	Foramen acétabulaire non perforant (fig. 7)	Berry, 1963	x																
	Fusion de la symphyse pelvienne	Berry et Searle, 1963												x					
	Dyssymphyse ischio-pubienne (fig. 7)	Searle, 1954	x																
	Torsion ischio-pubienne	Stein, 1957	x																
	Forme de la crête iliaque (fig. 7)	Stein, 1957	x																
	Forme de l'épine iliaque dorsale (fig. 7)	Callou, 2000														x			
Fémur	Apparence granulé du col du fémur	Stein, 1957	x																
	Fovéa capitis +/- marquée	Stein, 1957	x																
	Forme de la crête intertrochantérique (fig. 7)	Stein, 1957	x																
	Séparation entre le grand et le 3è trochanter (fig. 7)	Callou, 2000														x			
	Forme de la fosse intercondylienne	Stein, 1957	x																
Tibia	Dimension de la crête tibiale	Stein, 1957	x																
	Forme de la crête tibiale (fig. 7)	Callou, 2000														x			
	Forme de la tubérosité tibiale (fig. 7)	Stein, 1957	x																
	Tubérosité près de la fosse antérieure	Stein, 1957	x																
Fibula	Forme et taille de la tête	Stein, 1957	x																
Vertèbres	Dyssymphyse de l'atlas et de l'axis	Searle, 1954 ; Berry et Searle, 1963	x																
	Atlas, tubercule dorsal avec pointe (fig. 8)	Callou, 2000														x			
	Atlas, échancrure sagittale (fig. 8)	Callou, 2000														x			
	Fusion atlas-axis (fig. 8)	Searle, 1954 ; Berry et Searle, 1963	x		x	x	x	x	x	x			x	x	x				
	Fusion de vertèbres cervivales (autre que atlas/axis) (fig. 8)	Searle, 1954 ; Berry et Searle, 1963	x		x	x	x	x	x					x					
	Foramen transverse imparfait des atlas/axis (fig. 8)	Searle, 1954	x																
	C. III, foramen transverse imparfait	Searle, 1954	x																
	C. III, processus épineux présent	Berry et Searle, 1963	x		x	x	x	x	x	x			x	x	x				
	C. III, présence de foramen sur l'arc vertébral	Berry et Searle, 1963	x		x	x	x	x	x	x			x	x					
	C. IV, foramen transverse imparfait	Searle, 1954	x																

Parties anat.	*Caractères*	*Références bibliographiques*	*Espèces*																
			Mus	Apo	Min	Per	Rex	Rno	Rra	Mag	Mar	Mca	Lem	Sci	Cav	Ory	Vul	Hal	Cer
Vertèbres	C. IV/C. V, présence d'un tubercule ventral (fig. 8)	Berry et Searle, 1963						x											
(suite)	C. V, foramen transverse imparfait (fig. 8)	Searle, 1954 ; Berry et Searle, 1963	x		x			x											
	C. V, tubercule ventral du processus transverse dystopique (fig. 8)	Berry et Searle, 1963	x			x													
	C. VI, foramen transverse imparfait (fig. 8)	Berry, 1963 ; Berry et Searle, 1963	x			x	x												
	C. VI, tubercule ventral du processus transverse dystopique (fig. 8)	Searle, 1954 ; Berry et Searle, 1963	x			x		x		x					x				
	C. VI, tubercule ventral du processus transverse infléchi	Searle, 1954 ; Berry et Searle, 1963	x																
	C. VI/C. VII, foramen(s) supplémentaire(s) (fig. 8)	Weber, 1950	x																
	C. VII, présence de foramen transverse (fig. 8)	Berry et Searle, 1963	x				x	x	x						x				
	C. VII, dyssymphyse (fig. 8)	Weber, 1950	x																
	C. VIII, présence de foramen transverse (fig. 8)	Berry et Searle, 1963	;												x				
	Th. I/Th. II, dystopie du processus épineux	Searle, 1954 ; Berry et Searle, 1963	x																
	Th. I, processus épineux absent (fig. 9)	Berry 1963	x																
	Th. II, processus épineux absent (fig. 9)	Berry 1963	x																
	Th. II, taille du processus épineux	Deol et Truslove, 1957 ; Berry et Searle, 1963	x						x	x			x						
	Th. I, dyssymphyse (fig. 9)	Berry, 1963 ; Berry et Searle, 1963	x							x									
	Th. II, dyssymphyse (fig. 9)	Berry, 1963; Berry et Searle, 1963	x							x									
	Th. V/Th. VI, position du foramen de l'arc thoracique (fig. 9)	Searle, 1954	x																
	Dystopie du foramen de l'arc thoracique	Searle, 1954	x																
	Th. X, dyssymphyse (fig. 9)	Berry, 1963 ; Berry et Searle, 1963	x																
	Nb de vertèbres présacrées	Searle, 1954	x																
	Fusion des deux premières vertèbres sacrées (fig. 9)	Searle, 1954	x																
	Variation de la zone lombo-sacrée (asymétrie et sacralisation de L. VI/L. VII) (fig. 9)	Searle, 1954 ; Berry et Searle, 1963 ; Callou, 2000	x			x	x	x							x	x			
	Sacrum, présence de pointe crâniale (fig. 9)	Callou, 2000														x			
	Sacrum, double articulation sacro-iliaque (fig. 9)	Callou, 2000														x			
	Sacrum, participation de S. II à l'articulation (fig. 9)	Callou, 2000														x			

TABLEAU 1

Tableau récapitulatif des caractères ostéoscopiques de plusieurs espèces de Mammifères, relevés dans la littérature (Les références citées renvoient aux listes et aux représentations des caractères, pas à la première mention).

Rodentia :

Mus: Souris grise *Mus musculus*
Apo: Mulot sylvestre *Apodemus sylvaticus*
Min: Rat des moissons *Micromys minutus*
Per: Souris *Peromyscus maniculatus*
Rex: Rat polynésien *Rattus exulans*
Rno: Rat surmulot *Rattus norvegicus*
Rra: Rat noir *Rattus rattus*
Mag: Campagnol agreste *Microtus agrestis*
Mar: Campagnol des champs *Microtus arvalis*
Mca: Campagnol *Microtus californicus*
Lem: Lemming des toundras *Lemmus lemmus*
Sci: Ecureuil gris *Sciurus carolinensis*
Cav: Cobaye *Cavia porcellus*

Lagomorpha:

Ory: Lapin *Oryctolagus cuniculus*

Carnivora:

Vul: Renard *Vulpes vulpes*
Hal: Phoque gris *Halichoerus grypus*

Artiodactyla:

Cer: Cerf de Virginie *Cervus virginianus*

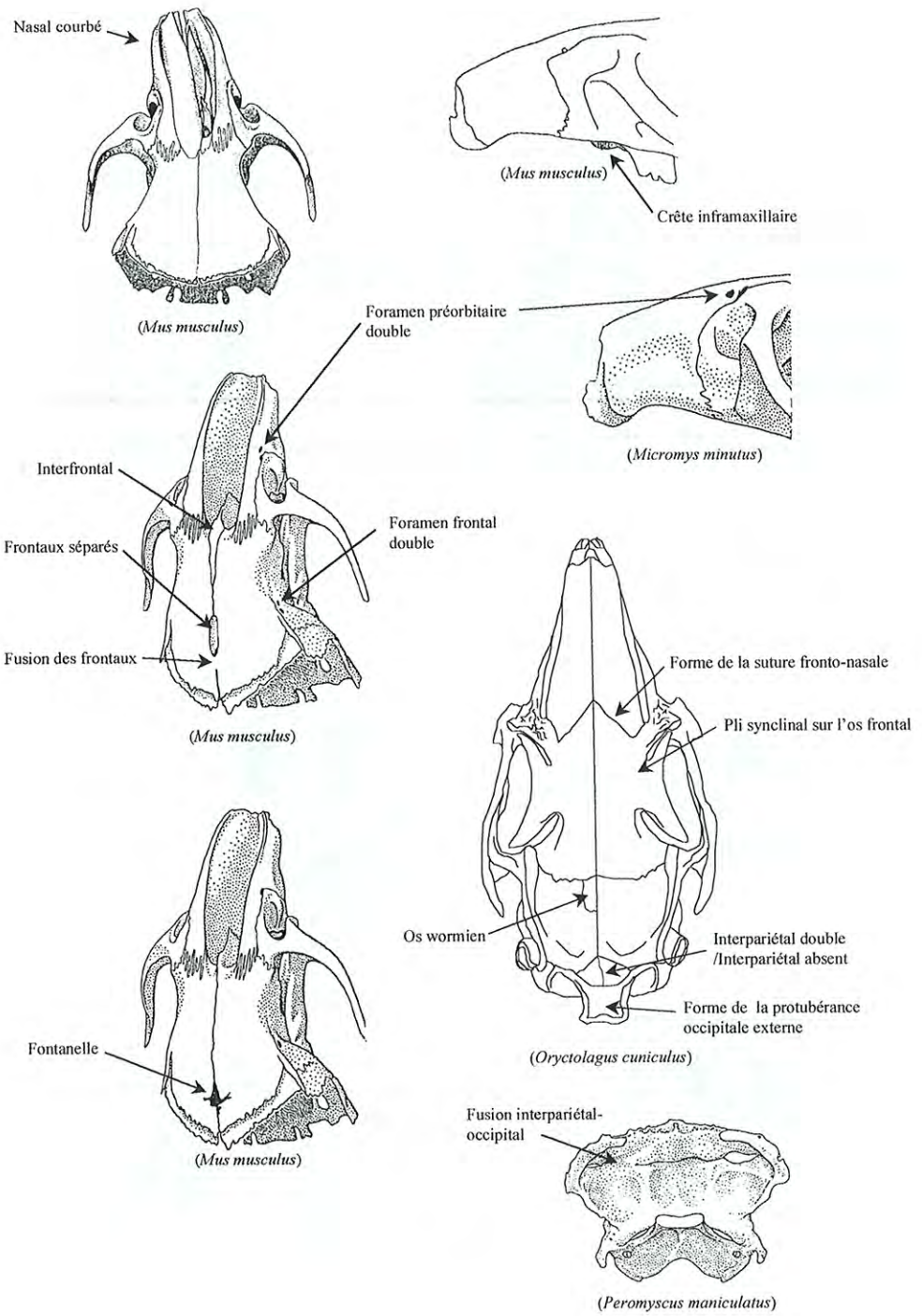


FIGURE 1

Représentation des caractères ostéoscopiques observés sur les crânes de rongeurs (d'après Deol, 1955; Berry, 1963; Berry & Searle, 1963; Searle, 1964) et de lagomorphes (Callou, 2000).

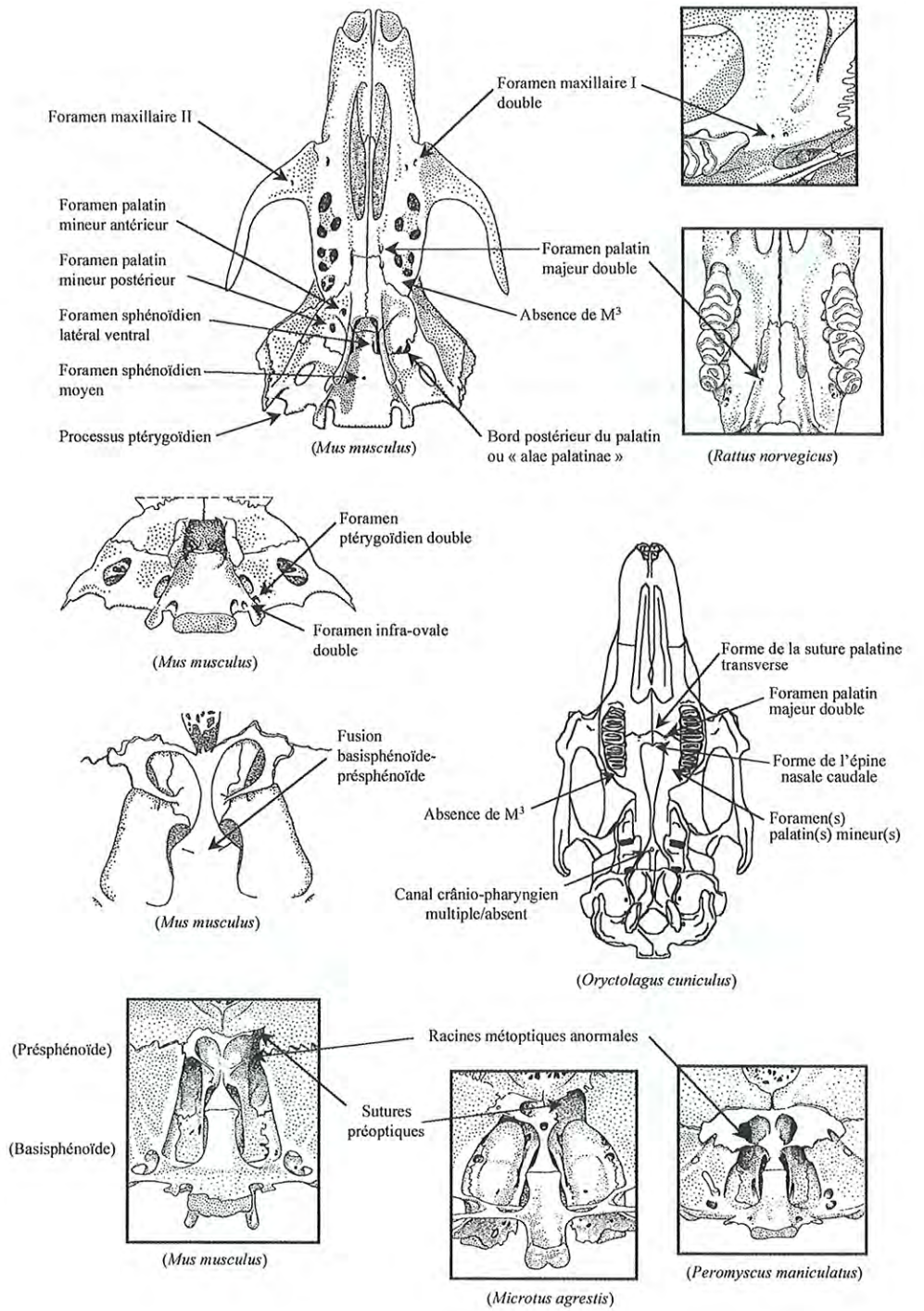


FIGURE 2

Sur les crânes de rongeurs (d'après Deol & Truslove, 1957; Berry, 1963; Berry & Searle, 1963) et de lagomorphes (Callou, 2000).

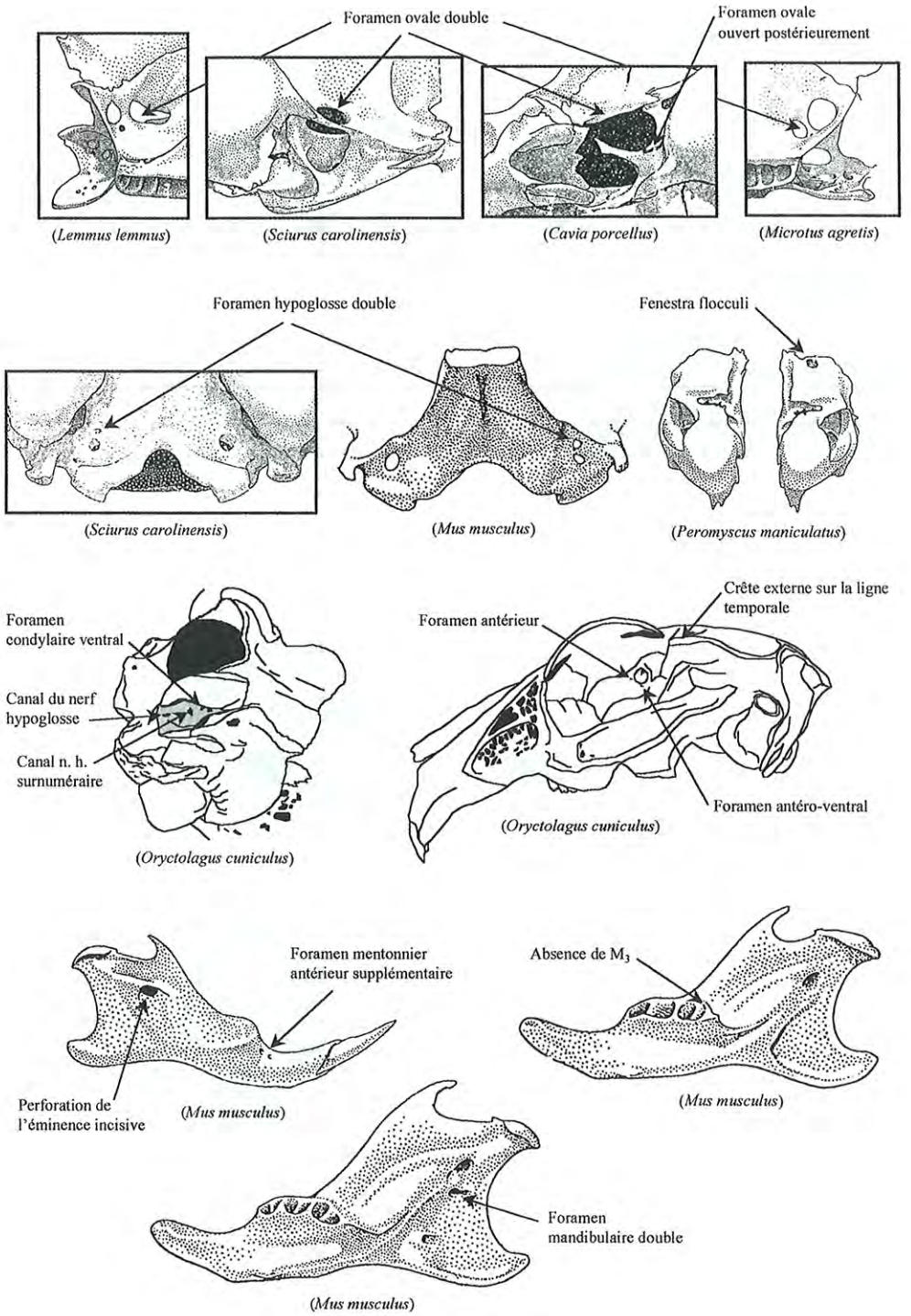


FIGURE 3

Sur les crânes et les mandibules de rongeurs (d'après Deol, 1955; Berry, 1963; Berry & Searle, 1963) et de lagomorphes (Callou, 2000).

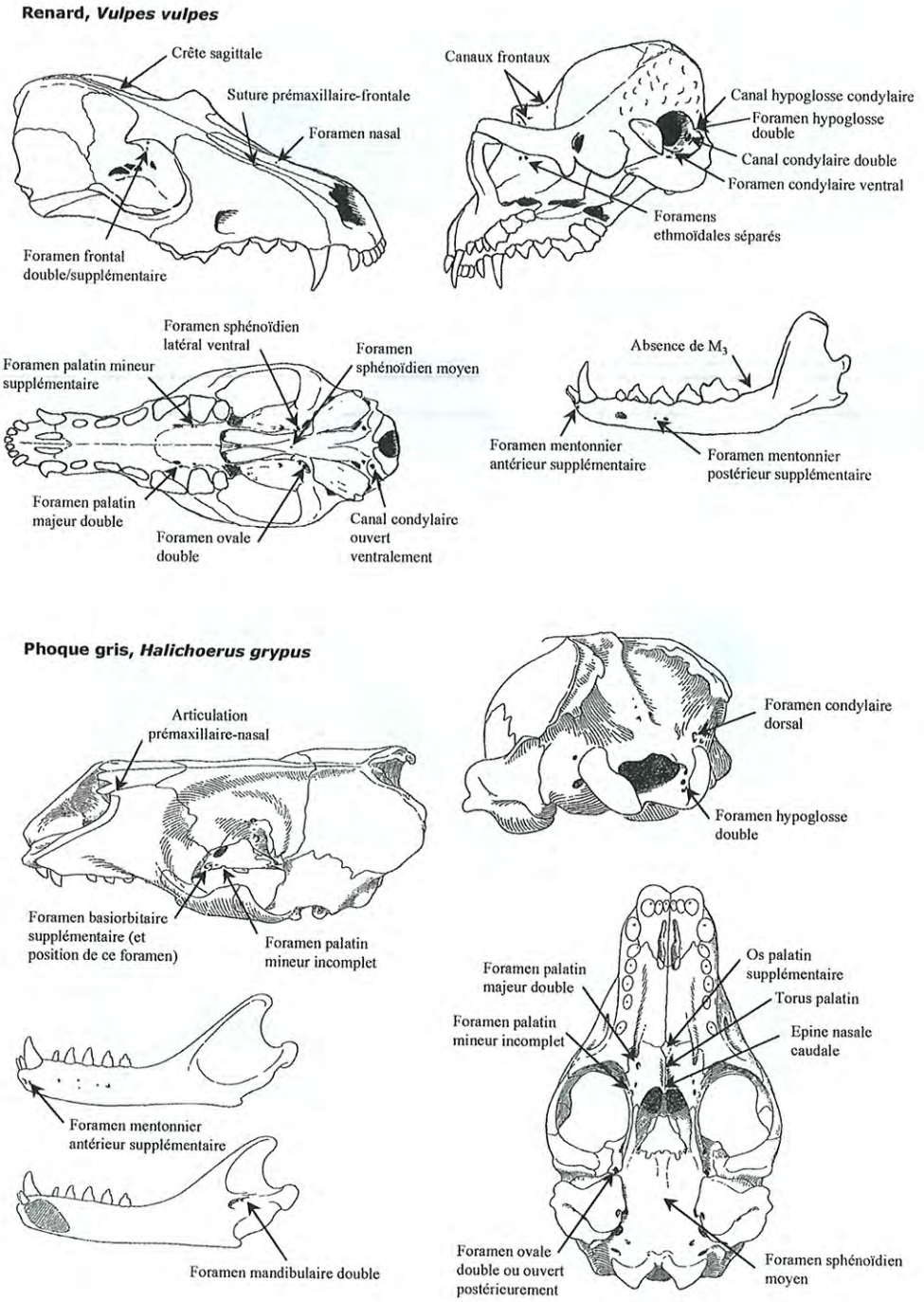


FIGURE 4

Sur les crânes et les mandibules de carnivores: renard *Vulpes vulpes* (d'après Sjøvold, 1977) et phoque gris *Halichoerus grypus* (d'après Berry, 1969).

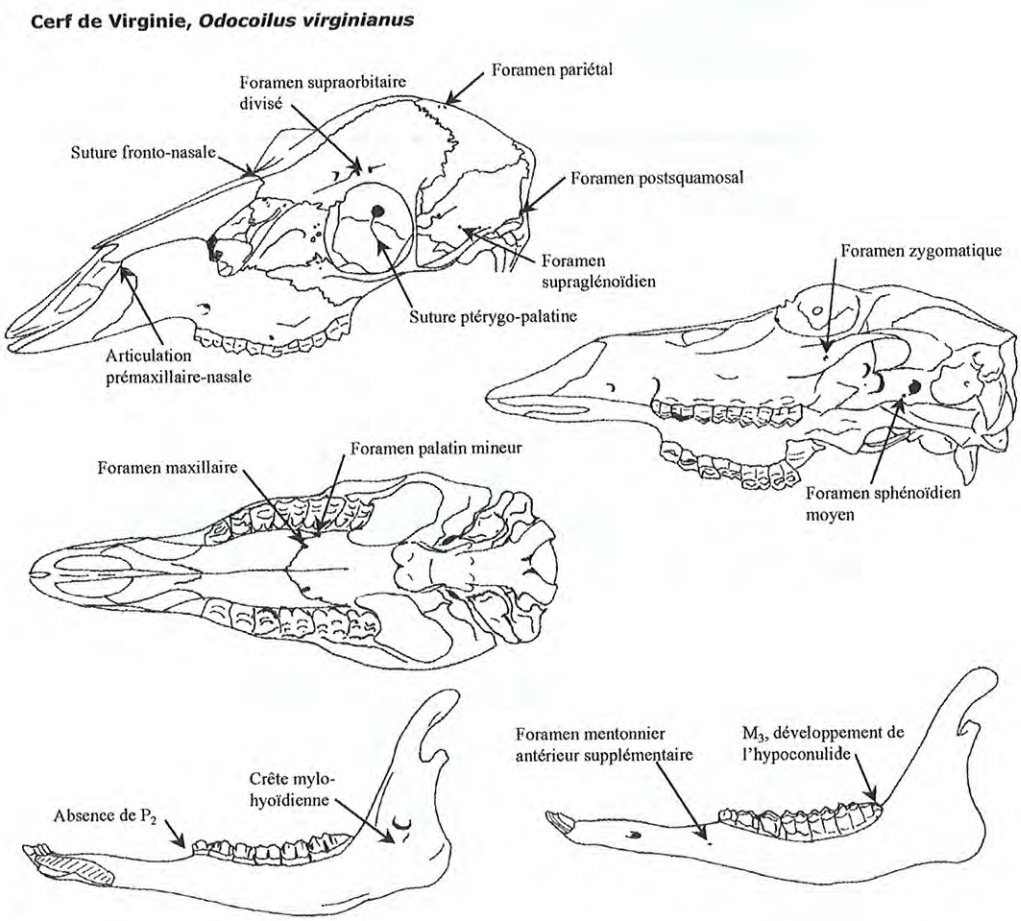


FIGURE 5

Sur les crânes et les mandibules d'artiodactyles: exemple du cerf de Virginie, *Odocoileus virginianus* (d'après Rees, 1969a).

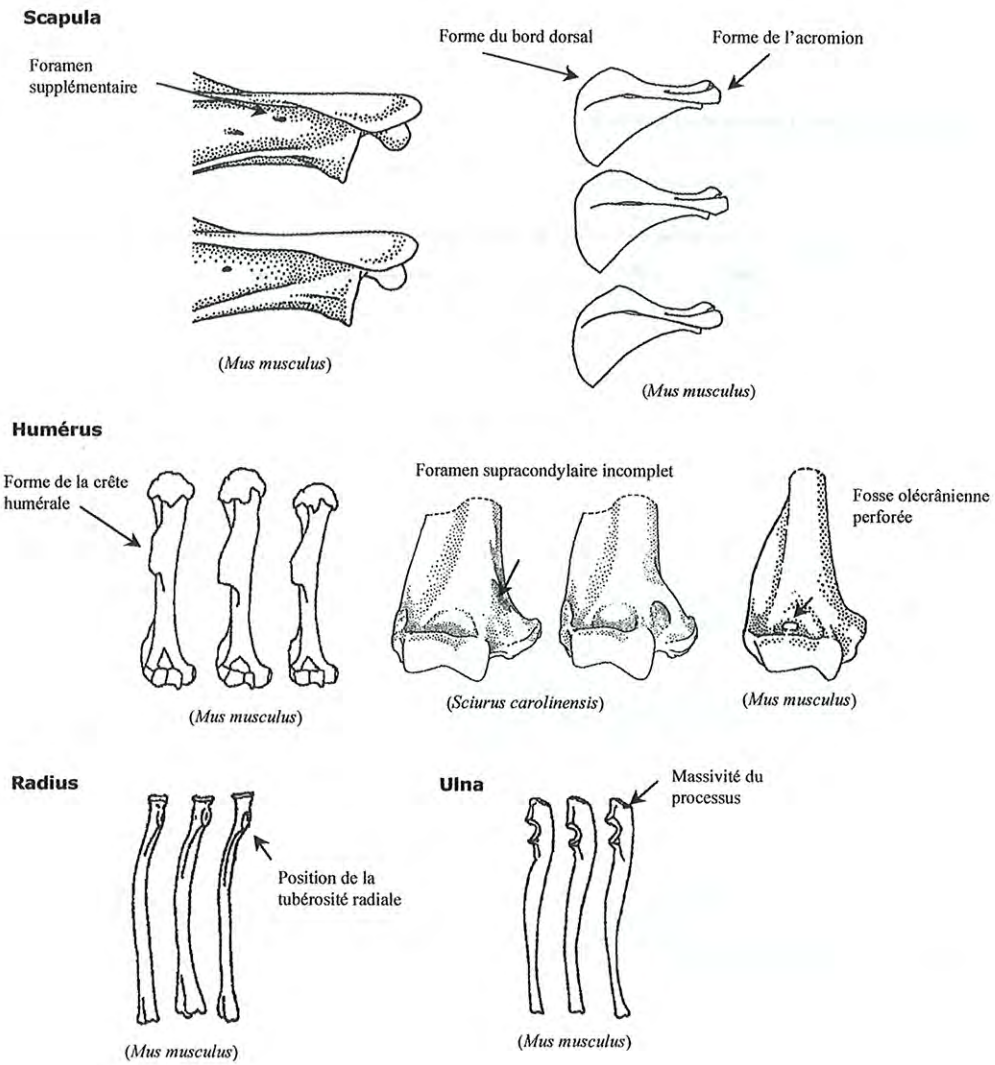


FIGURE 6
Sur le membre antérieur des rongeurs (d'après Stein, 1957; Berry & Searle, 1963; Berry, 1963) et de lagomorphes (Callou, 2000).

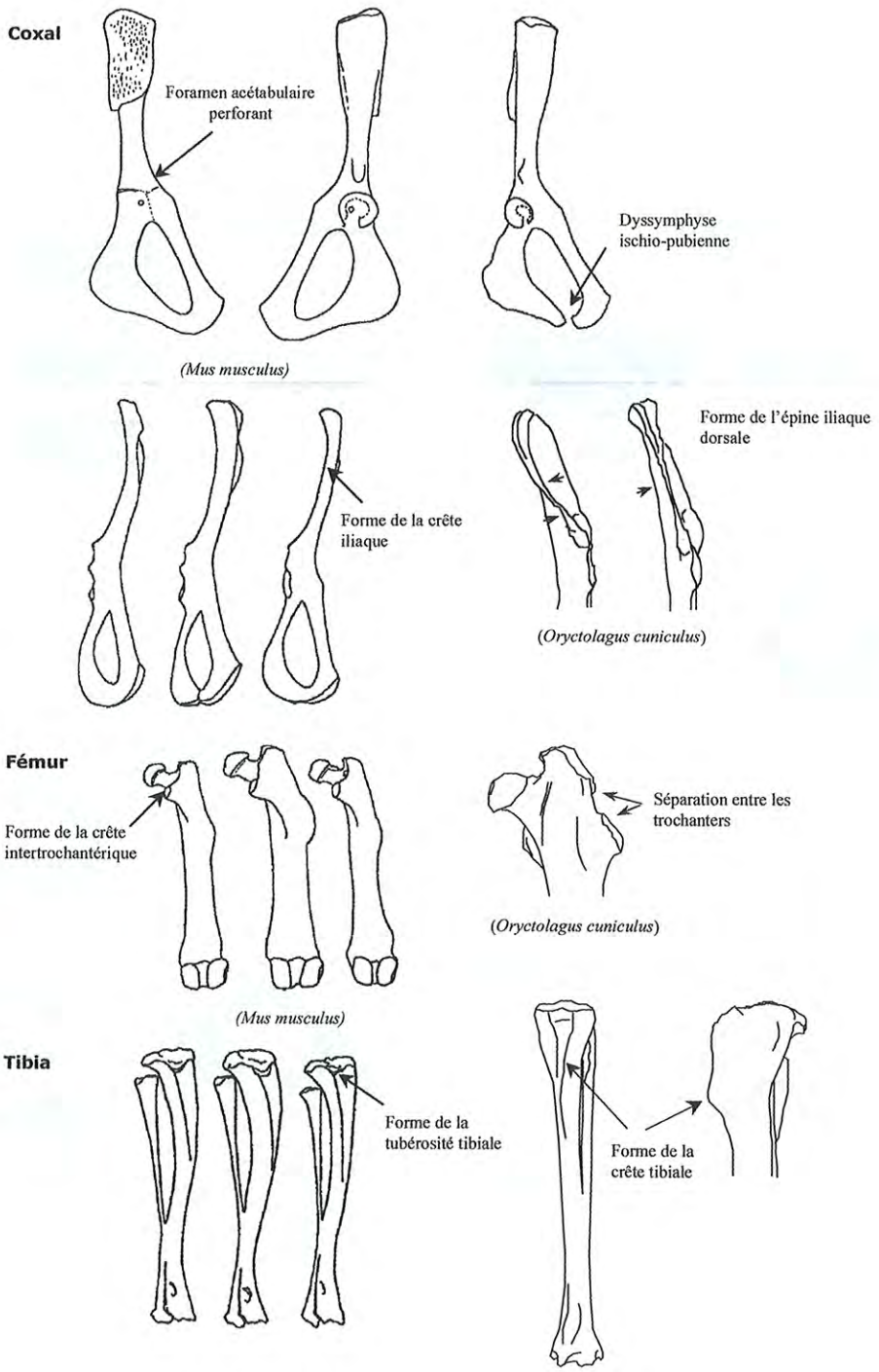


FIGURE 7

Sur le membre postérieur des rongeurs (d'après Stein, 1957; Berry, 1963) et de lagomorphes (Callou, 2000).

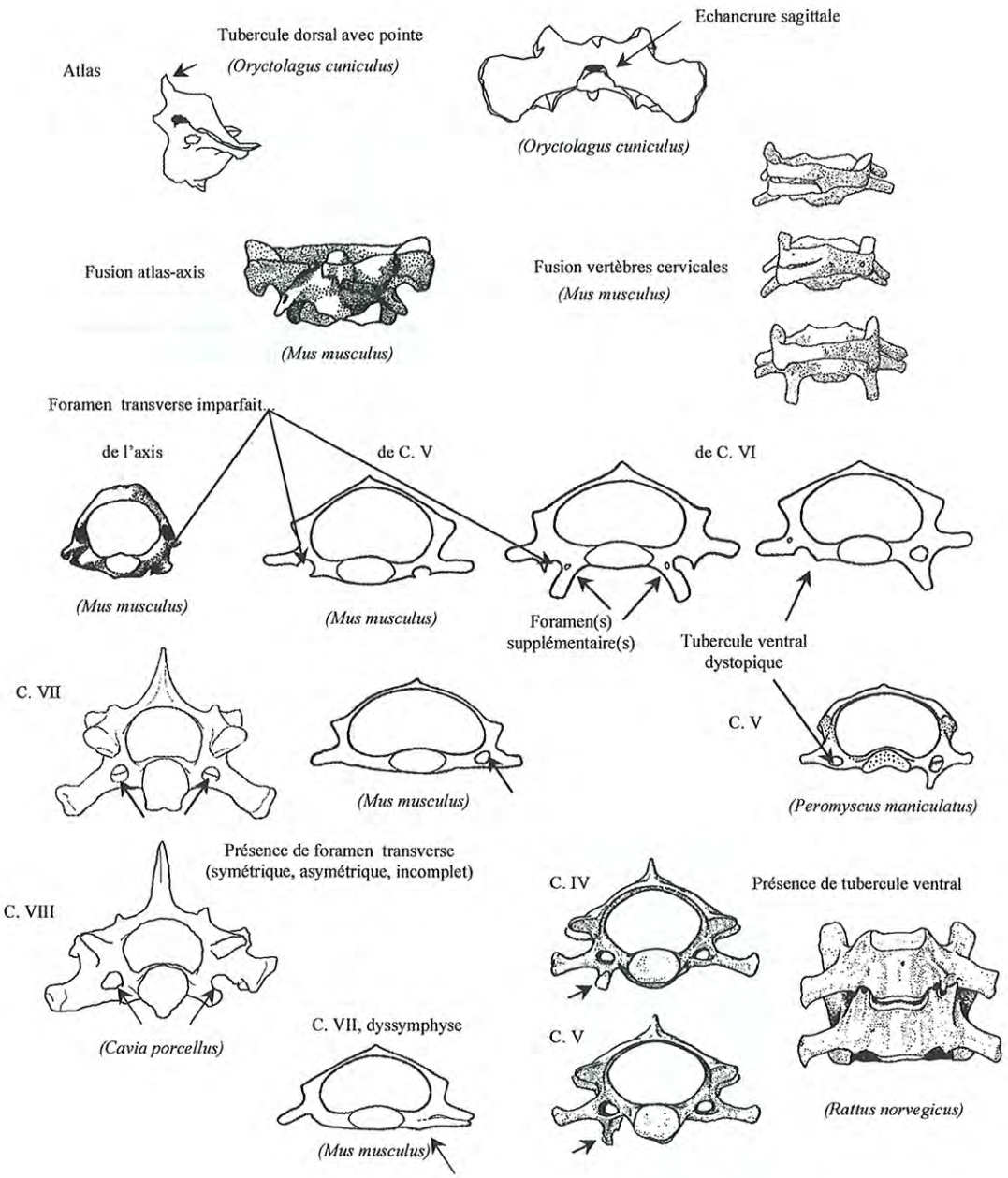


FIGURE 8

Sur les vertèbres cervicales de rongeurs (d'après Weber, 1950; Searle, 1954; Berry, 1963; Berry & Searle, 1963) et de lagomorphes (Callou, 2000).

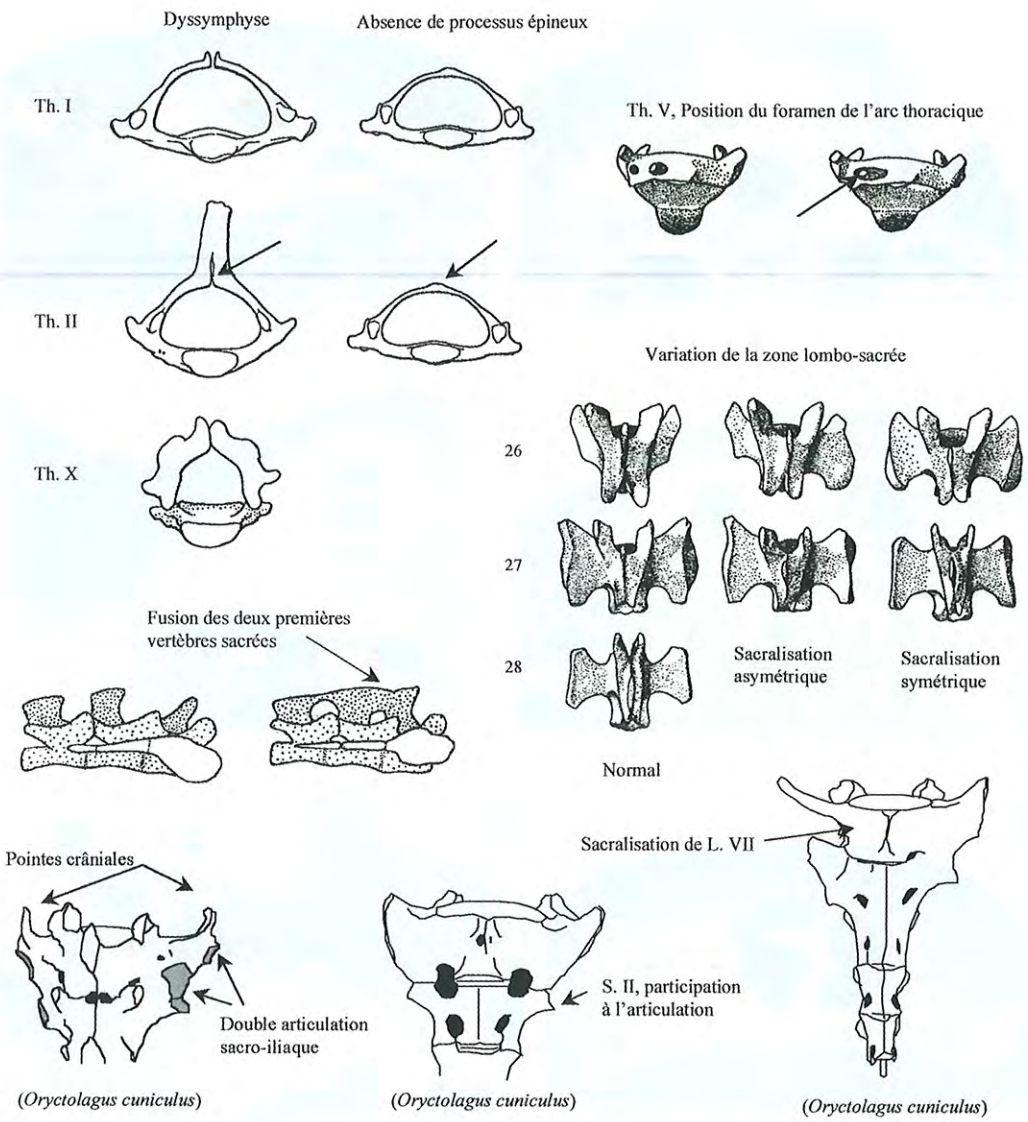


FIGURE 9

Sur les vertèbres thoraciques, lombaires et sacrées de rongeurs (exemple de la souris, *Mus musculus*; d'après Searle, 1954; Berry, 1963) et de lagomorphes (Callou, 2000).

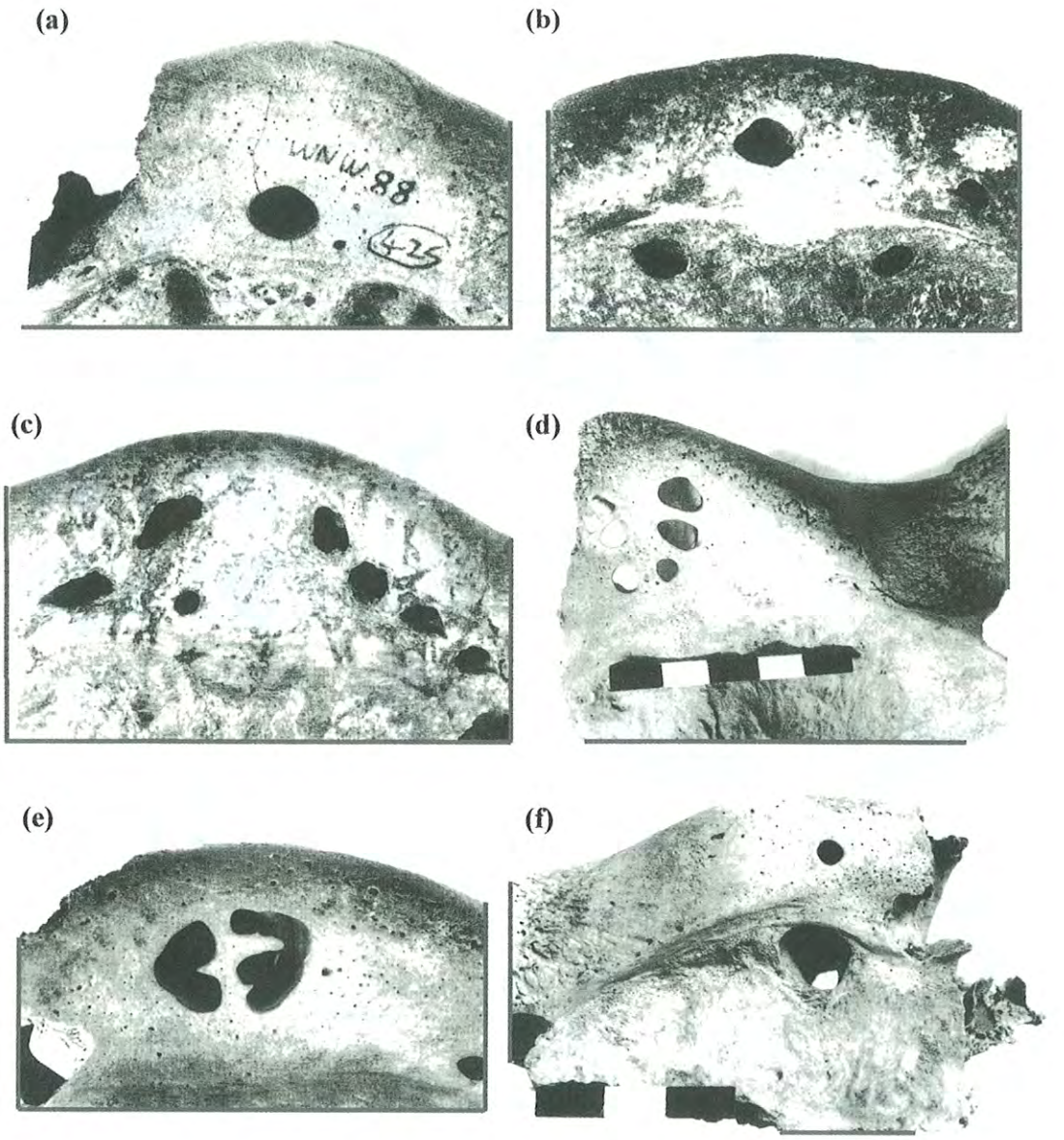


FIGURE 10

Vue postérieure de crânes archéologiques de bovins découverts en Grande-Bretagne et en Belgique présentant des perforations. Celles-ci peuvent être simples (a), multiples (b), multiples et linéaires (c), multiples et groupées (d et e) ou encore très "enfoncées" (f, trou inférieur). Les photos sont extraites de l'article de Brothwell *et al.*, 1996.

tilages. Certains caractères pourraient être assimilés à une "manifestation d'une vertèbre occipitale", c'est-à-dire qu'une partie de l'occipital proviendrait de la fusion d'une ébauche de vertèbres chez l'embryon. Le canal du nerf hypoglosse bi- ou multipartite serait dans ce cas (Braga, 1995).

3°) Les *os suturaux, fontanellaires et surnuméraires (os wormiens)*. Cette catégorie affecte essentiellement le crâne. Il s'agit de petits os venant s'intercaler entre deux os au niveau des sutures et à l'emplacement des fontanelles, et qui créent des sutures surnuméraires.

4°) La *présence ou l'absence d'orifices (foramens) et de sillons a priori* vasculaires et/ou nerveux est variable tant dans le nombre que dans la situation. Contrairement aux apparences, cette catégorie est ambiguë car certains caractères peuvent être dus à des variations *hyper-* ou *hypostotics*, occultant ou non des foramens.

HÉRITABILITÉ DES CARACTÈRES: DÉTERMINISME GÉNÉTIQUE OU INFLUENCE ENVIRONNEMENTALE?

La méconnaissance de la transmission des caractères ostéoscopiques a été révélée dès les années 50 grâce aux recherches menées sur la souris. Les analyses de lignées génétiquement contrôlées ou observées à l'état sauvage, ainsi que les études de populations humaines connues, ont permis d'élaborer de nombreuses théories et ont conduit à la création de divers modèles dont celui des "caractères quasi-continus à effet seuil" de Grüneberg (1952), ou celui polygénique de Falconer (1965). Suivant les auteurs, les caractères discrets dépendent exclusivement d'un mécanisme génétique (Berry & Berry 1967; Howe & Parsons, 1967); ou, au contraire, la participation de l'environnement est perçue comme dominante (Ossenberg, 1969; Corruccini, 1974); ou bien encore, un déterminisme génétique puis une modification en relation avec le milieu sont envisagés (Crubézy, 1991; Braga, 1995). Par ailleurs, certains auteurs comme Rösing (1982) considèrent que quelques caractères seulement peuvent être considérés comme génétiquement connus, tandis que pour les autres, la question reste en suspens.

A partir des années 70, l'influence de l'âge et/ou du sexe est reconnue dans la plupart des études sur l'Homme et l'animal. La recherche du déterminisme des caractères se tourne alors vers des populations structurellement connues, et donc mieux contrôlées.

Influence du milieu?

Une analyse portant sur une série de crânes portugais, pour lesquels l'âge et le sexe des individus étaient connus mais également la cause du décès, a montré l'existence d'une liaison significative entre la fréquence de certains caractères discrets et le niveau de vie des individus, entre le XIX^{e} siècle et le début du XX^{e} siècle (Bocquet-Appel, 1984). Cette étude a ainsi pu démontrer le rôle de facteurs extrinsèques, tels que la qualité de l'alimentation, dans l'apparition et la fréquence de certains caractères.

Des caractères longtemps considérés comme d'origine strictement génétique, comme le métopisme ou le torus mandibulaire, ont par ailleurs été remis en cause et l'influence de facteurs externes (pathologie, alimentation) a été démontrée. Bien que des exemples de métopismes familiaux aient été identifiés (Ossenberg, 1969), des études réalisées en Grande-Bretagne ont mis en évidence une présence importante de ce caractère chez des enfants souffrant d'anémie, ainsi que chez des individus porteurs d'une hyperostose poreuse (Stuart-Macadam, 1985). Dans le cas du torus mandibulaire, l'influence de facteurs extrinsèques est attestée par l'analyse d'un échantillon représentant 1500 mandibules appartenant à des hommes de différentes origines (Ossenberg, 1981): fréquence élevée dans les populations de l'Arctique, effet des changements alimentaires, régression avec l'âge, caractère plus marqué d'un côté que de l'autre en fonction du mode de consommation, etc.

Ou déterminisme génétique?

Chaque caractère serait déterminé par un certain nombre de gènes agissant simultanément. Il est même admis par certains auteurs (Hertzog, 1968; Cheverud & Buikstra, 1981b), sur la base des observations d'association entre les caractères, que les gènes responsables de l'expression des caractères interviennent par l'intermédiaire de processus de développement très localisés. Certaines séquences de l'ADN, impliquées dans des anomalies du nombre ou de segmentation des somites chez l'embryon (McGinnis *et al.,* 1984; cité par

Braga, 1995) pourraient être à l'origine de certains caractères discrets chez l'Homme (Crubézy, 1991) et les grands singes (Braga, 1993).

Des études anthropologiques ont d'autre part montré que les caractères *hypostotics* seraient dominants chez la femme tandis que les caractères *hyperostotics* le seraient chez l'homme (Ossenberg, 1969; Molto, 1983 cité par Crubézy, 1991). Les auteurs ont alors envisagé un lien avec la croissance qu'ils expliquaient par des paramètres de robustesse ou de gracilité des os (Crubézy, 1991). Or, cela n'a jamais pu être réellement démontré (Sjøvold, 1977).

Des études récentes, réalisées dans le même domaine (Crubézy, 1991), ont insisté sur la plus grande héritabilité des caractères *hyperostotics* par rapport aux caractères *hypostotics* et aux foramens, les os suturaires présentant un lien plus important avec la croissance. Il est également apparu que les foramens pouvaient être assimilés à des caractères *hypostotics* et que ces derniers étaient peu liés aux caractères *hyperostotics*. Ces recherches n'ont cependant pas rejeté le fait que tous ces caractères puissent être transmissibles.

Un autre phénomène semble intervenir sur ces variations: le stress. Celui-ci pourrait provoquer un retard dans la croissance de certaines zones et favoriser ainsi la présence ou l'absence de nombreux caractères de type *hypostotic*. La variation de tels caractères dans une population humaine serait alors liée à l'âge auquel le stress est intervenu (Crubézy, 1991). Un stress lié au climat, à la température, à l'alimentation, etc, semble également entraîner des variations dans les populations animales (Auffray *et al.*, 1999) et végétales. Les variables ostéoscopiques pourraient donc être considérées comme indicatrices d'une stabilité ou d'une instabilité du développement.

Les études sur le polymorphisme ont cherché à mieux comprendre les relations existant entre le gène (génotype) et son expression (phénotype). Si le gène intervient certainement, son expression peut dépendre de divers facteurs extrinsèques tels que l'alimentation, le biotope, le comportement territorial et social, etc. Et ces facteurs sont variables en fonction des individus, des groupes familiaux et du milieu dans lequel ceux-ci évoluent. Il semble par ailleurs qu'aucun caractère ostéoscopique n'a actuellement un déterminisme génétique parfaitement connu (Crubézy, 1995). Il apparaît en outre que tous les caractères ne peuvent pas être considérés de la même manière; certains correspondent à une variation du développement et de la croissance, d'autres sont liés à l'âge ou au sexe et enfin quelques-uns semblent déterminés génétiquement (Callou, 2000). Comme l'écrit Braga (1995): "*Décrire la variabilité, définir des caractères phénotypiques sur le squelette ne permet souvent pas d'accéder directement au génotype. Un ensemble de caractères phénotypiques ne peut en théorie être utilisé dans des comparaisons que si, d'une part il représente un échantillon aléatoire de gènes et, d'autre part, la variation phénotypique est directement fonction de la variation génotypique*". Il est donc essentiel de définir des caractères phénotypiques, c'est-à-dire ostéoscopiques, qui soient pertinents dans une analyse interpopulations. Il est également recommandé que les résultats des analyses puissent être confrontés à ceux des données génétiques.

LES CARACTÈRES OSTÉOSCOPIQUES (OU DISCRETS) CHEZ LES ANIMAUX ACTUELS[6]

Les premières recherches menées sur des populations animales actuelles de souris se rapportaient non pas au crâne mais à la colonne vertébrale, plus précisément aux régions cervicale et thoracique supérieure, considérées comme les parties les plus variables (Grüneberg, 1950; Weber, 1950). Cette zone a été également privilégiée dans la série d'études consacrée au lapin, "Morphogenetic studies of the rabbit", les auteurs s'intéressant essentiellement à l'effet de certains gènes sur la croissance et le développement de l'espèce à partir du stade fœtal (Sawin, 1945; Sawin & Hull, 1946; Hull, 1947; Crary & Sawin, 1949, 1955, 1957, 1963; Peck & Sawin, 1950; Sawin & Dietz, 1950; Tanner & Sawin, 1953; Latimer & Sawin, 1955a, 1955b, 1957, 1959a, 1959b, 1959c, 1960, 1963; Sawin & Crary, 1956, 1957; Crary *et al.*, 1958; Sawin *et al.*, 1959, 1962; Lamb & Sawin, 1963; Sawin & Hamlet, 1972).

[6] L'exemple des Primates ne sera pa abordé ici en raison de la trop forte homologie des caractères avec ceux de l'Homme (cf. Cheverud & Buikstra, 1981a et b, par exemple).

Les espèces

A la suite des études sur les souris, les principales recherches se sont naturellement portées sur les Rongeurs (Grüneberg, 1961; Berry & Searle, 1963; Berry, 1969, 1975; Hilborn, 1974; Berry & Rose, 1975): Sciuridae (*Sciurus carolinensis*), Caviidae (*Cavia porcellus*), Arvicolidae (*Microtus arvalis*, *M. californicus*, *M. agrestis*, *Lemmus lemmus*) et Muridae (*Micromys minutus*, *Apodemus sylvaticus*, *Rattus rattus*, *R. norvegicus*, *R. exulans*).

Les résultats ont fait apparaître: 1°) une grande diversité des caractères, certains pouvant être communs à plusieurs espèces, d'autres, plus rares, n'étant présents que chez une espèce; 2°) l'existence d'une importante variation entre les espèces et entre les populations d'une même espèce.

Il était par conséquent concevable, par cette approche, de vouloir caractériser des populations et d'effectuer des comparaisons géographiques, dans l'intention d'évaluer les différences entre des populations continentales et/ou insulaires et de mieux comprendre leur histoire. C'est dans cet esprit qu'ont été réalisées des recherches sur une grenouille *Rana cyanophlictis* (Grewal & Dasgupta, 1967; Grewal, 1978), sur le phoque gris *Halichoerus grypus* (Berry, 1969a), sur le cerf de Virginie *Odocoileus virginianus* (Rees, 1969a), sur le renard *Vulpes vulpes* (Sjøvold, 1977) et, plus récemment, sur le lapin *Oryctolagus cuniculus* (Callou, 2000).

Les études de populations restent donc rares et le nombre d'espèces analysées peu élevé. Les descriptions ponctuelles d'un caractère pour une espèce donnée sont en revanche très fréquentes. A titre d'exemples, nous citerons la variation du nombre de vertèbres de la salamandre *Plethodon cinereus* (Highton, 1960), la présence d'une racine supplémentaire à la troisième molaire supérieure chez le campagnol roussâtre *Clethrionomys glareolus* (Berry & Searle, 1963) et chez le mulot sylvestre *Apodemus sylvaticus* (Kahmann, 1969), l'absence de la troisième molaire et le foramen hypoglosse double chez la musaraigne murine *Suncus murinus* (Berry & Searle, 1963), le nasal courbé chez la chauve-souris et le hérisson *Erinaceus europaeus* (Berry & Searle, 1963), le foramen acétabulaire perforant chez la taupe *Talpa europaea* (Berry & Searle, 1963), la polydactylie du cobaye *Cavia porcellus* (Wright, 1934a, b), les os wormiens suturaux et fontanellaires du bœuf *Bos taurus*, du cheval *Equus caballus*, des Suidés *Sus scrofa* et de l'élan *Alces alces* (Cornevin, 1883), l'absence de la deuxième prémolaire inférieure (P_2) chez des bovins actuels, sauvages et domestiques (Andrews & Noddle, 1975), etc.

Les caractères

Le recensement effectué concerne exclusivement les caractères se rapportant aux Mammifères. Seuls ceux cités dans des études dont les objectifs étaient la recherche de caractères diagnostiques permettant une comparaison entre les espèces ou l'analyse géographique de différentes populations d'une même espèce ont été retenus. Cet inventaire ne doit donc pas être considéré comme un recensement exhaustif de tous les caractères discrets observés sur des animaux actuels.

Pour les dix-sept espèces étudiées dans cette optique, la liste comporte 84 caractères crâniens (76 pour le calvarium et 8 pour la mandibule) et 60 post-crâniens (Tableau 1). Les caractères identiques ou affectant la même partie anatomique, mais qui sont exprimés différemment en fonction des espèces, ne sont pas distingués dans ce décompte: foramen optique supplémentaire ou antéro-ventral supplémentaire, foramen maxillaire, maxillaire I, double ou supplémentaire, foramen palatin mineur ou mineur antérieur, foramen postsquamosal ou squamosal, foramen hypoglosse simple ou double, foramen acétabulaire perforant ou non perforant, processus épineux de la deuxième vertèbre thoracique (Th II) absent ou de dimension variable.

Une grande majorité des caractères se rapporte donc aux éléments crâniens, essentiellement au calvarium: 41 caractères crâniens pour la souris et une moyenne de 16 caractères pour les autres espèces, et 47 caractères post-crâniens, dont 26 sur le squelette axial, pour la souris et une moyenne de seulement 8 caractères pour les autres espèces. A titre d'illustration, notons l'absence de données pour le post-crânien du renard, du phoque ou du cerf de Virginie.

La plupart des caractères se rapportent à la quatrième catégorie définie par Ossenberg (1969), celle des foramens et canaux vasculaires, qu'ils soient présents, absents, multiples ou surnuméraires. Les os surnuméraires sont également bien représentés (interfrontal, interpariétal, fronto-nasal, os palatin supplémentaire), ainsi que les caractères *hypostotics* (absence de la troisième molaire, présence d'une fontanelle, persistance de certaines sutures: suture fronto-nasale, prémaxi-

llaire-frontale, ptérygo-palatine, préoptiques du présphénoïde) et enfin, les caractères *hyperostotics*, dominés par les fusions osseuses (nasaux, nasal-turbinal, lacrymal-maxillaire, frontaux, interfrontal-frontal, turbinal-prémaxillaire, interpariétal-occipital, squamosal-frontal, squamosal-pariétal, périotique-occipital, basisphénoïde-présphénoïde ou basisphénoïde-basioccipital). Il faut ajouter à ces quatre catégories, un ensemble de données plus subjectives qui se rapporte à la forme de certaines parties anatomiques, les éléments concernés étant principalement post-crâniens. Ces caractères posent le problème de leur reproductibilité tant la forme de la zone concernée paraît variable; difficultés non pas entre espèces, mais sur des individus d'une même espèce, voire sur un même individu d'une observation à l'autre. C'est notamment le cas de la forme de l'extrémité acromiale de la clavicule ou de la torsion ischio-pubienne du pelvis chez la souris. Une description détaillée, dans la formulation et dans la représentation, est impérative pour les caractères de ce type.

Lorsqu'on examine à présent la nature des caractères, on constate une certaine homogénéité entre les auteurs. Celle-ci n'est *a priori* guère surprenante compte-tenu du protocole adopté dès l'origine, qui consistait à retrouver des caractères déjà identifiés chez une autre espèce, l'Homme y compris, en se fondant sur un principe d'homologie anatomique. Or, si certains caractères pouvaient être communs à deux espèces, d'autres se révélaient diagnostiques d'une espèce: présence d'un interpariétal chez le campagnol des champs ou du foramen zygomatique chez le cerf, par exemple. D'autre part, le passage d'un groupe à un autre a rapidement montré ses limites. Dans son étude sur le renard, Sjøvold (1977) a tenté d'appliquer les caractères décrits préalablement par Truslove (1961) et Hilborn (1974) sur les rongeurs, ce qui s'est révélé impossible. Il lui a donc fallu constituer son propre référentiel à partir du matériel d'étude. Cet exemple démontre qu'il est possible d'utiliser un ensemble de caractères uniquement entre des taxons proches: entre deux rongeurs ou entre le renard et le loup, ou le chien quelle que soit la race à laquelle il appartient (Sjøvold, 1977). Dans le cas de recherches sur des taxons plus éloignés, il faut renouveler le jeu de caractères. Cela reste évidemment vrai pour les Lagomorphes par rapport aux Rongeurs.

Quelques caractères apparaissent pourtant communs aux petits et aux grands mammifères: foramen palatin majeur double, foramen palatin mineur supplémentaire, foramen frontal double, foramen ovale double, foramen ovale ouvert postérieurement, foramen sphénoïdien moyen, foramen sphénoïdien latéral ventral et foramen hypoglosse double, forme de l'épine nasale caudale.

Si on considère à présent l'aspect quantitatif, il apparaît que tous les caractères ostéoscopiques n'ont pas une valeur identique; certains sont fréquents, la fréquence variant en fonction du groupe ou de la population, d'autres sont rencontrés occasionnellement et constituent un ensemble de caractères rares. Ces deux groupes de caractères interviennent dans les comparaisons de populations, mais doivent faire l'objet d'un traitement différent.

Cet inventaire souligne la richesse et la variété des caractères ostéoscopiques crâniens découverts sur des animaux actuels et la potentialité de ceux du squelette post-crânien. Ces derniers n'ont pour l'instant pas été réellement exploités et demeurent au stade de la description.

Apports des caractères ostéoscopiques (ou discrets) à la connaissance des populations animales actuelles

Dans leur étude sur différents genres et espèces de Rongeurs, Berry & Searle (1963) ont fait apparaître plusieurs points:

1°) Les effets de la domestication. La comparaison de formes "domestiques" et sauvages de rat surmulot, *Rattus norvegicus*, a révélé des différences de fréquence entre les caractères. Il n'a pas été possible cependant d'obtenir des résultats aussi tranchés sur les deux formes du cobaye.

2°) Une stabilité dans la fréquence de certaines variables à l'intérieur d'une espèce. Ils soulignent néanmoins les biais provoqués par la taille de l'échantillon et surtout par le fait que la plupart des caractères sont décrits originellement sur une seule espèce (la souris); celle-ci présente évidemment le plus fort taux de stabilité.

3°) Les différences entre deux populations sauvages d'une même espèce.

Dans sa recherche sur le mulot *Apodemus sylvaticus*, Berry (1975b) rappelait qu'aucune population n'est génétiquement stable et que l'immigration, les transferts et/ou les isolements

entraînent la séparation de petits groupes d'individus et favorisent des effets de fondation. Les animaux domestiques correspondent évidemment à ce schéma d'isolement par rapport aux populations sauvages dont ils sont issus. Pourtant, à l'exception de l'article de Berry & Searle (1963) sur les Rongeurs (formes domestiques du cobaye et du rat) et de la recherche menée sur les lapins (Callou, 2000), cette question n'avait jamais été abordée avec les caractères ostéoscopiques.

Les études entre différents groupes d'une même espèce ont en revanche fait l'objet de plusieurs approches. Les premières ont cherché à se démarquer de l'influence de l'environnement en étudiant des groupes isolés dans une zone très circonscrite, dans le but de prouver que les variations de caractères entre ces groupes ne pouvaient être que le reflet de la génétique[7]. Grüneberg (1961) a ainsi étudié 150 rats noirs *Rattus rattus*, adultes et subadultes, prélevés dans cinq endroits différents autour de Dehli (Inde) qui bénéficiaient par conséquent de conditions climatiques identiques et qui étaient supposés avoir une alimentation similaire.

Bien que ne concernant pas des Mammifères mais une grenouille, *Rana cyanophlictis*, les études de Grewal & Dasgupta (1967, 1978) réalisées dans la même aire géographique que celles des rats sont intéressantes d'un point de vue méthodologique. S'agissant d'animaux aquatiques, l'éventualité d'une introgression entre les cinq populations de grenouille était tout d'abord écartée. Il y a eu ensuite deux études sur les mêmes populations, utilisant des caractères et une procédure semblables, à presque dix ans d'intervalle. La première année, les chercheurs ont constaté une très grande diversité entre les populations, à l'exception de deux d'entre elles présentant un faible taux de divergence alors qu'elles étaient géographiquement relativement éloignées. Dix ans plus tard, une des populations avait disparu après assèchement de la zone, une population présentait des modifications tandis que les autres restaient stables.

Les conclusions de ces trois études étaient que la séparation des groupes à un moment donné, à partir d'une population initiale que les auteurs supposaient unique, a entraîné un appauvrissement du nombre des caractères ainsi qu'une diminution de fréquence de certains d'entre eux. Ne pouvant être liées à l'influence de l'environnement, puisque les effets de celui-ci étaient estimés contrôlés, les modifications ne pouvaient qu'être le reflet d'une dérive génétique.

D'autres approches se sont consacrées à l'origine des populations. Berry (1969), par exemple, a analysé 1234 crânes de mulot provenant de 26 localités (plusieurs îles des Hébrides et des Shetlands, différentes populations continentales). Son objectif était de valider l'hypothèse de Corbet sur l'introduction anthropique récente des animaux dans les îles. De nombreuses sous-espèces d'*Apodemus*, présentant des variations de pelage et des différences métriques, étaient identifiées sur les îles. Les résultats ont montré, qu'en dépit d'un isolement historique, donc récent, les populations insulaires étaient assez divergentes les unes des autres mais semblaient présenter une certaine similarité avec les populations continentales (Irlande, Angleterre, France et Norvège).

Quelques années plus tard, Berry & Rose (1975) se sont intéressés à l'évolution des populations de campagnols *Microtus arvalis* sur les îles de Guernesey et des Orcades et à leur lien avec des populations continentales (France, Péninsule ibérique, Allemagne, Hongrie, Yougoslavie et Grèce), leur but étant de vérifier si ces populations étaient relictuelles ou introduites. D'après leurs résultats: 1°) la population de Guernesey étant extrêmement proche des campagnols germaniques, elle pouvait être considérée comme relictuelle et 2°) les trois populations des Orcades formaient un groupe à part, présentant de grandes affinités avec les populations du sud de l'Europe. Les auteurs supposaient alors que les campagnols auraient été importés à partir de cette zone par les premiers colonisateurs humains.

Ces conclusions sont évidemment séduisantes. Elles soulignent l'intérêt qu'il peut y avoir à exploiter des caractères ostéoscopiques dans la reconstitution de l'origine des populations. Elles sont pourtant à considérer avec prudence car elles font suite à l'enthousiasme provoqué par une première étude d'un des auteurs (Berry & Berry, 1967). Les biais méthodologiques qui peuvent survenir dans ce type d'approche sont donc partiellement masqués. De plus, le déterminisme et les conditions de transmissions des caractères étaient

[7] Les recherches menées sur des populations de souris sauvages ne répondaient pas aux mêmes exigences; elles venaient soit de pays différents, Angleterre, Ecosse et Suisse (Weber, 1950), soit de zones géographiques variées dans l'Est des Etats-Unis (Deol, 1958).

considérés connus alors qu'ils étaient en réalité à peine entrevus.

LES CARACTÈRES OSTÉOSCOPIQUES (OU DISCRETS) CHEZ LES ANIMAUX FOSSILES

La première étude archéologique utilisant des caractères discrets a été réalisée sur les crânes humains des sépultures collectives néolithiques de Niederbösa et Nordhausen (Feustel & Ullrich, 1964/65). Si, depuis cette date, les analyses paléo-anthropologiques se sont multipliées (Rösing, 1982; revue par Crubézy, 1991), l'application de la méthode est en revanche restée anecdotique ou inexistante en archéozoologie. Plusieurs raisons liées à la méthode elle-même, aux caractères ou au matériel osseux peuvent expliquer cette absence.

1°) La méconnaissance de la méthode. L'emploi des caractères discrets pour l'étude des populations animales ne fait pas encore partie de nos jours des méthodes classiques de l'archéozoologie et, à ce titre, n'apparaît pas dans les manuels ayant trait à la discipline (Davis, 1987; Chaix & Méniel, 1996, par exemple). Tant que des études ne démontreront pas l'apport des caractères discrets pour des populations animales en général et des populations fossiles en particulier, les variables discrètes ne seront pas exploitées, ou tout du moins enregistrées, aussi systématiquement que peuvent l'être les variables métriques.

2°) La méconnaissance des apports de cette méthode. Les hésitations des anthropologues dans les années 80 et leurs critiques à l'encontre des caractères discrets et sur les limites de leur application à des populations anciennes y ont certainement contribué. La littérature semblait en effet plus orientée sur les difficultés d'attribuer à ces caractères une origine, génétique ou environnementale, plutôt que sur leur contribution à la connaissance de la domestication, à l'histoire des populations, à la reconstitution des lignées familiales, etc.

3°) Certains caractères discrets ont longtemps été et sont encore parfois considérés comme des anomalies du développement (Baker & Brothwell, 1980; Miles & Grigson, 1991).

4°) A l'exception de quelques variables telles que la présence d'un os surnuméraire ou l'absence d'une dent, les caractères ostéoscopiques ne peuvent être observés et enregistrés que s'ils sont recherchés. De plus, ceux-ci ne peuvent faire l'objet d'une recherche que s'ils ont été préalablement décrits pour l'espèce ou pour un groupe semblable. Les difficultés de transposition des caractères entre espèces différentes ont été évoquées précédemment.

5°) L'enregistrement systématique des caractères discrets sur du matériel faunique est exceptionnel et seul O'Connor (1984, 1988, 1990) en Grande-Bretagne semble le faire. Toutefois, seuls des travaux sur une espèce donnée, comme cela a été le cas pour le lapin (Callou, 2000), ou sur une problématique régionale (transformation liée à l'insularité, relations entre différents groupes évoluant dans une aire géographique circonscrite, etc) paraissent justifier la mise en œuvre d'une telle approche. Plus que la systématisation, et plus encore que pour toute autre méthode, une problématique bien définie doit être privilégiée dans l'utilisation des caractères ostéoscopiques; et cela est d'autant plus vrai que l'héritabilité des caractères n'est apparemment que partielle.

6°) L'état de conservation du matériel. Les caractères discrets sont le plus souvent décrits sur le calvarium et la mandibule puis, dans une moindre mesure, sur les éléments du squelette post-crânien. Or, sauf exceptions, les crânes sont les parties anatomiques les plus fragmentées. La fragmentation gêne d'ailleurs la reconnaissance de certains caractères, qui sont habituellement localisés sur des sutures, sur des zones où l'os est peu épais, sur des parties fragiles (bulle tympanique, présphénoïde, etc).

Il existe pourtant, dans la littérature archéologique, quelques mentions de caractères discrets se rapportant aux restes fauniques:

Rainure le long de la courbure externe de la corne des ovins

Une rainure le long de la courbure externe de la corne des ovins a été observée par Noddle (1978) sur des races actuelles à face noire (Irish blackface) et chez les Norfolk Horn ainsi que sur certains restes archéologiques anglais et écossais datant du Moyen Age.

Perforations crâniennes

Les perforations crâniennes, évoquées pour la première fois par Baker & Brothwell (1980), ont depuis été recensées sur des restes provenant de dix-sept sites archéologiques de France, de Gran-

de-Bretagne, de Belgique, de Suisse, d'Allemagne et des Pays-Bas (Grenouilloux, 1989; Brothwell *et al.*, 1996). Relevées exclusivement sur des crânes de bovins (Figure 10), elles présentent une même localisation, sur l'occipital à l'arrière des éminences frontales et nuchales. Aucun cas de perforations à l'extérieur de la région de la protubérance occipitale externe ou de la ligne nuchale supérieure n'a été observé[8]. L'hypothèse d'un parasitisme ou d'une infection (tumeur) ayant été écartée après analyse microscopique des surfaces osseuses, il restait deux solutions: soit une origine génétique, soit la répercussion d'une pression humaine.

Une explication des perforations crâniennes par le port du joug avait été proposée par Ryder (1970). La présence de ces trous sur le crâne d'un jeune individu et sur des animaux des deux sexes dans le matériel découvert à Bruges tendrait à la réfuter (Brothwell *et al.*, 1996) mais, d'un autre côté, l'absence de ces traces dans le matériel récent et actuel pourrait correspondre à l'abandon des bovins comme force de traction. Si elle se confirmait, cette hypothèse apporterait beaucoup à l'histoire des pratiques agricoles. Toutefois, en l'état actuel de la recherche sur ce caractère, il convient d'être circonspect, les données demeurant encore trop rares.

Une autre explication, plus plausible à notre sens, est physiologique et génétique. De telles perforations correspondent en effet à un développement excessif du sinus frontal caudal (Baker & Brothwell, 1980; Grenouilloux, 1989), et sont de type congénital. Dans ce cas, les perforations deviennent des caractères ostéoscopiques et non plus des caractères extrinsèques provoqués indirectement par l'action de l'homme.

Variation du nombre de dents

L'absence d'une dent est un caractère discret classique chez l'homme (cf. revue par Crubézy, 1991) comme chez les animaux actuels (Berry, 1963; Berry & Searle, 1963; Rees, 1969a, 1969b; Sjøvold, 1977; Callou, 2000) et fossiles (Andrews & Noddle, 1975; Baker & Brothwell, 1980; O'Connor, 1984, 1988, 1990; Callou, 2000). La raison n'est sans doute pas due uniquement à une fréquence plus élevée que pour un autre caractère mais plutôt à la facilité d'observation.

Andrews & Noddle (1975) ont étudié l'absence de la deuxième prémolaire de la mandibule (P_2) chez des ruminants (bovins et ovins) fossiles, datés du Néolithique au Moyen Age, et ont dressé une revue détaillée des mentions faites sur des animaux récents (différentes races de bovins mais aussi bouquetin, antilope, gnou et cerf de Virginie). Depuis cette publication, les exemples archéologiques pour les moutons et pour les bœufs se multiplient (O'Connor, 1984, 1988, 1990; Stallibrass, 1982, cité par O'Connor, 1988). Jackson (1915, 1917, 1925) avait déjà constaté cette disparition sur des bovins préhistoriques, protohistoriques et romains et avait avancé l'hypothèse d'une dégénérescence de la dent et d'une perte prématurée. Les analyses radiographiques réalisées par Andrews & Noddle (1975) ont montré que la prémolaire déciduale est effectivement perdue mais que la permanente est réellement absente. Une théorie évoquée pour expliquer ce manque est celle de Epstein (1972, cité par Andrews & Noddle, 1975), qui voit un lien avec la réduction des os de la face au cours de la domestication. Toutefois, il apparaît que cette absence de la prémolaire touche aussi bien des espèces domestiques que des espèces sauvages et qu'elle affecte des groupes non domestiqués comme les insectivores (Kindahl, 1967). Comme le soulignent Andrews & Noddle (1975), la cause de cette variation est inconnue et le facteur héréditaire demeure une possibilité, un défaut du développement fœtal étant également envisageable.

Un traitement quantitatif, et non pas seulement qualitatif comme dans la plupart des références citées précédemment, permet de constater une fréquence relativement élevée dans certaines populations anciennes. C'est notamment le cas des mandibules de bœuf découvertes sur le site de General Accident à Tanner Row (York), qui présentent ce caractère à 19% dans les niveaux romains et 19% dans les niveaux médiévaux, et de celles découvertes à Castleford dans le West Yorkshire dont 26% ne possèdent pas de deuxième prémolaire (O'Connor, 1988). Ces pourcentages, non négligeables, sont-ils exceptionnels ou bien simplement remarquables en l'absence de comparaison? Une recherche plus systématique de ce caractère devrait permettre de tester sa significativité et de s'assurer de sa rareté dans le temps et dans l'espace. O'Connor

[8] Un crâne de bovin découvert sur le site de Cadbury-Camelot présente des perforations sur l'os frontal. La forme des trous et leur répartition ont permis aux auteurs de l'étude de les attribuer aux racines végétales (Baker & Brothwell, 1980).

(1988) suggère cependant une explication: les troupeaux étaient plus petits et donc plus endogames dans le passé, aussi des caractères récessifs comme l'absence d'une dent pouvaient-ils être plus facilement exprimés.

Les dents surnuméraires paraissent par comparaison plus rares. Bökönyi (1974, cité par Baker & Brothwell, 1980) mentionne un crâne de cheval présentant une incisive surnuméraire, sur un site hongrois daté du VIII^{e} siècle. Colyer (1936) estimait du reste que cette anomalie dentaire était présente à 0,6% chez les chevaux[9].

Une autre variation dentaire concerne la réduction des dents et plus précisément la disparition de la troisième colonnette (hypoconulide) sur la troisième molaire inférieure (M_3) des bovins. Ce caractère est relevé sur des sites romains et médiévaux (O'Connor, 1984, 1988, 1990; Albarella & Davis, 1996), Maltby (1975) proposant même que ce caractère puisse être restreint aux périodes romaine et saxonne en Grande-Bretagne.

Foramen mentonnier sur la surface latérale de la mandibule

Le foramen mentonnier, correspondant à l'ouverture antérieure du canal mandibulaire, existe chez les herbivores et les carnivores et semble très variable en taille et en nombre. Il est décrit sur des mandibules de bovins de plusieurs sites britanniques (Baker & Brothwell, 1980).

Fosse irrégulière dans la surface articulaire du condyle de la mandibule de bœuf

La présence d'une fosse irrégulière dans la surface articulaire du condyle de la mandibule de bœuf a été constatée sur des mandibules archéologiques par O'Connor (1988) et discutée pour l'ensemble des Ongulés par Baker & Brothwell (1980).

Foramen nourricier des corps vertébraux très large

D'après Baker & Brothwell (1980), l'élargissement du foramen nourricier des corps vertébraux affecte principalement la région lombaire et n'était, à l'époque de la parution de leur ouvrage, connu que sur des restes archéologiques. Caractère bilatéral, il a été relevé chez des bovins mais également chez des équidés.

Foramen dans la fosse olécrânienne de l'humérus

Un foramen dans la fosse olécrânienne de d'humérus n'est décrit que par O'Connor (1988) sur les bovins du site de General Accident à Tanner Row (York).

Présence d'un métacarpien vestigial fusionné

Des exemples de métacarpiens vestigiaux fusionnés sont mentionnés sur des bovins et des équidés (Baker & Brothwell, 1980).

Position du foramen nourricier sur le fémur

Le foramen nourricier occupe généralement une position fixe chez la plupart des Artiodactyles. Cependant, des exceptions ont été enregistrées chez le mouton et chez le cerf. Chez le mouton en particulier, le foramen peut se situer en position proximale, distale ou mésiale sans qu'il y ait apparemment de différences fonctionnelles (Noddle, 1978). Des variations existent tant sur du matériel fossile que sur de l'actuel. En l'absence de données quantitatives et d'un échantillonnage plus conséquent, les résultats obtenus par Noddle (1978) doivent être considérés comme une première tendance. Il semble en fait que les trois foramens soient présents simultanément *in utero* et que deux sur les trois se ferment lors du développement de l'agneau (O'Connor, 1984). Le dernier foramen peut même disparaître sur les individus âgés (Noddle, 1978).

Syndactylie

Baker & Brothwell (1980) mentionnent le cas de phalanges distales fusionnées chez un porc fossile.

Duplication de la troisième phalange

La duplication de la troisième phalange aurait été relevée chez un capriné (Baker & Brothwell, 1980).

[9] L'ouvrage de Colyer sur les variations et pathologies dentaires des animaux a été réédité et commenté par Miles & Grigson (1991).

CONCLUSION

La première remarque qui s'impose à la suite de cet inventaire et de celui concernant les espèces actuelles est le faible nombre de caractères communs relevé entre les littératures archéozoologique et zoologique. Les variations dentaires, et surtout la disparition de la deuxième prémolaire inférieure, sont les seuls traits comparables relevés. Tout se passe comme s'il existait deux "philosophies": la première, zoologique, analyse de manière détaillée une espèce animale puis tente de transposer ce "modèle" aux autres espèces avec les difficultés que l'on a déjà soulignées; la seconde, archéozoologique, fait comme si la première n'existait pas et se satisfait du matériel fossile comme seul objet d'étude. La seule analyse réellement comparative entre l'actuel et l'archéologique était jusqu'alors celle de Noddle (1978) sur le mouton.

La seconde observation porte sur le traitement des caractères ou, pour être plus exacte, sur son absence. L'archéozoologie en est encore au stade de la description des caractères mais se fonde sur une méthode impropre à cette approche. En effet, au lieu d'identifier les caractères sur des os complets et sur des collections présentant un nombre d'individus statistiquement suffisant, la recherche semble se faire à partir de quelques restes archéologiques, souvent fragmentés. Parler de recherche est d'ailleurs sans doute excessif car la majorité des caractères signalés précédemment (rainure le long de la corne, perforation crânienne, variation du nombre de dents, position du foramen nourricier du fémur, syndactylie, etc) ne peuvent pas passer inaperçus lors de l'étude d'un matériel faunique et est mentionnée incidemment. Ce manque d'examen approfondi explique certainement le déficit des caractères crâniens, dont le nombre devrait être élevé si on considère ceux relevés chez les espèces actuelles.

L'exemple du lapin Oryctolagus cuniculus (Callou, 2000)

L'étude des caractères ostéoscopiques chez le lapin a été réalisée pour répondre à plusieurs objectifs:

* Identifier et sélectionner des caractères propres à l'espèce.

Cette recherche a été menée à partir de collections actuelles, sur des populations très différentes dans leurs statuts (populations domestiques et sauvages) et dans leurs origines géographiques (populations issues de milieux variés, sur le continent et dans les îles), la zone échantillonnée s'étendant du nord de la France au sud de la Péninsule Ibérique et comprenant aussi l'île de Zembra, en Tunisie. L'ensemble des populations (22 au total) représente plus de 600 individus, d'âge et de sexe connus pour la plupart.

Le nombre de caractères identifiés s'élève à 29, dont 20 sont localisés sur le crâne (calvarium et mandibule) et 9 sur le post-crânien (squelette axial et membre postérieur). Certains se sont révélés fortement liés à l'âge (1 caractère), au sexe (5 caractères) ou bien présentent une fréquence inférieure à 5% dans chaque population (7 caractères "rares"). Des caractères bilatéraux, dissymétriques ou asymétriques ont également été enregistrés, leur faible nombre ne permettant toutefois pas de conclure en termes de stress de population.

* Démontrer l'intérêt de ces caractères dans l'analyse des populations.

Des analyses factorielles des correspondances effectuées avec les caractères non liés à l'âge ou au sexe et dont la fréquence est supérieure à 5%, ont permis de distinguer deux groupes distincts de populations sauvages, cette bipartition recouvrant en partie celle définie par les analyses génétiques (type A et type B), obtenue à partir des mêmes échantillons (Monnerot *et al.*, 1994). A l'intérieur de ces groupes, certaines populations présentent des traits remarquables; il s'agit principalement de celle de l'île de Zembra. L'isolement des individus et l'effet de fondation dus à l'insularité ont en effet permis l'émergence de caractères ostéoscopiques spécifiques. Il n'est cependant pas possible en l'état actuel des recherches de conclure à une adaptation morphologique d'origine strictement génétique, strictement mésologique ou bien résultant de plusieurs influences.

Des analyses similaires (AFC) ont fait apparaître une très nette séparation entre les populations sauvages et domestiques. Cette distinction des formes domestique et sauvage résulte de la combinaison de 7 caractères principaux.

* Vérifier leur apport dans la connaissance de l'histoire des populations.

Il est tentant d'imaginer que la fréquence élevée de certains caractères des populations anciennes, soutenue par des comparaisons entre sites, pourrait

être expliquée en termes de génétique des populations. Il serait alors possible d'envisager suivre l'évolution phylogéographique de l'espèce. Il est également tentant de vouloir estimer l'impact de l'action anthropique sur les populations sauvages et de vouloir cerner l'origine de la domestication. Malheureusement, le choix du lapin comme modèle d'étude ne s'est pas révélé le plus judicieux pour transposer les résultats obtenus sur les individus actuels à des restes fossiles. La fragmentation importante des os, qui affecte majoritairement le crâne, a en effet empêché d'analyser conjointement les données.

L'ensemble de ces résultats reste néanmoins très prometteur car il confirme que la distribution des caractères ostéoscopiques n'est pas aléatoire, ceux-ci dépendant à la fois de facteurs génétiques et mésologiques. Par ailleurs, même s'il n'a pas été possible de déterminer la part exacte des uns par rapport à celle des autres, les premiers semblent dominer puisqu'ils permettent la discrimination des populations (sauvages et domestique) en fonction de leur type génétique. Un tel résultat laisse entrevoir les possibilités pour l'étude d'autres espèces animales actuelles, mais aussi fossiles.

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Faunal Remains Associated with Late Saladoïd and Post-Saladoïd Occupations at Anse à la Gourde, Guadeloupe, West Indies: Preliminary Results

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ABSTRACT: The study of the large faunal assemblage recovered from the Saladoïd (400-600 A.D.) and Troumassoïd (800-1400 A.D.) occupation levels in a trench at the site of Anse à la Gourde, Guadeloupe, permitted an evaluation not only of the richness and diversity of the faunal spectrum, but also of the ecosystems exploited and the techniques of capture, based on the taxonomic list and the size estimates for snappers (Lutjanidae), grunts (Haemulidae), and parrotfishes (Scaridae). The large sample size also permitted a statistical analysis of the data obtained from each archaeological layer. These analyses indicated significant changes in the exploitation of the animal resources through time.

KEY WORDS: ZOOARCHAEOLOGY, GUADELOUPE, WEST INDIES, FISH, GRUNT, SNAPPER, PARROTFISH, HAEMULIDAE, LUTJANIDAE, SCARIDAE

RESUMEN: La capas saladoïdes tardías (400 – 600 A.C.) y troumassoïdes (800 – 1 400 A.C.) del sondeo realizado en el sitio Anse à la Gourde, Guadeloupe, permitió caracterizar tanto el espectro de fauna (gracias a los índices de riqueza y de diversidad), así como los ecosistemas explotados y las técnicas de captura utilizadas (gracias al conjunto faunístico específico y a la talla de ciertos peces: Haemulidae, Lutjanidae y Scaridae). La gran cantidad de huesos permitió también testar estadísticamente las informaciones obtenidas sobre cada capa arqueológica. Gracias a estos análisis se pudo observar que ciertas mutaciones eran significativas.

PALABRAS CLAVE: ARQUEOZOOLOGÍA, GUADELOUPE, PEQUEÑAS ANTILLAS, PEZ, HAEMULIDAE, LUTJANIDAE, SCARIDAE

RÉSUMÉ: Les couches saladoïdes tardives (400 – 600 ap. J.-C.) et troumassoïdes (800 - 1400 ap. J.-C.) d'un sondage du site l'Anse à la Gourde ont livré un abondant matériel faunique. L'étude de ces restes a permis d'une part, de caractériser la richesse et la diversité du spectre de faune, et d'autre part, de reconstituer les écosystèmes exploités et les techniques de capture (au travers de la liste taxonomique et par l'estimation de la taille de trois familles de poissons: Haemulidae, Lutjanidae et Scaridae). La grande quantité d'ossements a permis d'étayer statistiquement les informations obtenues sur chaque couche archéologique. Ces approches indiquent quelques variations significatives de l'exploitation des ressources animales dans le temps.

MOTS CLEFS: ARCHEOZOOLOGIE, GUADELOUPE, PETITES ANTILLES, POISSON, GORETTE, VIVANEAU, POISSON-PERROQUET, HAEMULIDAE, LUTJANIDAE, SCARIDAE

INTRODUCTION

The importance of marine resources in the pre-Columbian Caribbean is suggested by the island environment and substantiated by several zooarchaeological studies (Wing, 1977, 1989, 1994, 1995; Wing & Scudder, 1983; deFrance, 1988; Carlson, 1995; Keegan, 1997). Analyses of faunal

assemblages from various sites in the Lesser Antilles provide data on the subsistence patterns and on the environments that were exploited by the pre-Columbian Amerindians (Rouse, 1989a; Watters & Rouse, 1989; Watters, 1998). Guadeloupe is an island for which we have a small amount of data. The site of Anse à la Gourde in Grande-Terre provides a long chronological sequence with large refuse areas. Based on one refuse area, this zooarchaeological study was undertaken to investigate the nature of both marine and terrestrial exploitation in a chronological perspective (molluscs have been excluded from this study). The large faunal samples from successive levels of the site provide an understanding of the prehistoric economy, the prehistoric fisheries and the long term effects of fishing on the natural resources.

This article deals with the preliminary results from the material recovered during the 1997-1998 excavations. Although we are still in the process of studying the new data recovered during the 1999-2000 excavations, the initial results confirm the main interpretations discussed here.

MATERIAL AND METHODS

Anse à la Gourde is one of the major village sites located along the eastern coast of Grande-Terre in Guadeloupe (Figures 1, 2). It occupies 4.5 hectares (Figure 3). The coastal strip is a refuse area and the remains of house posts, burials and fireplaces are located inland from the shore. A trench through the large refuse area indicated a deeply stratified unit (Z64S93C01), corresponding to an Amerindian Ceramic period occupation from 400 to 1400 A.D. (Rouse, 1989b, 1992, 1995; Delpuech *et al.*, 1997). This last unit was selected for analysis because it is very rich in well preserved faunal remains (vertebrates, crabs, and urchins) and it covers all the occupation periods.

The trench measuring 1 x 1 square meter was excavated in 10 cm arbitrary levels. The material from this unit was water sieved through a 2.8 mm gauge screen. The stratigraphy reveals nine successive occupations (Figure 4). The analysis of the ceramics reveals that occupation levels III, IV, VI, IX, X, and XVIII are of the late Saladoïd period, ranging from 400 to 600 A.D. Occupation levels XX, XXI, XXIII, and XXIV are different phases of the Troumassoïd period, ranging from 800 to 1400 A.D. (Delpuech *et al.*, 1997). In order to point out differences between samples, the data is grouped into five phases: Saladoïd 1 (S1 = levels III, IV and VI), Saladoïd 2 (S2 = IX, X, XVIII), Post-Saladoïd 1 (PS1 = XX and XXI), Post-Saladoïd 2 (PS2 = XXIII), and Post-Saladoïd 3 (PS3 = XXIV).

Spectrum of taxa

The faunal remains were sorted and identified to their lowest taxonomic levels using comparative collections at the following institutions: the Florida Museum of Natural History in Gainesville; The *Laboratoire d'Anatomie Comparée* of the *Muséum National d'Histoire Naturelle* in Paris; The Laboratory of Zooarchaeology of the *Centre de Recherches Archéologique*s in Valbonne; and the specimens collected by the author in 1997, which are now at the *Service Régional de l'Archéologie de Guadeloupe*.

The number of identified specimens (NISP), the minimum number of individuals calculated by paired elements (MNI), and the weight of the remains (in grams) were quantified for each taxon in each level. Each of these methods of quantification has its own advantage (see Chaplin, 1971; Ducos, 1975; Poplin, 1976a, 1976b, 1977; Grayson, 1984; Lyman, 1994). Comparisons were made between samples using both NISP and MNI.

An understanding of subsistence during antiquity, at least concerning the flesh meat portion of the diet, is based on the identified taxa and their relative abundances in each period. One dietary aspect is diversity, which can be measured by calculating the taxonomic richness, according to the size of samples. In order to check the reliability of samples in relation to their size, a rarefaction curve was constructed by plotting MNI on the *x* axis and the number of taxa (S) on the *y* axis. Richness was also estimated by applying the Margaleff index (dI) (1958, cited by Bobrowski & Ball, 1989) to the samples from each level. This index was calculated using the formula $dI = (S-1)/(\text{Log}_e N)$ where S is the number of species and N is the total NISP for each level. Diversity and homogeneity were estimated using the Simpson Reciprocity index (H'), calculated using the formula $H' = 1/\sum pi^2$, where pi = ni/N, ni = NISP per taxon, and N = total NISP for the sample (Grayson, 1984). In order to evaluate the differences between the samples, Chi^2 square tests of NISP across species were carried out (the MNI of some species was too small to be used in a Chi^2 test).

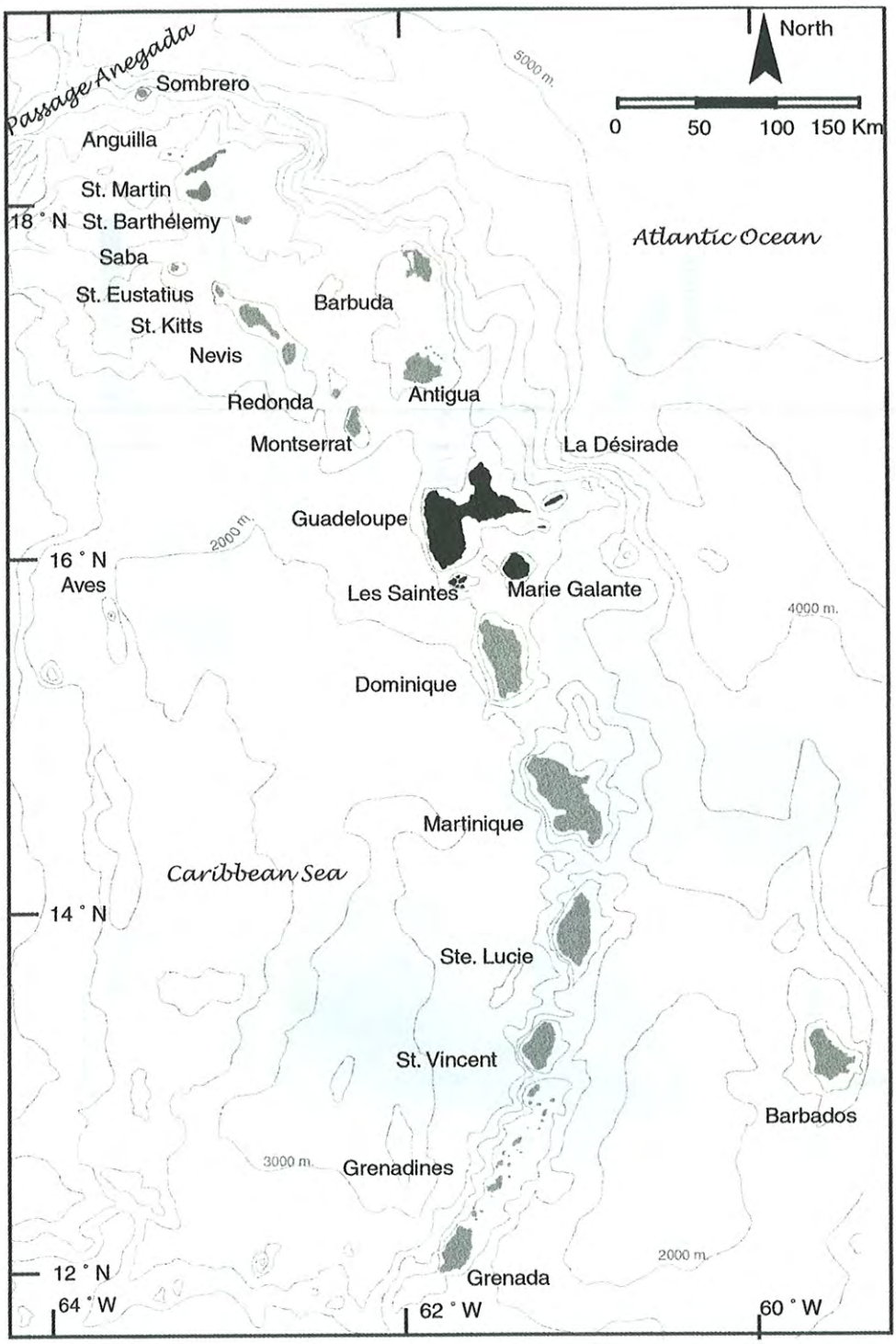


FIGURE 1

Map of the West Indies.

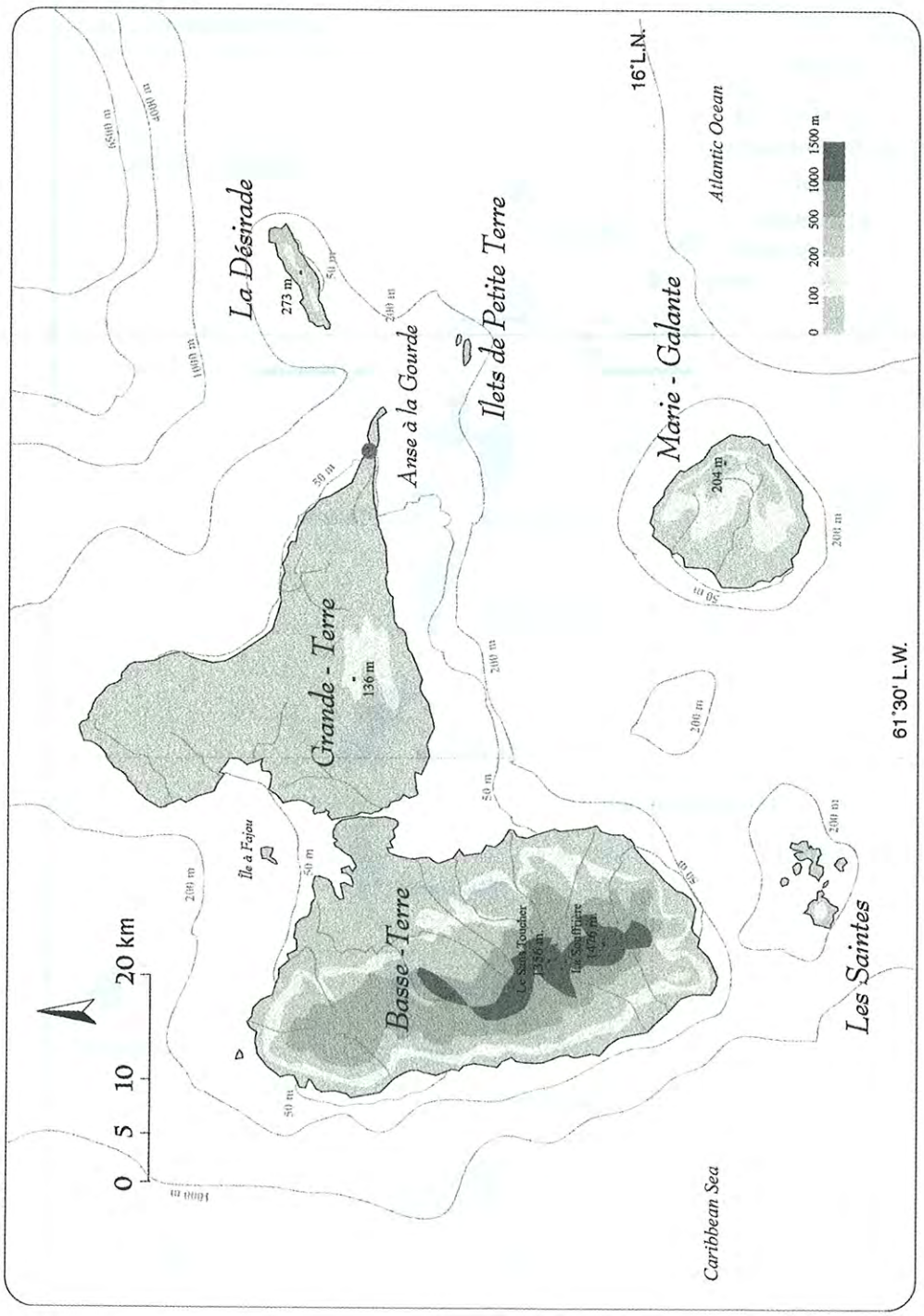


FIGURE 2
Location of Anse à la Gourde in Guadeloupe.

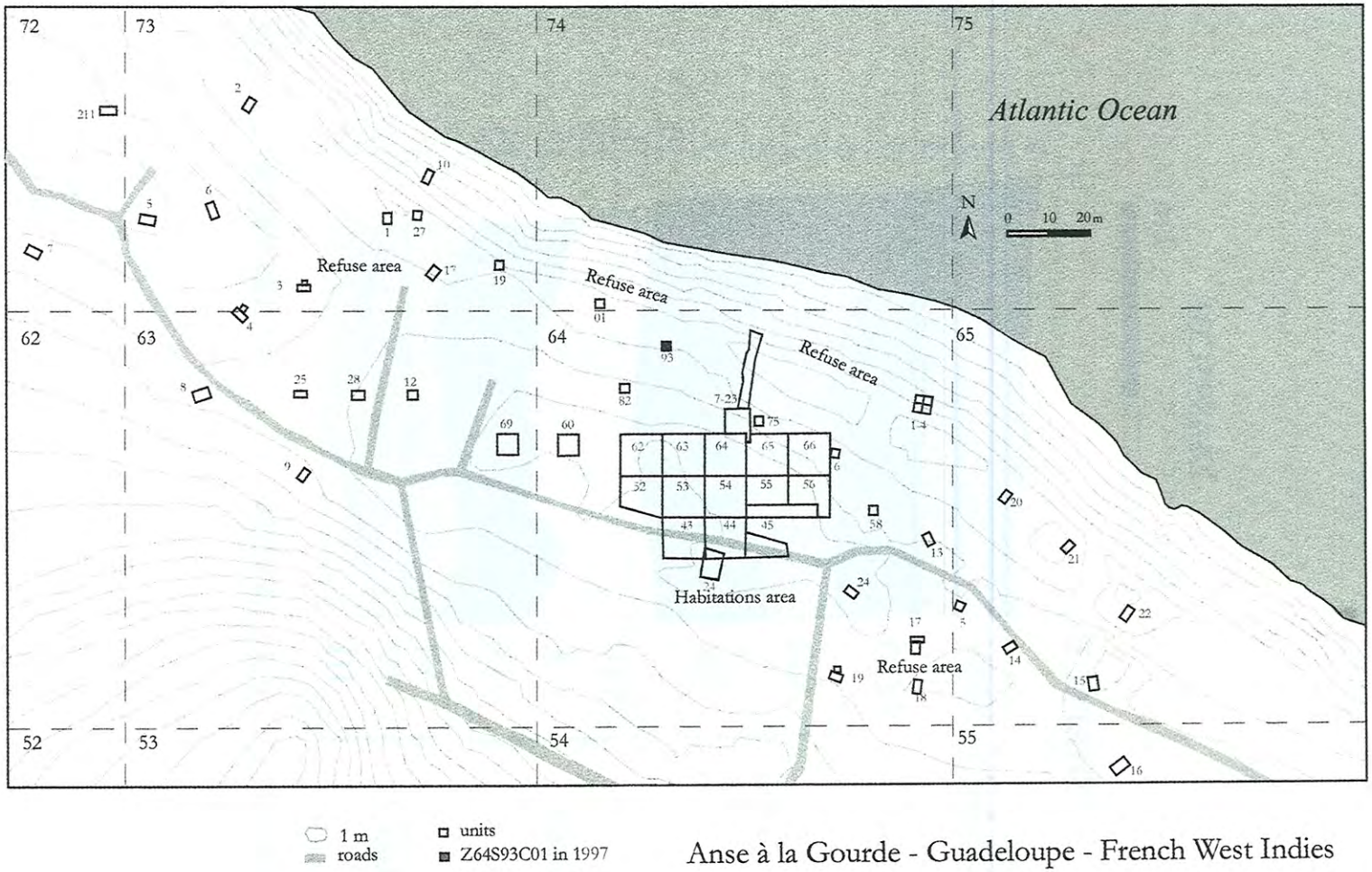


FIGURE 3
Location of unit Z64S93C01 at Anse à la Gourde.

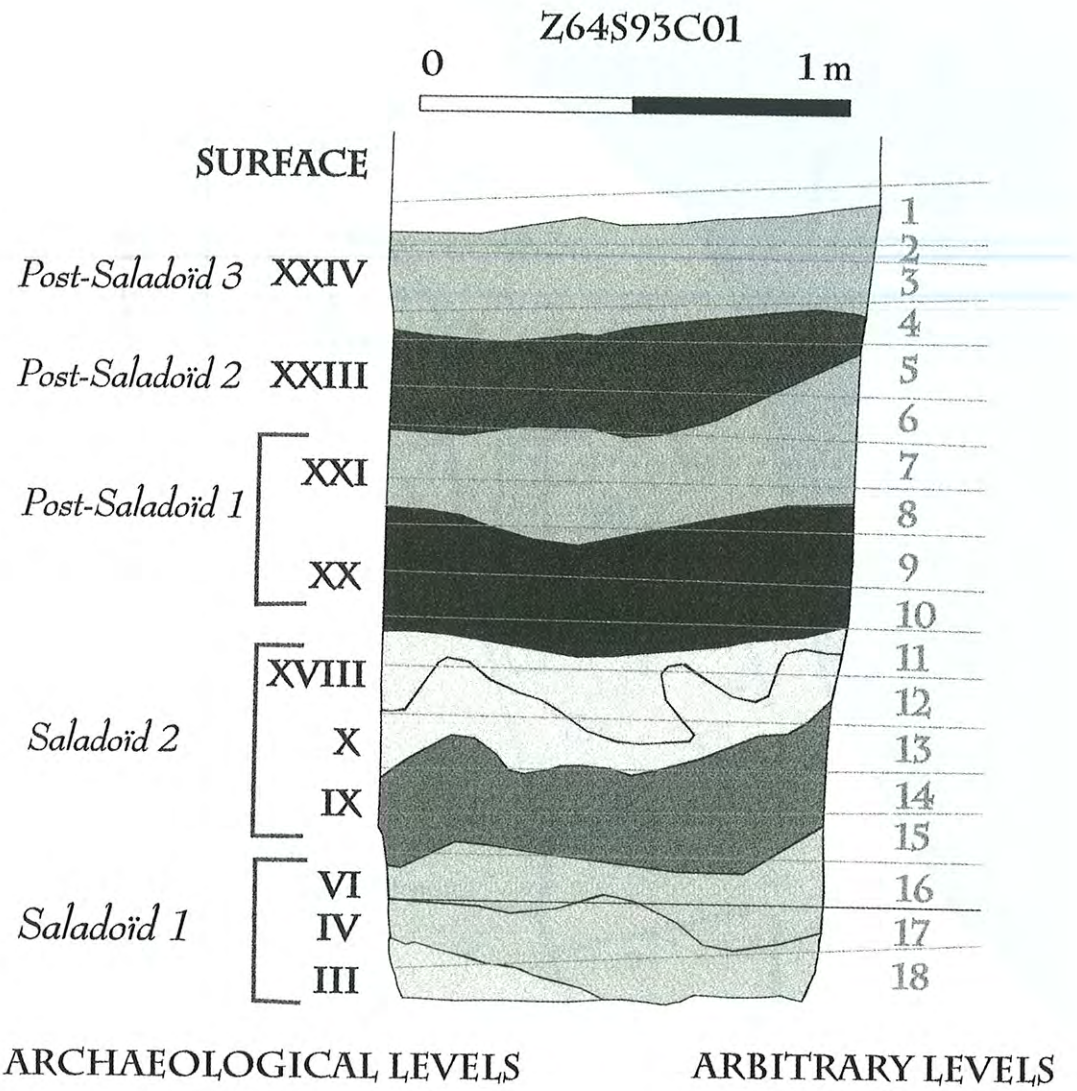


FIGURE 4
Arbitrary levels and archaeological level of unit Z64S93C01 at Anse à la Gourde.

Body size reconstruction

The sizes of fish from archaeological sites illustrate both the different ecosystems where the animals were probably caught, as well as the techniques used to catch them. There are many ways of estimating body size (live weight or standard length) based upon different measurements of fresh fish skeletal parts (Casteel, 1974, 1978; Desse, Desse-Berset & Rocheteau, 1987, 1989, 1996; Wheeler & Jones, 1989; Leach & Boocock, 1993, 1995; Béarez, 1995; Leach *et al.*, 1996a, 1996b, 1996c). For some Caribbean taxa, body weights are estimated using the first vertebrae width or otolith length (Reitz & Cordier, 1983; Adams, 1985; Reitz *et al.*, 1987; Reitz & Wing, 1999). Correlations between the body weight or length and otolith length or vertebral width did not seem to provide accurate estimates of weight for some taxa in this study (correlation coefficients were too small). As a result, various regression lines were fitted and equations were calculated for the different skeletal parts of the most common taxa from the samples, i.e., grunts (Haemulidae), snappers (Lutjanidae) and parrot-fishes (Scaridae). The comparative specimens used in producing the equations belong to the Greater and Lesser Antilles, and Florida. The "least squares method" was applied to determine the metrical relationship between live standard lengths and various measurements of skull elements (examples in Figure 5). As illustrated by the example of the *Sparisoma* standard length for all the taxa and skeletal parts (Figure 6), the standard error of the estimates was smaller for the power curve, than for the linear, the exponential, and the logarithmic curves. Consequently, the power curve was chosen to estimate the length of the archaeological specimens.

Equations were calculated at the level of species, genus and family when correlations were significant, as recommended by Desse & Desse-Berset (1996a, 1996b) (examples at the level of genus in Appendix 1).

Before choosing measurements for analysis, the random nature of the processes of destruction indicated by the distruibution of body parts was verified for each sample of unit Z93S64C01, as suggested by Leach & Boocock (1994:73; 1995:27). All measurements are in millimetres and all weights are in grams. Details of the basic statistics of these formulas will be published elsewhere.

RESULTS AND INTERPRETATIONS

The taphonomic study concluded that all bones were dissociated and partly broken, and that all parts of the skeleton were present. The majority of bones were well-preserved, although some of them showed evidence of erosion possibly due to exposure to acidic conditions or weathering. None of the bones exhibited evidence of cut marks, gnaw marks or burning. Because their bones were also dissociated and broken, mammals such as dogs (*Canis familiaris*), agoutis (*Dasyprocta* cf. *leporina*), and rice rats (Oryzomyini) were probably eaten, though no evidence of butchery or cooking was present on their bones. These taxa are common in Lesser Antillean sites and they were undoubtedly consumed (Wing, 1995; Wing & Wing, 1995). The animal bones regularly thrown into a refuse area near the habitation during the occupations, were not disturbed by animals and survived the attacks from sand, sea, and weather elements, etc.

Richness, diversity and faunal assemblage

A total of 191,978 fragments were identified, at least by class, with 22,287 crab and sea urchin fragments, 27,864 fishes, 1,414 reptiles, 273 birds, and 4,199 mammal remains. These represent a minimum of 3,842 individuals (MNI). A total of 46 families (89 species) of vertebrates, crustacean, and sea urchins were identified (Table 1, Appendix 2).

Crustaceans and sea urchins were represented by seven families and 20 species (Table 1, Appendix 2). The land crabs (Gecarcinidae) and the land hermit crabs (Coenobitidae) were the most abundant. The fishes belong to 26 families and 55 species, of which the doctor-fishes (Acanthuridae), jacks (Carangidae), trigger-fishes (Balistidae), and parrot-fishes (Scaridae) were the most abundant. Among the reptiles, sea turtles (Cheloniidae) and iguanas (Iguanidae) were the most frequent taxa. Pigeons and doves (Columbidae) predominated among the birds. Rice rats (Cricetidae tribe Oryzomyini) and agoutis (Dasyproctidae) were the most abundant mammals.

From the bottom to the top of the stratigraphy, we observed a strong increase in the relative abundance of fish remains until the late Saladöid level (S2), and a slight decline after the Post-Saladöid

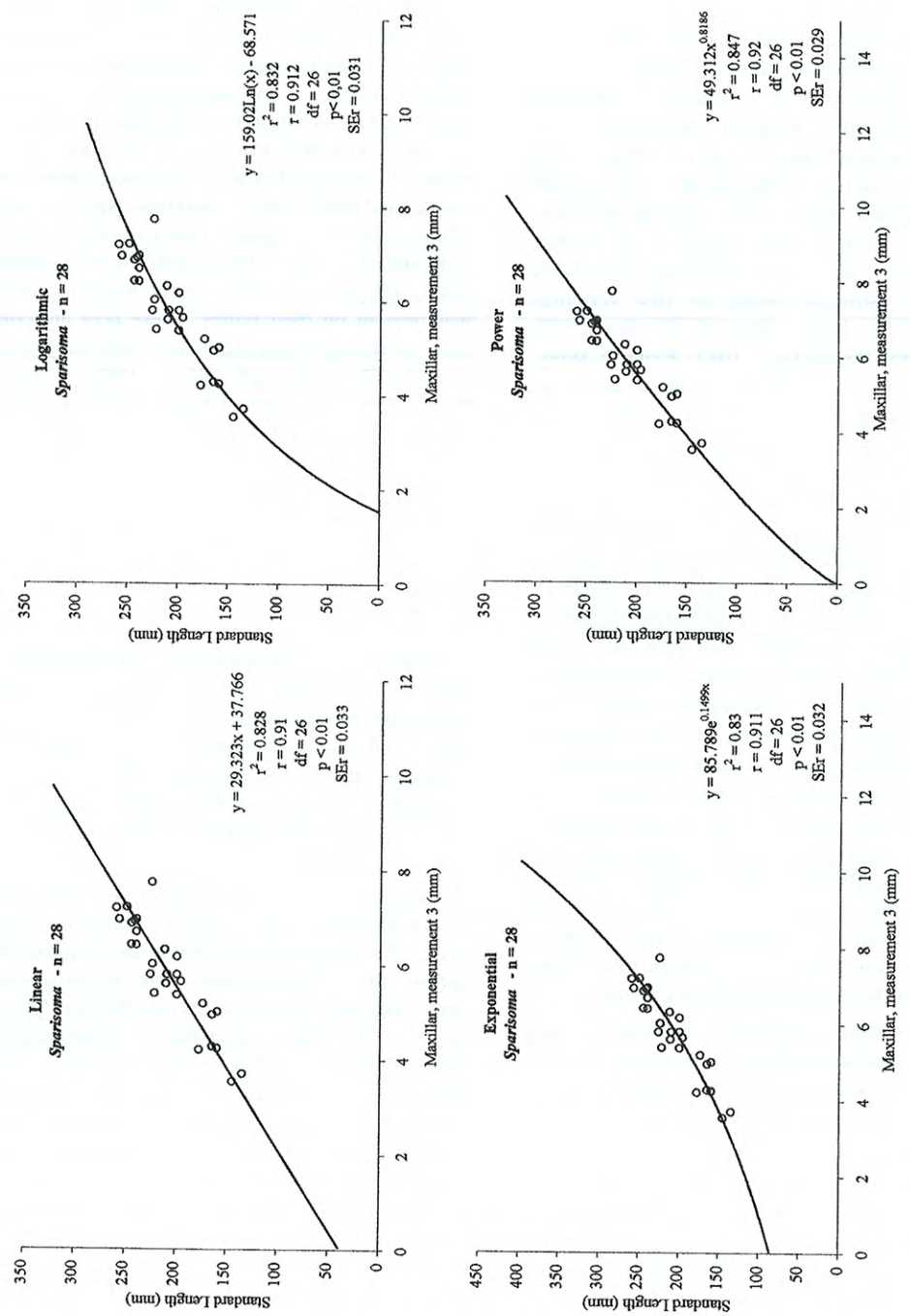


FIGURE 5
Examples of the best-fit curves (for *Sparisoma*).

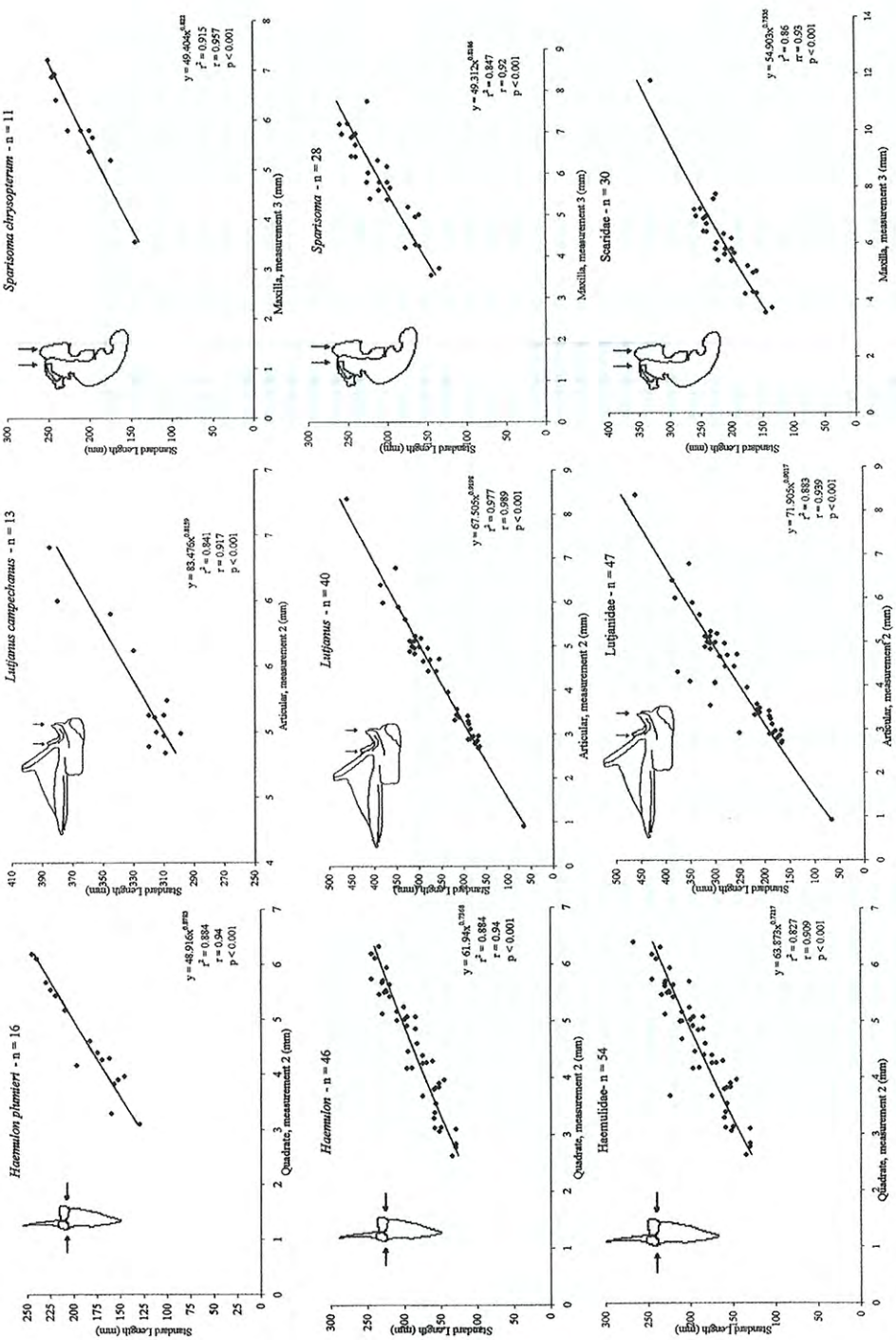


FIGURE 6

Examples of allometric regressions for the estimation of the Standard Length at the rank of species, genus and family from the same measurement.

Haemulon

measurements		y =	a	x	b	r²	r	df	SEr	t	p
premaxilla	M1	y =	96.38	x	0.6022	0.785	0.886	44	0.032	27.99	< 0.01
premaxilla	M2	y =	26.878	x	0.7397	0.846	0.920	44	0.023	40.42	< 0.01
premaxilla	M3	y =	62.165	x	0.7433	0.790	0.889	44	0.031	28.69	< 0.01
maxilla	M1	y =	83.642	x	0.6549	0.862	0.928	44	0.020	45.59	< 0.01
maxilla	M2	y =	53.729	x	0.6343	0.847	0.920	44	0.023	40.80	< 0.01
maxilla	M3	y =	61.996	x	0.6082	0.820	0.905	44	0.027	34.04	< 0.01
dentary	M1	y =	110.32	x	0.4968	0.725	0.851	44	0.041	20.97	< 0.01
dentary	M2	y =	90.535	x	0.5695	0.786	0.886	44	0.032	28.02	< 0.01
articular	M1	y =	84.159	x	0.6566	0.796	0.892	44	0.030	29.66	< 0.01
articular	M2	y =	82.677	x	0.7093	0.805	0.897	44	0.029	31.15	< 0.01
quadrate	M1	y =	61.94	x	0.7368	0.884	0.940	44	0.017	55.12	< 0.01
quadrate	M2	y =	113.59	x	0.661	0.764	0.874	44	0.035	25.10	< 0.01
hyomandibula	M1	y =	27.776	x	0.8523	0.844	0.919	44	0.023	39.89	< 0.01
parasphenoïd	M1	y =	83.593	x	0.6657	0.697	0.835	43	0.045	18.48	< 0.01
vomer	M1	y =	42.194	x	0.765	0.853	0.924	44	0.022	42.64	< 0.01
neurocrane	M1	y =	77.754	x	0.5705	0.824	0.908	43	0.026	34.60	< 0.01
neurocrane	M2	y =	79.442	x	0.6025	0.891	0.944	43	0.016	57.81	< 0.01
neurocrane	M3	y =	50.383	x	0.7095	0.878	0.937	44	0.018	52.05	< 0.01
otolith	M1	y =	11.292	x	1.2613	0.745	0.863	43	0.038	22.70	< 0.01
otolith	M2	y =	24.258	x	1.0925	0.536	0.732	43	0.069	10.57	< 0.01
first vertebra	M1	y =	75.298	x	0.6033	0.877	0.936	43	0.018	51.07	< 0.01
first vertebra	M2	y =	82.841	x	0.5977	0.877	0.936	43	0.018	51.03	< 0.01
first vertebra	M3	y =	86.005	x	0.6287	0.762	0.873	41	0.036	24.06	< 0.01
vertebra 2-20	M1	y =	81.637	x	0.6422	0.848	0.921	159	0.012	77.04	< 0.01
vertebra 2-20	M2	y =	77.712	x	0.6422	0.893	0.945	159	0.008	111.51	< 0.01
vertebra 2-20	M3	y =	51.767	x	0.67	0.804	0.897	160	0.015	58.36	< 0.01
Total Length	TL	y =	1.4902	x	0.8878	0.930	0.964	44	0.010	93.72	< 0.01
Weight	W	y =	46.622	x	0.2712	0.922	0.960	44	0.012	83.49	< 0.01

p < 0.01 = significant correlation

Lutjanus

measurements		y =	a	x	b	r²	r	df	SEr	t	p
premaxilla	M1	y =	89.884	x	0.9731	0.899	0.948	38	0.016	59.62	< 0.01
premaxilla	M2	y =	25.391	x	0.9903	0.958	0.979	38	0.007	148.84	< 0.01
premaxilla	M3	y =	33.388	x	1.0405	0.937	0.968	38	0.010	97.34	< 0.01
maxilla	M1	y =	92.583	x	0.9136	0.831	0.911	38	0.027	34.07	< 0.01
maxilla	M2	y =	28.540	x	1.0616	0.964	0.982	38	0.006	172,00	< 0.01
maxilla	M3	y =	33.308	x	1.0587	0.965	0.982	38	0.006	175.47	< 0.01
dentary	M1	y =	110.690	x	0.9122	0.836	0.914	38	0.026	35.24	< 0.01
dentary	M2	y =	42.770	x	0.987	0.931	0.965	38	0.011	87.91	< 0.01
articular	M1	y =	48.725	x	0.98	0.910	0.954	38	0.014	67.04	< 0.01
articular	M2	y =	68.031	x	0.9155	0.979	0.989	38	0.003	295.15	< 0.01
quadrate	M1	y =	53.244	x	0.9449	0.961	0.98	37	0.006	157.39	< 0.01
quadrate	M2	y =	102.38	x	0.9243	0.892	0.944	37	0.017	54.51	< 0.01
hyomandibula	M1	y =	19.196	x	0.9909	0.980	0.99	37	0.003	312.27	< 0.01
vomer	M1	y =	19.511	x	1.098	0.966	0.983	37	0.005	178.92	< 0.01
otolith	M1	y =	65.601	x	0.5394	0.496	0.704	19	0.110	6.40	< 0.01
otolith	M2	y =	63.522	x	0.7055	0.666	0.816	19	0.073	11.21	< 0.01
first vertebra	M1	y =	54.385	x	0.8806	0.946	0.972	36	0.009	109.98	< 0.01
first vertebra	M2	y =	62.246	x	0.8774	0.931	0.965	36	0.011	85.69	< 0.01
first vertebra	M3	y =	68.514	x	0.8367	0.944	0.972	35	0.009	105.34	< 0.01
vertebra 2-20	M1	y =	57.034	x	0.8734	0.939	0.969	138	0.005	188.60	< 0.01
vertebra 2-20	M2	y =	58.126	x	0.8405	0.958	0.979	138	0.004	275.74	< 0.01
vertebra 2-20	M3	y =	40.985	x	0.9348	0.937	0.968	138	0.005	181.21	< 0.01
Total Length	TL	y =	0.7151	x	1.018	0.993	0.997	38	0.001	913.43	< 0.01
Weight	W	y =	39.819	x	0.3022	0.980	0.99	38	0.003	319.50	< 0.01

Sparisoma

measurements		y =	a	x	b	r²	r	df	SEr	t	p
premaxilla	M1	y =	80.028	x	0.4263	0.542	0.736	26	0.087	8.50	< 0.01
premaxilla	M2	y =	52.556	x	0.536	0.780	0.883	26	0.042	21.21	< 0.01
premaxilla	M3	y =	85.048	x	0.8047	0.614	0.784	26	0.073	10.76	< 0.01
maxilla	M3	y =	82.179	x	0.8348	0.717	0.847	26	0.053	15.85	< 0.01
maxilla	M4	y =	65.798	x	0.7515	0.767	0.876	26	0.044	19.90	< 0.01
maxilla	M5	y =	49.312	x	0.9186	0.850	0.92	26	0.029	31.72	< 0.01
dentary	M3	y =	42.130	x	0.6595	0.564	0.751	26	0.082	9.11	< 0.01
dentary	M4	y =	39.874	x	0.6221	0.721	0.849	26	0.053	16.12	< 0.01
articular	M3	y =	116.810	x	0.6712	0.753	0.868	26	0.047	18.62	< 0.01
articular	M4	y =	93.485	x	0.7674	0.558	0.747	26	0.084	8.94	< 0.01
quadrate	M3	y =	79.341	x	0.8021	0.543	0.737	26	0.086	8.53	< 0.01
quadrate	M4	y =	162.680	x	0.6243	0.750	0.866	26	0.047	18.36	< 0.01
hyomandibula	M1	y =	25.650	x	0.9019	0.841	0.917	26	0.030	30.6	< 0.01
upper pharyngeal	M1	y =	146.990	x	0.6416	0.638	0.798	26	0.068	11.66	< 0.01
upper pharyngeal	M2	y =	100.800	x	0.7077	0.761	0.872	26	0.045	19.31	< 0.01
upper pharyngeal	M3	y =	75.602	x	0.5923	0.661	0.813	26	0.064	12.69	< 0.01
lower pharyngeal	M1	y =	43.287	x	0.6257	0.689	0.830	26	0.059	14.10	< 0.01
lower pharyngeal	M2	y =	58.973	x	0.5176	0.544	0.737	26	0.086	8.55	< 0.01
lower pharyngeal	M3	y =	92.909	x	0.6417	0.685	0.828	26	0.060	13.91	< 0.01
cleithra	M1	y =	100.900	x	0.7848	0.658	0.811	25	0.066	12.33	< 0.01
cleithra	M2	y =	54.042	x	0.8395	0.730	0.854	25	0.052	16.44	< 0.01
cleithra	M3	y =	121.000	x	0.6593	0.506	0.711	25	0.095	7.49	< 0.01
parasphenoïd	M5	y =	47.986	x	0.743	0.822	0.906	26	0.034	26.89	< 0.01
parasphenoïd	M6	y =	31.814	x	0.8278	0.807	0.898	26	0.036	24.63	< 0.01
otolith	M1	y =	172.07	x	0.0834	0.011	0.107	13	0.255	0.42	> 0.10
otolith	M2	y =	262.98	x	-0.3651	0.049	0.222	13	0.245	0.90	> 0.10
neurocrane	M1	y =	71.106	x	0.6501	0.846	0.920	26	0.029	31.51	< 0.01
neurocrane	M2	y =	77.119	x	0.6955	0.794	0.891	26	0.039	22.88	< 0.01
neurocrane	M3	y =	57.032	x	0.7056	0.811	0.900	26	0.036	25.15	< 0.01
first vertebra	M1	y =	61.016	x	0.772	0.877	0.936	24	0.024	38.65	< 0.01
first vertebra	M2	y =	88.920	x	0.6584	0.858	0.926	25	0.027	33.90	< 0.01
first vertebra	M3	y =	97.697	x	0.6266	0.771	0.878	21	0.048	18.43	< 0.01
vomer	M1	y =	100.99	x	0.589	0.549	0.741	26	0.085	8.69	< 0.01
vertebra 2-20	M1	y =	73.728	x	0.7582	0.846	0.920	88	0.016	56.50	< 0.01
vertebra 2-20	M2	y =	70.706	x	0.7232	0.878	0.937	88	0.013	73.12	< 0.01
vertebra 2-20	M3	y =	38.503	x	0.9358	0.803	0.896	88	0.021	43.15	< 0.01
Total Length	TL	y =	1.185	x	0.9309	0.913	0.955	26	0,021	57.84	< 0.01
Weight	W	y =	38.366	x	0.298	0.883	0.940	26	0.022	42.54	< 0.01

APPENDIX 1

Power equations calculated for estimations of Standard Length and basic statistics.

Class	Family	NISP	Weight (g.)	MNI	% NISP	% Weight	% MNI
Invertebrata	Palinuridae	187	12.5	8	0.8	1.3	0.3
	Coenobitidae	9 947	367.8	1 756	44.6	38.3	72.7
	Portunidae	33	1.0	2	0.2	0.1	0.1
	Xanthidae	998	88.2	16	4.5	9.2	0.7
	Gecarcinidae	5 032	325.0	573	22.6	33.8	23.7
	Ocypodidae	27	1.2	7	0.1	0.1	0.3
	Echinoidea	6 063	165.6	52	27.2	17.2	2.2
	7	22 287	961.3	2 414	100	100	100
Pisces	Carcharhinidae	8	0.6	2	0	0	0.2
	Dasyatidae	12	0.6	3	0	0	0.2
	Elopidae	6	0.6	2	0	0	0.2
	Albulidae	23	1.0	4	0.1	0.1	0.3
	Muraenidae	27	1.0	3	0.1	0.1	0.2
	Clupeidae	2 282	12.1	95	8.2	1.1	7.1
	Belonidae	759	24.0	26	2.7	2.2	1.9
	Holocentridae	679	18.3	76	2.4	1.7	5.6
	Centropomidae	69	5.1	5	0.3	0.5	0.4
	Serranidae	620	76.1	31	2.2	6.9	2.3
	Priacanthidae	1	0	1	0	0	0.1
	Carangidae	5 467	172.6	204	19.6	15.6	15.1
	Lutjanidae	1 334	95.0	53	4.8	8.6	3.9
	Haemulidae	1 915	58.3	200	6.9	5.3	14.8
	Sparidae	26	3.7	2	0.1	0.3	0.2
	Sciaenidae	62	2.1	11	0.2	0.2	0.8
	Kyphosidae	13	0.2	2	0.1	0	0.2
	Pomacanthidae	1	0	1	0	0	0
	Sphyrenidae	41	1.7	4	0.2	0.1	0.3
	Labridae	1 123	39.0	41	4.0	3.5	3.0
	Scaridae	2 934	279.4	221	10.5	25.3	16.4
	Acanthuridae	6 153	211.1	297	22.1	19.1	22.0
	Scombridae	406	54.5	9	1.5	4.9	0.7
	Balistidae	3 842	48.2	50	13.8	4.4	3.7
	Ostraciidae	24	0.5	3	0.1	0	0.2
	Diodontidae	37	1.1	3	0.1	0.1	0.2
	26	27 864	1106.8	1 349	100	100	100
Amphibia	Anura	2	0.1	1	0.2	0	5.3
Reptilia	Cheloniidae	902	125.5	2	63.8	88.4	10.5
	Iguanidae	388	14.9	8	27.4	10.5	42.1
	Lacertilia	122	1.5	8	8.6	1.1	42.1
	4	1 414	142.0	19	100	100	100
Aves	cf. Procellariidae	15	0.8	2	5.5	11.6	13.3
	cf. Anatidae	8	0.6	1	2.9	9.8	6.7
	cf. Laridae	1	0.1	1	0.4	1.2	6.7
	cf. Columbidae	246	5.1	10	90.1	77.1	66.6
	cf. Mimidae	3	0	1	1.1	0.3	6.7
	5	273	6.6	15	100	100	100
Mammalia	Chiroptères	74	1.3	9	1.8	0.7	20.0
	Canidae	34	3.3	2	0.8	1.9	4.5
	Oryzomyine	2 798	92.6	28	66.6	53.7	62.2
	Dasyproctidae	1 293	75.4	6	30.8	43.7	13.3
	4	4 199	172.6	45	100	100	100
Total	46	56 037	2389.3	3 842			

TABLE 1

NISP, Weight, MNI, and S by family and class for the unit as a whole.

Class	Family	Species	English name	French name	Ecosystem
Crustacea	Palinuridae	*cf. Panulirus sp.*	lobster	langouste épineuse	reef
	Coenobitidae	*Coenobita clypeatus*	hermit crab	bernard-l'hermite terrestre	terrestrial
	Portunidae	*cf. Callinectes sp.*	blue crab	crabe cancroïde bleu	reef
	Xanthidae	*cf. Carpillius corallinus*	coral crab	crabe corallien	reef
		sp. 1	sea crab	crabe de mer	reef
		sp. 2	sea crab	crabe de mer	reef
		sp. 3	sea crab	crabe de mer	reef
		sp. 4	sea crab	crabe de mer	reef
		sp. 5	sea crab	crabe de mer	reef
	Gecarcinidae	*cf. Cardisoma guanhumi*	great land crab	crabe terrestre	terrestrial
		cf. Gecarcinus ruricola	black, blue or mountain crab	crabe terrestre	terrestrial
		cf. Gecarcinus lateralis	black land crab	crabe terrestre	terrestrial
	Ocypodidae	*Ocypode quadrata*	sand crab	crabe blanc	terrestrial
		Uca sp. 1	fiddler crab	crabe violoniste	terrestrial
		Uca sp. 2	fiddler crab	crabe violoniste	terrestrial
		Uca sp. 3	fiddler crab	crabe violoniste	terrestrial
		Uca sp. 4	fiddler crab	crabe violoniste	terrestrial
		Uca sp. 5	fiddler crab	crabe violoniste	terrestrial
Echinoidea	Echinometridae	*Echinometra sp.*	rock-boring urchin	oursin lie-de-vin	reef
	Echinidae		variegated urchin	oursin commun	reef
Pisces	Carcharhinidae		sharks	requins	reef
	Dasyatidae	*cf. Dasyatis americana*	southern stingray	pastenague américaine	estuarine
		cf. Aetobatis narinari	spotted eagle ray	ange de mer	estuarine
	Elopidae	*Elops saurus*	mulets	mulets	estuarine
	Albulidae	*Albula vulpes*	bonefish	baramme	estuarine
	Murenidae	*cf. Echnida catenata*	chain moray	murène à gueule pavée	reef
		Gymnothorax sp.	moray	murène	reef
	cf. Clupeidae	*cf. Engraulidae, or cf. Atherinidae*	herring/sardine/anchovy	pisquette	estuarine
	Belonidae	*Tylosurus crocodilus*	houndfish	orphie de terre	estuarine
		cf. Platybelone argalus	keeled needlfish	orphie de canal	estuarine
		cf. Strongilura timucu	Timucu needlefish	aiguillette timucu	estuarine
	Holocentridae	*cf. Holocentrus sp.*	squirrelfish	cardinal	reef
		cf. Sargocentron sp.	squirrelfish	cardinal	reef
	Centropomidae	*Centropomus cf. undecimalis*	snook	brochet de mer	estuarine
	Serranidae	*Epinephelinae*	grouper	mérou, vieille	reef
		cf. Epinephelus sp.	grouper	mérou, vieille	reef
		cf. Epinephelus adscencionis	rock hind	waliwa	reef
		cf. Cephalopholis fulva	coney	tanche	reef
	Priacanthidae	*cf. Priacanthus cruentatus*	glasseye	soleil batard	reef
	Carangidae	*Decapterus sp.*	mackerel scad	coulirou de canal	reef
		Caranx sp.	jack	carangue	reef
		Caranx ruber	bar jack	carangue franche	reef
		Caranx hippos	crevalle jack	carangue grasse	reef
	Lutjanidae	*Lutjanus sp.*	snapper	vivaneau	reef
		Lutjanus buccanella	blackfin snapper	vivaneau oreilles noires	reef
		Lutjanus purpureus	red snapper	vivaneau rouge	reef
		Lutjanus vivanus	silk snapper	vivaneau franc	reef
		Ocyurus chrysurus	yellowtail snapper	colas	reef
	Haemulidae	*Anisostremus sp.*	margate	lippu	reef
		Haemulon sp.	grunt	gorette	reef
	Sparidae	*cf. Calamus pennatulata*	pluma	daubenet plume	estuarine
		cf. Calamus sp.	porgy	gueule ferrée	estuarine
		cf. Archosargus rhomboidalis	sea bream	rondeau des pâturages	estuarine
	Sciaenidae	*cf. Equetus acuminatus*	cubbyu	monsieur l'abbé	estuarine
		cf. Equetus lanceolatus	jackknife fish	monsieur l'abbé	estuarine
		Equetus sp.	drum	monsieur l'abbé	estuarine
	Kyphosidae	*Kyphosus sectatrix*	bermuda chub	agouti	reef
	Pomacanthidae	*cf. Holacanthus sp.*	rock beauty	ange des Caraïbes	reef
	Sphyraenidae	*Sphyraena barracuda*	great barracuda	barracuda	reef
		Sphyraena sp.	southern sennet	bambokio	reef
	Labridae	*Bodianus rufus*	spanish rufus	capitaine de roche	reef
		Halichoeres sp.	wrasse	girelle	reef
	Scaridae	*Scarus sp.*	parrotfish	chat	reef
		Sparisoma sp.	parrotfish	chat	reef
		Sparisoma chrysopterum	redtail parrotfish	perroquet queue rouge	reef
		Sparisoma viride	stoplight parrotfish	chat	reef
		Sparisoma aurofrenatum	redband parrotfish	perroquet à bandes rouges	reef
		Sparisoma rubiprinne	yellowtail parrotfish	perroquet queue jaune	reef
	Acanthuridae	*Acanthurus sp.*	dostorfish	surgien	reef
	Scombridae	*Euthynnus sp.*	little tuny	bonite	pelagic
		Thunus cf. albacares	yellowfin tuna	thon ailes jaunes	pelagic
	Balistidae	*cf. Balistes vetula*	queen triggerfish	bourse blanche	reef
	Ostraciidae	*cf. Lactophrys sp.*	smooth trunkfish	coffre mouton	estuarine
	Diodontidae	*Chilomycterus sp.*	burrfish	diodon	reef
		Diodon cf. hystrix	porcupinefish	diodon de roche	reef
Amphibia	cf. Leptodactylidae	cf. Leptodactylus fallax	frogs	grenouilles	terrestrial
Reptiles	Cheloniidae		sea turtle	tortue marine	pelagic, terrestrial
		cf. Chelonia mydas	green turtle	chélonée franche	pelagic, terrestrial
	Iguanidae	*Iguana sp.*	West Indies iguana or green iguana	iguane des Petites Antilles ou iguane vert	terrestrial
	Lacertilia cf. Teiidae	cf. Ameiva cineracea	ameiva	ameive de Guadeloupe	terrestrial
Aves	cf. Procellariidae	*Puffinus sp.*	shearwater	puffin	terrestrial
	cf. Anatidae	*Anas sp.*	duk, teal	canard, sarcelle	terrestrial
	cf. Laridae	*cf. Larus sp.*	gull	mouette	terrestrial
	Columbidae	*Zenaida cf. aurita*	dove	tourterelle	terrestrial
	cf. Mimidae	*cf. Margarops sp.*	trasher	grive fine, grosse grive	terrestrial
Mammalia	Chiroptera		bat	chauve-souris	terrestrial
	Canidae	*Canis familiaris*	domestic dog	chien domestique	terrestrial
	Oryzomyine	*Megalomys cf. desmarestii*	rice rat	rat pilori	terrestrial
	Dasyproctidae	*cf. Dasyprocta leporina*	agouti	agouti	terrestrial
Number of taxa		89			

APPENDIX 2

Faunal spectrum and ecosystems of the whole assemblage Z64S93C01.

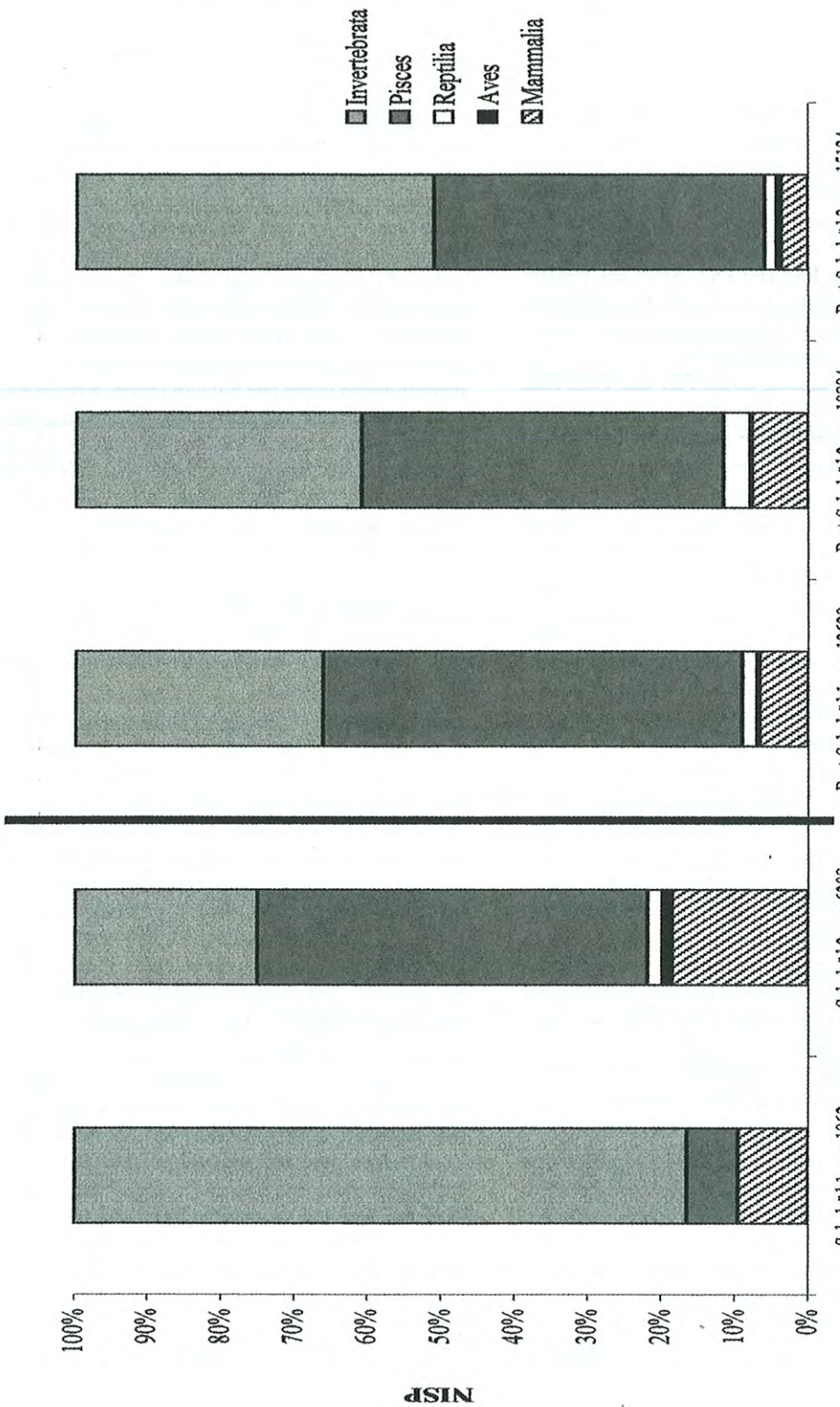


FIGURE 7
Faunal classes by archaeological level (percentage of the NISP).

level (PS1) (Figure 7). Conversely, crustaceans and sea urchins showed a decrease between levels S1 and S2, then a slight increase in level PS3. Mammals were most abundant in the late Saladoïd level (S2). Dogs were absent from the Saladoïd and the third Post-Saladoïd levels (Appendix 3). The NISP of agoutis increased progressively from S1, but decreased between PS2 and PS3. Remains of rice rats increased between S1 and S2, and between PS1 and PS2, but decreased between S2 and PS1 and between PS2 and PS3. Birds and reptiles were scarce throughout the levels. In conclusion, the global spectrum changed among the levels: mammals were abundant towards level S2 and well represented among levels PS1 and PS2. Fish decreased, while crabs and urchins increased from level S2 until level PS3. It seems that each occupation had a distinctive faunal selection.

The rarefaction curve (Figure 8) indicates that the sample from level S1 was not large enough to reflect species richness, nor to reflect the proportions of the rarest species. The samples from levels S2, PS1, PS2 and PS3 were close to the asymptote of this curve and included common as well as rare taxa. They were considered to be an adequate representation of the population being studied. The samples from levels S1, S2, and PS1 included respectively 25, 53, and 72 taxa, but PS2 and PS3 contained 67 and 66 taxa, although they are the largest samples.

The richness index for the whole sequence was 8.1, but differences can be seen between levels in Figure 9. The richness for S2, PS2, and PS3 reached values between 5.9 and 6.8, while PS1 had a higher index of 7.5. These results indicate that Saladoïd 2, Post-Saladoïd 2 and 3 lacked of some of the rarer taxa present in the first Post-Saladoïd deposit. According to Grayson (1984), the higher the value of the richness index, the richer the spectrum, thus the broader the exploitation of resources. Consequently, the inhabitants of Post-Saladoïd 1 had a broader exploitation subsistence than those of Saladoïd 2, Post-Saladoïd 2, or 3.

The diversity index for the whole sequence was 11.3, but differences were also observed between levels. The S2 and PS1 had high diversity indices (12.3 and 12.9, respectively), while PS2 and PS3 had small indices (11.4 and 7.8, respectively) (Figure 9). The diversity index represents the number of equally common species; the higher the values, the more evenly distributed the NISP is across species (Grayson, 1984: 160). Thus, the more the acquisition of the resources is diversified, the more equal the distribution between the samples. A faunal sample with both high richness and diversity suggests a generalised subsistence (Leonard & Jones, 1989).

Figure 10 showing the 20 most abundant families, based on NISP, illustrates this phenomenon. According to the decreasing relative frequencies, the most important taxa of the whole assemblage were land hermit crabs (Coenobitidae), doctor-fishes (Acanthuridae), sea urchins (Echinoidea), jacks (Carangidae), land crabs (Gecarcinidae), trigger-fishes (Balistidae), parrot-fishes (Scaridae), and rice rats (Oryzomyini), anchovies (Clupeidae) and grunts (Haemulidae). The rice rats predominated in the late Saladoïd level, with jacks, land hermit crabs, and land crabs. A terrestrial animal (either a rice rat, a land hermit crab, or a land crab) appeared among the three most important taxa of each level. Sea urchins were among the three most important taxa of the most recent three levels. Fish, especially jacks and doctor-fishes were abundant, jacks particularly in the earlier levels and doctor-fishes in the later deposits. These lists illustrate the natural importance of animals that are typically found on land and in the sea around Grande-Terre.

In conclusion, a strategy of selection based on a small number of dominant species was found in Post-Saladoïd 3. However, Post-Saladoïd 1 had both high richness and diversity indices, and its spectrum of taxa illustrated a generalised subsistence, with a large spectrum and equally distributed species. Saladoïd 2 was apparently impoverished, but had a high diversity index and its spectrum illustrated equally distributed species. Post-Saladoïd 2 had a high richness index, but a low diversity index, and its spectrum illustrated a specialisation with few taxa, but accompanied by a large quantity of species.

Comparisons of the distributions were undertaken in chronocultural stages, and statistically tested pairwise (Chi^2). Differences between the assemblages were all significant (Table 2). Hermit crabs, rice rats, urchins, jacks, and doctor-fishes were the taxa that created the differences between levels S2, and PS1, PS2 and PS3. Land crabs, hermit crabs, rice rats, jacks, sea turtles, herrings, and trigger-fishes created the differences between levels PS1, PS2 and PS3. Land crabs, hermit crabs, rice rats, sea turtles, and agoutis created the differences between levels PS2 and PS3. Without those taxa, the differences between the levels would

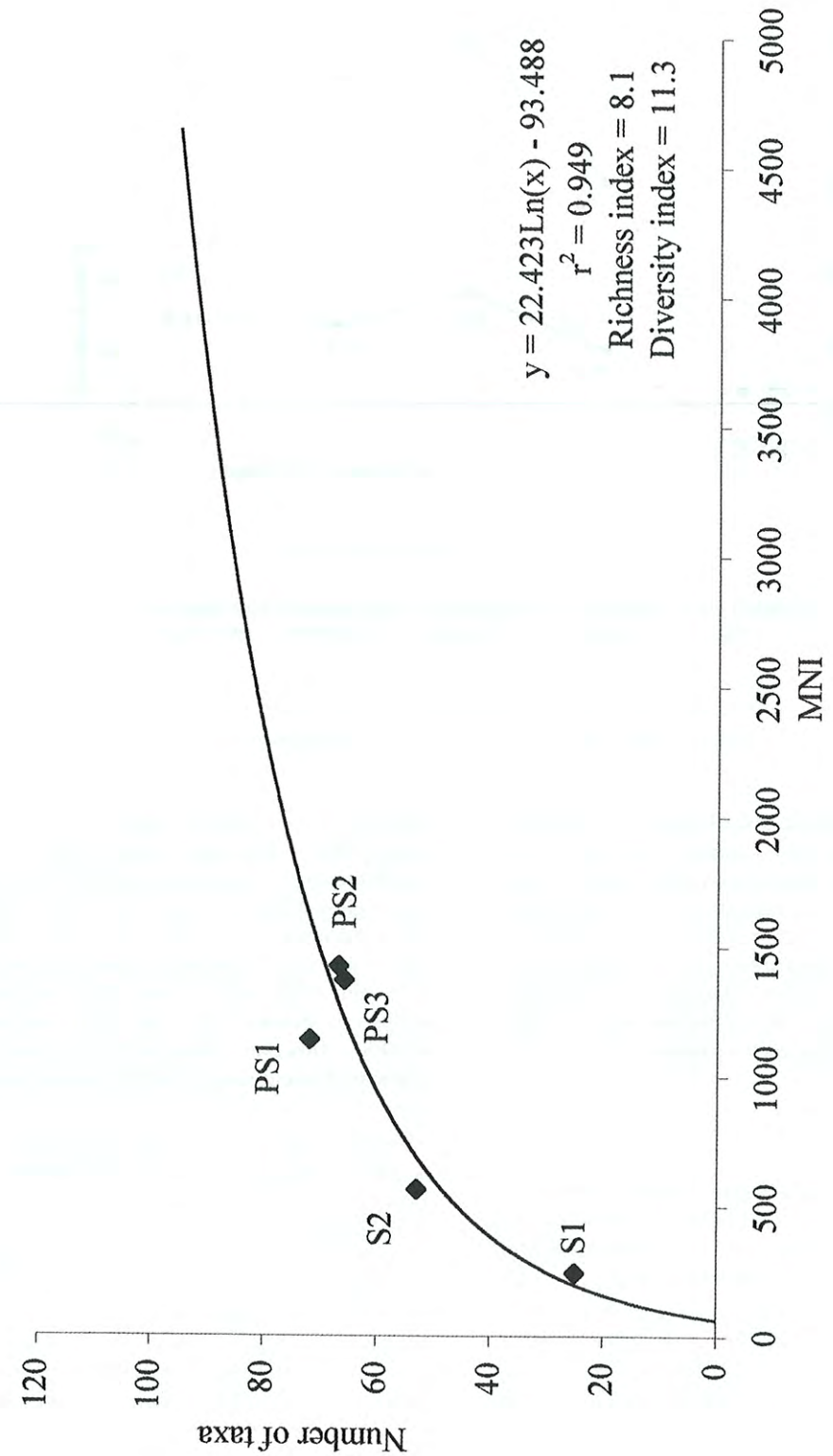


FIGURE 8

Richness curve (number of taxa and MNI) by archaeological level (PS = Post-Saladoïd, S = Saladoïd).

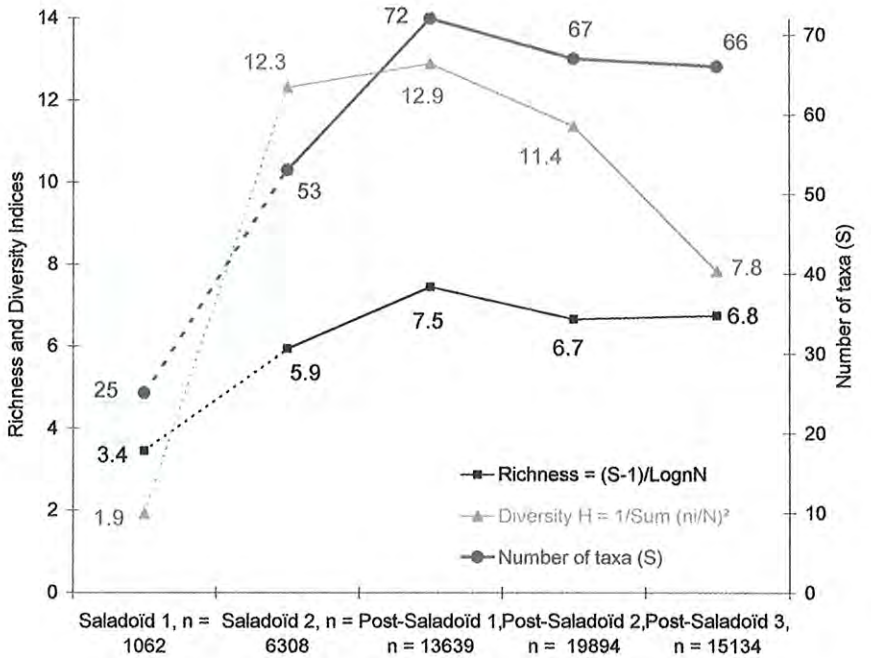


FIGURE 9
Richness and diversity indices, and number of taxa by archaeological level.

have been rendered insignificant. In conclusion, terrestrial crabs and mammals, sea turtles and some reef fishes (like doctor-fishes, jacks or triggerfishes) were not exploited in the same proportions throughout each period. The Post-Saladoïd 3 seems to have had a specialised economy, and although Saladoïd 2, Post-Saladoïd 1 and 2 had generalised economies, the inhabitants selected different species during each occupation.

Fish sizes

The results of the length estimates for fish are presented in Table 3 and Figure 11. Details of the basic statistics of the 3,951 measurements will be presented the author's PhD dissertation.

According to the Agostino test (Chenorkian, 1996), none of the size class distributions of grunts (Haemulidae) were normal (Table 4). Most individuals were between 120 and 160 mm long and few small individuals gave a slight skew toward the small size classes (Figure 11). The smallest individual was 52 mm, and the largest was 317 mm length (Table 3). The general mean length was 147 mm. However, the maximum, minimum and mean were slightly different in each level. For example, maximal lengths varied between 251 mm (PS1) and 317 mm (PS3); minimal lengths varied between 52 mm (PS1) and 73 mm (PS3); and mean lengths vary between 145.7 mm (PS1) and 148.9 mm (PS3). However, shapes of the size class distributions of grunts seem generally similar through time.

The PS1 and PS2 size class distributions of snappers (Lutjanidae) had normal distributions (Table 4), while S1+S2 and PS3 did not have a normal distribution, although they resembled normal curves for size with a few large individuals giving the curve a slight skew toward the large size (Figure 11). The smallest individual was 59 mm and the largest 824 mm long (Table 3). The mean was 207 mm long. Maximum lengths varied from 401 mm (PS2) to 824 mm (PS3); minimal lengths varied from 59 mm (PS1) to 82 mm (PS2); and mean lengths varied from 201 mm (PS2) to 215

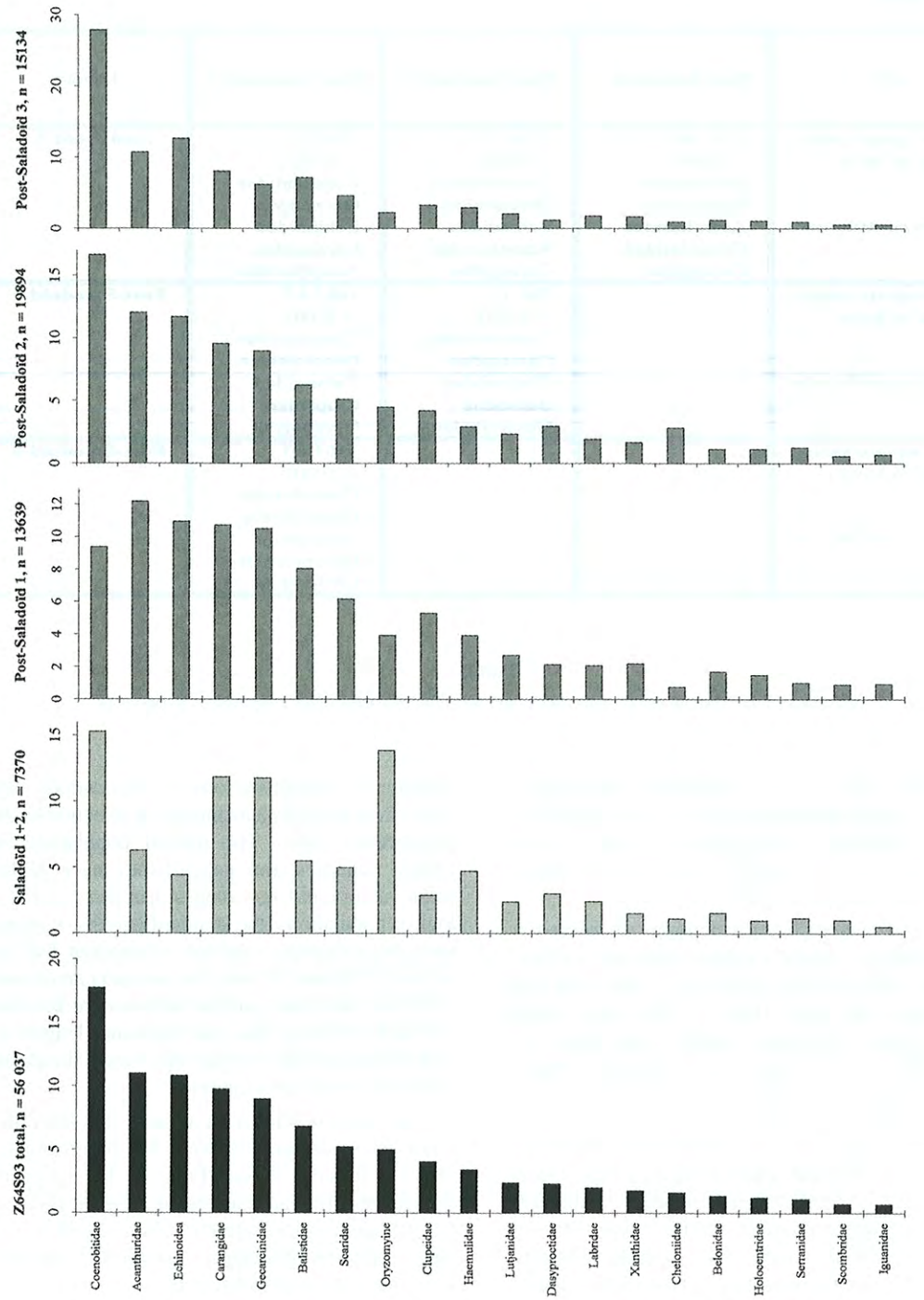


FIGURE 10
Diversity distribution by archaeological level (percentage of NISP).

Chi² tests

df = 26	Post-Saladoïd 1	Post-Saladoïd 2	Post-Saladoïd 3	Levels
chi square value	1251.89	1856.73	3097.32	**Saladoïd 2**
risk of error	< 0.001	< 0.001	< 0.001	
main contributions	Oryzomyini Echinoidea Acanthuridae Coenobitidae Carangidae	Coenobitidae Oryzomyini Echinoidea Acanthuridae Carangidae	Coenobitidae Oryzomyini Echinoidea Carangidae Acanthuridae	
chi square value		784.12	1883.67	**Post-Saladoïd 1**
risk of error		< 0.001	< 0.001	
main contributions		Coenobitidae Carangidae Cheloniidae Balistidae Gecarcinidae	Coenobitidae Gecarcinidae Carangidae Clupeidae Oryzomyini	
chi square value			1161.00	**Post-Saladoïd 2**
risk of error			< 0.001	
main contributions			Coenobitidae Gecarcinidae Oryzomyini Dasyproctidae Cheloniidae	

TABLE 2

Chi² values on the NISP by taxon, significance, and taxa providing the highest contributions to the value.

mm (PS3). The size class distributions of snappers slightly changed through time. In S1+S2 and PS3, most of individuals were between 150 and 275 mm long, while in PS1 and PS2, most of individuals were between 125 and 250 mm long.

All of the size class distributions of parrot-fishes (Scaridae) formed a normal distribution (Table 4). The smallest individual was 65 mm long and the largest 567 mm (Table 3). The mean length was 218 mm. Maximum length varied from 463 mm (PS1) to 567 mm (S1+2); minimal lengths varied from 65 mm (PS1) to 105 mm (S1+2); and mean lengths varied from 212 mm (S1+2) to 222 mm (PS1). The size class distributions of parrot-fishes also changed slightly through time. Most individuals of S1+S2 were between 150 and 200 mm long. Most individuals of PS1 were between 200 and 250 mm long. PS2 showed relatively equal proportions in each size class between 125 and 275 mm long, while PS3 resembled normal curves for size with a few large individuals.

Most fish were intermediate in size. Few juveniles and few large adults were caught, and a large quantity of individuals were of intermediate size. This effect suggests a technique of selection of the intermediate sizes. The natural populations of grunts, snappers and parrot-fishes have higher mean values and larger ranges than these archaeological populations: the standard lengths of grunts from the reference collection of modern fish are between 130 and 267 mm, the snappers are between 66 and 460 mm, and parrotfishes are between 135 and 260 mm; thus the estimated lengths of archaeological fish beyond this range should be interpreted with great caution.

The pairwise Chi² tests showed that the differences between samples were not significant for grunts and parrot-fishes (Table 5). For snappers, significant differences appeared between PS1 and S2 and between PS2 and PS3 (Table 5). However, the distribution of snappers during PS1 and PS2 were not significantly different.

The sizes of the fish did not decrease nor increase through time, and if the curves are globally homogeneous throughout the levels, selections must have been made on the size of the fishes

Haemulon	number of individuals	mean	maximum	minimum	standard deviation
Natural population (Fisher, 1978)		*198.00*	*171.42*	*229.63*	*14.32*
Reference collection	*54*	*192.30*	*267.00*	*130.00*	*34.41*
Saladoïd 1 + 2	330	145.82	282.53	60.73	30.78
Post-Saladoïd 1	519	145.70	251.34	52.62	30.89
Post-Saladoïd 2	625	146.76	299.09	67.15	30.03
Post-Saladoïd 3	431	148.91	317.51	73.27	32.59
Total	**1905**	**146.80**	**317.51**	**52.62**	**31.01**

Lutjanus	number of individuals	mean	maximum	minimum	standard deviation
Natural population (Fisher, 1978)		*385.99*	*224.39*	*797.01*	*73.65*
Reference collection	*47*	*264.17*	*460.00*	*66.00*	*75.83*
Saladoïd 1 + 2	155	209.87	544.74	78.59	64.51
Post-Saladoïd 1	340	205.30	562.05	62.26	71.65
Post-Saladoïd 2	376	201.38	401.83	82.03	57.55
Post-Saladoïd 3	278	215.42	824.12	59.76	66.11
Total	**1149**	**207.08**	**824.12**	**59.76**	**65.20**

Sparisoma	number of individuals	mean	maximum	minimum	standard deviation
Natural population (Fisher, 1978)		*471.49*	*1628.49*	*231.41*	*157.6*
Reference collection	*28*	*208.11*	*260.00*	*135.00*	*35.32*
Saladoïd 1 + 2	144	212.26	566.77	105.94	58.88
Post-Saladoïd 1	252	222.00	463.92	65.33	63.31
Post-Saladoïd 2	288	215.87	489.55	104.61	63.82
Post-Saladoïd 3	213	218.55	467.81	69.10	66.38
Total	**897**	**217.65**	**566.77**	**65.33**	**63.63**

TABLE 3

Basic statistics of the estimated standard length by archaeological level for three fish taxa.

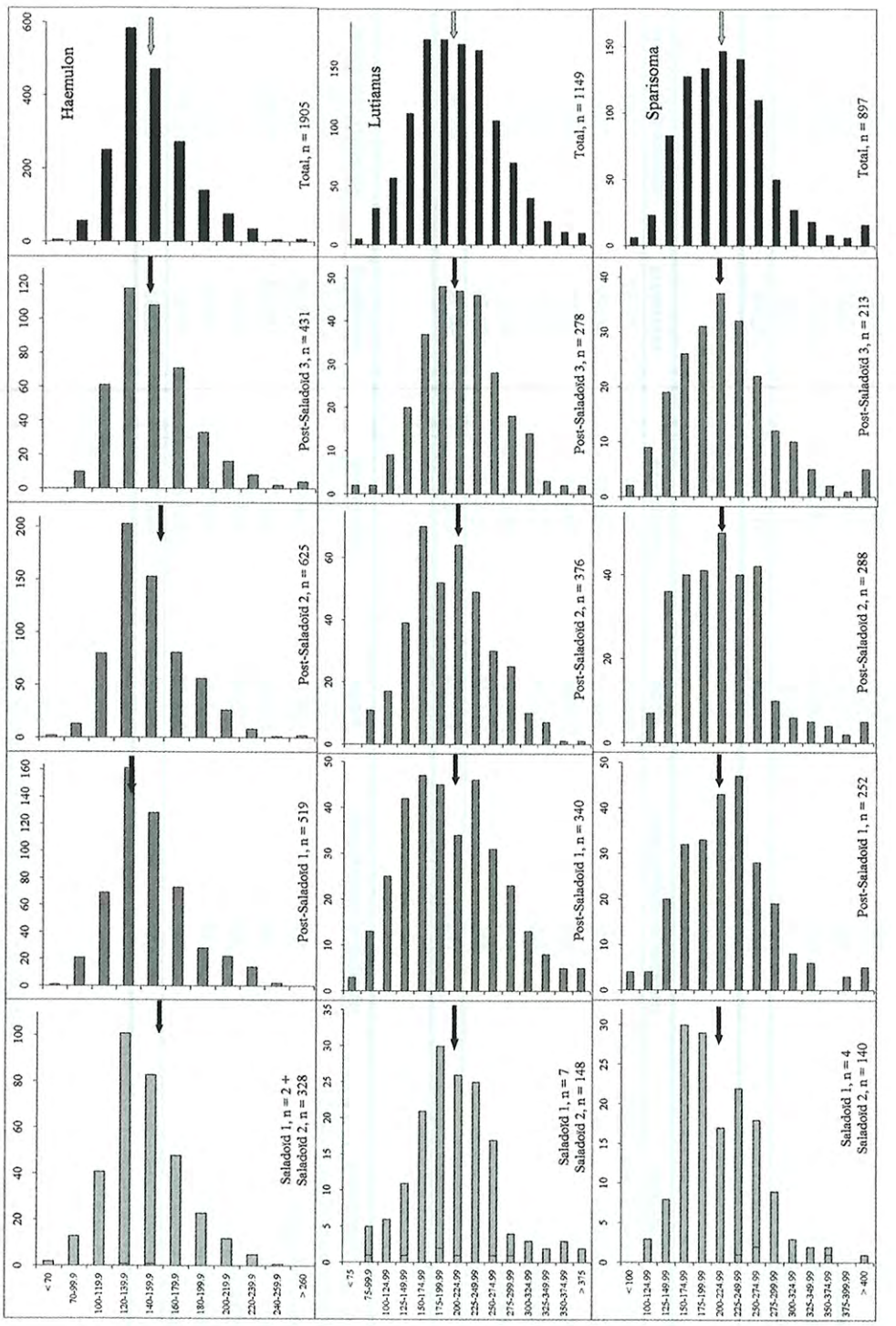


FIGURE 11

Curves of estimated standard length for *Haemulon*, *Lutjanus*, and *Sparisoma* by archaeological level.

Agostino tests of Normality
Ho = normal distribution at the confidence level of 0.05

		Saladoïd	Post-Saladoïd 1	Post-Saladoïd 2	Post-Saladoïd 3
Haemulon	**Statistic U**	922434.00	2292547.09	3222772.55	1645544.81
	Statistic D	0,28	0.276	0,27	0,27
	Statistic Q	**-4,23**	**-5.16**	**-6.13**	**-7.11**
	Number of Measurements	330	519	625	431
	Standard error	30,84	30.92	30.05	32.63
	Signification	**Ho rejected**	**Ho rejected**	**Ho rejected**	**Ho rejected**
Lutjanus	**Statistic U**	407977.55	2308092.51	2300570.19	1277765.85
	Statistic D	0.26	0.28	0.28	.25
	Statistic Q	**-7.84**	**-2.11**	**0.41**	**-17.79**
	Number of Measurements	155	340	376	278
	Standard error	64.72	71.76	57.63	66.22
	Signification	**Ho rejected**	**Ho accepted**	**Ho accepted**	**Ho rejected**
Sparisoma	**Statistic U**	317631.24	1097306.83	1421151.24	827623.80
	Statistic D	0.26	0.27	0.27	0.27
	Statistic Q	**-8.78**	**-4.86**	**-7.73**	**-3.54**
	Number of Measurements	144	252	288	213
	Standard error	59.08	63.44	63.94	66.53
	Signification	**Ho rejected**	**Ho rejected**	**Ho rejected**	**Ho rejected**

TABLE 4

Agostino test values and significance of the normality of the estimated length distributions.

Chi² tests

Haemulon

df = 8	Post-Saladoïd 1	Post-Saladoïd 2	Post-Saladoïd 3	Levels
Chi square value	2.71	5.21	5.70	
risk of error, p	0.95	0.74	0.68	**Saladoïd**
difference	ns	ns	ns	
Chi square value		11.40	10.27	
risk of error, p		0.18	0.25	**Post-Saladoïd 1**
difference		ns	ns	
Chi square value			8.46	
risk of error, p			0.39	**Post-Saladoïd 2**
difference			ns	

Lutjanus

df = 11	Post-Saladoïd 1	Post-Saladoïd 2	Post-Saladoïd 3	Levels
Chi square value	18.12	16.89	8.95	
risk of error, p	0.08	0.11	0.63	**Saladoïd**
difference	ns	ns	ns	
Chi square value		20.99	25.59	
risk of error, p		0.03	0.007	**Post-Saladoïd 1**
difference		significant	significant	
Chi square value			14.67	
risk of error, p			0.20	**Post-Saladoïd 2**
difference			ns	

Sparisoma

df = 10	Post-Saladoïd 1	Post-Saladoïd 2	Post-Saladoïd 3	Levels
Chi square value	11.78	14.51	14.01	
risk of error, p	0.30	0.15	0.17	**Saladoïd**
difference	ns	ns	ns	
Chi square value		11.58	3.85	
risk of error, p		0.31	0.95	**Post-Saladoïd 1**
difference		ns	ns	
Chi square value			10.24	
risk of error, p			0.42	**Post-Saladoïd 2**
difference			ns	

TABLE 5

Chi² values on the estimated lengths and significance for the main fish taxa.

during the Saladoïd and the first two Post-Saladoïd levels. The absence of the smallest specimens could be linked to the use of pots, tramails (large pots), nets, bottom trawls, or hooks and lines, which are good techniques for selecting the biggest fish. Only the specimens in the last Post-Saladoïd level resembled a normal curve, suggesting a selection over the natural range of the species. The large range of size of the samples suggests the simultaneous use of diverse fishing techniques, with nets, pots, hooks and lines, spears, bows, poisons, trawls, etc. This result corroborates our observation concerning the richness and diversity indices, that is, a generalised subsistence during the last Post-Saladoïd occupation.

Selected ecosystems and fishing techniques

The reconstruction of the selected ecosystems have been based on the ecological preference of the species and the size profiles of the faunal sample (Appendix 2).

The species represented on this site could all have been procured from adjacent environments (Figure 12). Most of the fish are primarily reef fish, such as trunkfish, porcupinefish, doctor-fish, parrotfish, triggerfish, grunt, squirrelfish, and small grouper. Throughout the Post-Saladoïd levels (from PS1 until PS3), there was a decline in the use of animals typically found on land, such as rice rats and agoutis. Moreover, beginning in the first Post-Saladoïd period, there was also a decrease of the exploitation of fish from the rocky substrate in inshore water and a corresponding increase in the use of coral reef species, particularly doctor-fishes, parrotfishes, and triggerfishes. As suggested by the insignificant number of small and juvenile fishes, there was no overexploitation of the natural ecosystems.

The geological, geographic, edaphic, and climatic characteristics of the Grande-Terre area produce a mosaic of conditions which sustains a diverse animal life. In particular, the varied marine ecosystems are determined by the nature of the lagoon, the island shelf, and the banks. The present location of the site is on a white-sand beach one kilometre long on the Atlantic Ocean. It is separated from the island of La Désirade by swift ocean currents. A coral barrier reef protects the lagoon, and the beach vegetation is xerophytic. A salt pond is located around La Pointe des Châteaux to the east and a mangrove forest is situated in the Grand-Cul-de-Sac Marin to the west.

The fishing techniques in use today in Guadeloupe are adapted to the sea bottoms, period of the year, species and size of fish. Reef fish are caught from a small boat with hoop nets, pots, or traps, during the whole year, but especially from May to December, because of the rain and hurricane season. Small fish and juveniles are caught with cast nets and lines from the beach in shallow waters, lagoons, or mangrove canals, where they are used to feeding and sheltering. For example, grunts less than 122 mm long (standard length) are juveniles that hide in coral reefs during the day and feed in the shallow waters near the shore, and on the seagrass beds at night (Wing, pers. comm.). The bottom fish, such as large grouper or snapper, are caught with tramails all year round, except from December to February, when the currents are unfavorable. The permanent pelagic fishes, such as anchovies, needlefish, houndfish, little tuny, mackerel scad, and barracuda, are caught during the whole year with surface hooks and lines, seines, or casting nets. The seasonal pelagic species, such as mackerel and tuna, are caught by dragnet fishing from January to June in inshore waters, or in the swift currents flowing between Guadeloupe and La Désirade, from large boats (Aubin-Roy, 1968; Odum, 1971; Hurault, 1972; Wing, 1977, 1994; Bonniol, 1979, 1981; Wing & Reitz, 1982; Béarez, 1995). Although these fishing techniques are employed today, they could have not been used by the pre-Columbian inhabitants of the Caribbean, because some of these techniques were introduced by Europeans, Africans or Asians (seines, cast nets, tramails and pots). However, similar techniques such as reed curtains could have been used. In fact, Amerindians from French Guyana (Galibis) used to close the estuary with a reed curtains during high tide. When the tide ebbed, fishes and crabs that tried to reach the sea remained prisoners. At least, at the beginning of European colonisation, Amerindians had a very high level of navigation technology, using large pirogues to travel from the Guyanas to the Caribbean islands.

Thus, one of the explanations for the diverse fauna is that the wide variety of ecosystems near the site were exploited and that numerous and diverse fishing techniques were probably used.

CONCLUSIONS

The archaeological faunal assemblage from Anse à la Gourde provided information about the

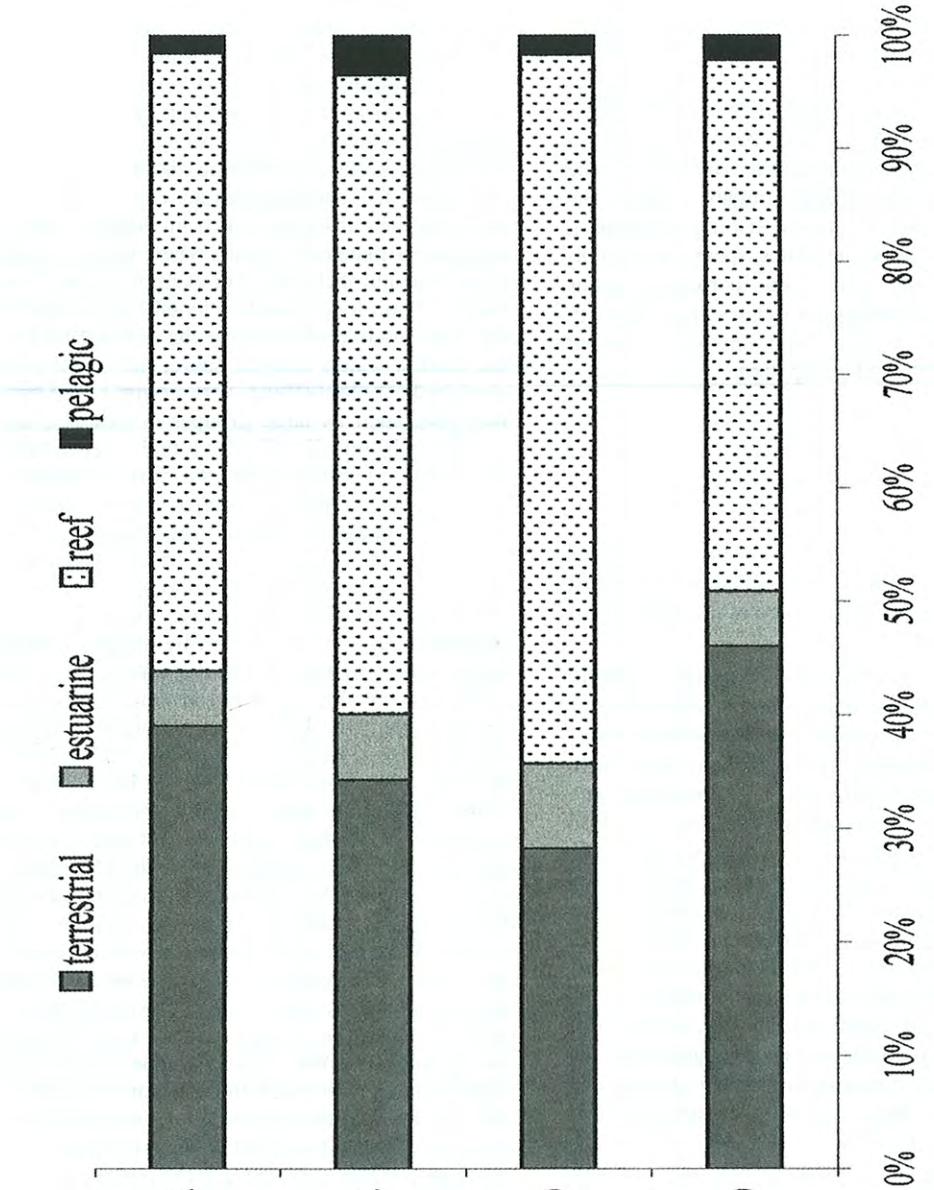


FIGURE 12
Selected ecosystems by archaeological level.

Families	Saladoïd 1			Saladoïd 2			Post-Saladoïd 1			Post-Saladoïd 2			Post-Saladoïd 3			TOTAL		
	NR	Weight	NMI	NR	Weight	NMI	NR	Weight	NMI	NR	Weight	NMI	NR	Weight	NMI	NR	Weight	NMI
Palinuridae	5	0.15	1	21	1.08	4	52	4.01	7	27	1.95	2	82	5.3	3	187	12.49	8
Coenobitidae	748	23.38	156	380	13.32	67	1281	62.46	245	3312	122.69	567	4226	145.84	836	9947	367.69	1756
Portunidae							33	1.01	3							33	1.01	2
Xanthidae				113	11.41	10	299	26.55	16	335	30.88	20	251	19.38	3	998	88.22	16
Gecarcinidae	131	5.14	62	738	49.85	84	1434	111.52	216	1787	105.25	216	942	53.28	120	5032	325.04	573
Ocypodidae							25	0.92	8				2	0.27	2	27	1.19	7
Echinoidea	4	0.11	1	323	8.46	8	1493	47.47	21	2327	58.62	23	1916	50.95	18	6063	165.61	52
Carcharhinidae				4	0.29	4	2	0.12	2				2	0.2	1	8	0.61	2
Dasyatidae				3	0.17	2	2	0.21	2	6	0.17	2	1	0.01	1	12	0.56	3
Elopidae				2	0.2	2				4	0.44	2				6	0.64	2
Albulidae				1	0.03	1	3	0.15	2	11	0.47	4	8	0.35	2	23	1,00	4
Muraenidae				1	0.01	1	10	0.43	7	10	0.26	2	6	0.26	2	27	0.96	3
Clupeidae				215	1.36	21	724	3.24	42	839	4.56	46	504	2.97	29	2282	12.13	95
Belonidae	3	0.06	1	111	4.51	14	232	6.46	20	231	7.74	16	182	5.22	8	759	23.99	26
Holocentridae				74	2.16	14	205	5.18	22	232	6.53	22	168	4.47	9	679	18.34	76
Centropomidae				15	0.68	6	10	0.66	4	26	2.01	5	18	1.73	5	69	5.08	5
Serranidae	3	0.64	1	83	5.8	14	141	15.46	26	253	18.87	25	140	35.28	17	620	76.05	31
Priacanthidae										1	0.01	1				1	0.01	1
Carangidae	18	0.67	4	857	25.62	56	1465	45.8	72	1905	41.74	97	1222	58.72	60	5467	172.55	204
Lutjanidae	7	0.88	2	171	12.36	28	370	27.71	31	473	27.56	29	313	26.5	18	1334	95.01	53
Haemulidae	2	0.04	1	348	10.65	60	539	14.4	70	580	19.65	72	446	13.51	41	1915	58.25	200
Sparidae				2	0.11	2	15	2.22	5	3	0.15	1	6	1.23	2	26	3.71	2
Sciaenidae				5	0.47	4	27	0.41	9	22	0.92	9	8	0.26	4	62	2.06	11
Kyphosidae				1	0.02	1				3	0.12	2	9	0.1	2	13	0.24	2
Pomacanthidae							1	0.02	1							1	0.02	1
Sphyraenidae				4	0.2	1	14	0.49	5	14	0.62	6	9	0.42	3	41	1.73	4
Labridae	3	0.09	1	176	5.56	19	285	8.60	30	387	12.48	26	272	12.26	16	1123	38.99	41
Scaridae	7	0.69	2	362	34.91	47	844	84.22	83	1019	69.69	86	702	89.97	60	2934	279.48	221
Acanthuridae	5	0.26	1	460	15.72	25	1663	61.44	96	2399	76.65	98	1626	57.13	61	6153	211.2	297
Scombridae	9	0.76	2	67	13.43	7	125	13.81	13	120	8.91	7	85	17.57	4	406	54.48	9
Balistidae	17	0.25	1	390	5.83	11	1099	13.25	18	1249	14.97	12	1087	13.85	12	3842	48.15	50
Ostraciidae							8	0.29	3	13	0.16	2	3	0.04	1	24	0.49	3
Diodontidae				1	0.1	1	19	0.29	5	8	0.2	1	9	0.52	2	37	1.11	3
Anura							2	0.03	1							2	0.03	1
Cheloniidae				83	34.77	5	105	19.62	6	568	32.21	3	146	38.93	3	902	125.53	2
Iguanidae				37	1.71	6	132	4.63	7	139	4.43	6	80	4.14	4	388	14.91	8
Lacertilia				14	0.34	4	47	0.36	10	34	0.33	6	27	0.51	6	122	1.54	8
Procellariidae				9	0.34	1							6	0.42	1	15	0.76	2
Anatidae				3	0.41	1							5	0.23	1	8	0.64	1
Laridae							1	0.08	1							1	0.08	1
Columbidae				68	1.45	6	44	1.01	6	59	1.48	6	75	1.11	4	246	5.05	10
Mimidae										1	0.01	1	2	0.01	1	3	0.02	1
Chiroptera	3	0.09	1	17	0.19	2	29	0.56	3	2	0.11	1	23	0.32	2	74	1.27	9
Canidae							27	2.58	2	7	0.7	1				34	3.28	2
Oryzomyini	85	2.01	6	938	34.35	17	538	16.71	12	894	24.31	14	343	15.29	8	2798	92.67	28
Dasyproctidae	12	0.62	1	211	13.05	6	294	15.56	7	594	33.54	5	182	12.65	3	1293	75.42	6
Total identified	**1062**	**35.84**	**244**	**6308**	**310.92**	**562**	**13639**	**619.94**	**1139**	**19894**	**731.19**	**1444**	**15134**	**691.2**	**1375**	**56037**	**2389.29**	**3842**
Unidentified																		
Crustaceans	337	5.56		1892	48.91		8325	234.62		4774	142.3		2814	66.48		18142	497.87	
Osteichthyes	201	3.39		13538	211.9		35468	517.54		41691	668.3		25650	453.32		116548	1854.45	
Mammalia				316	5.46		435	8.55		311	5.75		189	6.41		1251	26.17	
Total unidentified	538	0,00		15746	0,00		44228	0,00		46776	0,00		28653	0,00		135941	0,00	
Total	**1600**	**44.79**	**244**	**22054**	**577.19**	**562**	**57867**	**1380.65**	**1139**	**66670**	**1547.74**	**1444**	**43787**	**1217.41**	**1375**	**191978**	**4767.78**	**3842**

APPENDIX 3

NISP, Weight, MNI, and S by family for each archaeological level.

animals that were used for food during the prehistoric occupation of the site.

Although the same complex of common species appeared throughout the excavation of unit Z64S93C01, a shift in the predominant species was observed. Hermit crabs, rice rats, urchins, jacks, and doctor-fishes predominatde in the Saladoïd deposits. Land crabs, hermit crabs, rice rats, jacks, sea turtles, herrings, and trigger-fishes predominated in the Post-Saladoïd levels. An analysis of the remains did not indicate overexploitation of these animals but rather a shift toward a greater dependence upon marine resources during Post-Saladoïd periods.

In general, grunts, snappers and parrotfishes had adults lengths, with few small and large individuals. Selections must have been made on the size of fish during both Saladoïd levels and the first two Post-Saladoïd levels. Only the last Post-Saladoïd level suggested a selection over the natural range of the species.

Based on the ecological context in which the species are usually found, it is clear that a great variety of different ecosystems was exploited. These included the tropical forests, dry lands, sand beaches, salt ponds, shallow inshore waters, rocky substrates, coral reefs, estuaries, mangroves, and pelagic waters. Catching animals from such varied habitats would naturally result in a diverse faunal assemblage.

The fauna from unit Z64S93C01 as a whole is rich and diverse, particularly in the second Saladoïd and the first Post-Saladoïd deposits. This suggests a more generalised subsistence during these periods. The second and third Post-Saladoïd periods were still rich, but less diversified. This suggests a more specialised subsistence economy, mainly during the Post-Saladoïd 3. The decrease in diversity could be linked to a less extensive use of the wider ecosystems and a more intensive use of the immediate vicinity, namely coral reefs and the lagoon.

The size characteristics, species characteristics, and the natural environment of the encountered species suggest that a variety of different techniques were used to catch them.

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Los pingüinos como presas durante el Holoceno.
Información biológica, fósil y arqueológica para discutir su disponibilidad en el sur de Patagonia

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RESUMEN: Los Spheniscidae fueron escasamente explotados por los cazadores-recolectores del sur de Patagonia. Como una de las explicaciones posibles para entender esta escasa explotación, en este trabajo se presenta la hipótesis de variaciones en la distribución reproductiva del taxón. Para sustentar esta hipótesis, se presenta información biológica relacionada con la sensibilidad del taxón a las fluctuaciones climáticas y ambientales. Los pingüinos responden a los cambios ambientales a corto plazo con cambios en sus parámetros reproductivos, mientras que responden a los cambios a largo plazo con cambios en su distribución y abundancia. Además, se presenta un primer análisis de la información fósil disponible, la estimación del rango histórico de su distribución reproductiva en la costa atlántica, y una evaluación del registro arqueológico en Patagonia. Por último, se establecen cuáles son los requerimientos que deberá cumplir la evidencia para poder evaluar confiablemente esta hipótesis.

PALABRAS CLAVE: SPHENISCIDAE, DISTRIBUCIÓN REPRODUCTIVA, DISPONIBILIDAD DE PRESAS, PATAGONIA, ZOOARQUEOLOGÍA

ABSTRACT: Spheniscidae were hardly exploited by the hunter-gatherers of Southern Patagonia. A hypothesis of changes in their breeding distribution during the Holocene is presented in this paper as one of the possible explanations of such an infrequent exploitation. To support this hypothesis, biological information on penguin vulnerability to climatic and environmental fluctuations is presented. Penguins respond to short term changing environmental conditions with modifications in breeding parameters, and to long term changes, with modifications in their distribution and abundance. In addition, some of the available fossil evidence is presented, along with the historical information on the breeding distribution in the Atlantic coast, and the archaeological record of Patagonia. Finally, some requisites are established for further studies in order for them to allow a reliable testing of this hypothesis.

KEY WORDS: SPHENISCIDAE, BREEDING DISTRIBUTION, PREY AVAILABILITY, PATAGONIA, ZOOARCHAEOLOGY

"[...] I have suggested that ecological and anatomical characteristics of the species still extant with wich ancient man interacted were enduring objects for which uniformitarian assumptions might be securely warranted (Binford, 1981: 28)"

INTRODUCCIÓN

Dada la escasa profundidad temporal abarcada por el poblamiento humano de Patagonia, la afirmación de Binford (1981) puede extenderse a las aves marinas de la región, cuya ecología y anatomía actual constituyen una de las bases sobre las cuales asentar explicaciones acerca de su potencial explotación por los grupos humanos. Un tema a considerar es que las aves marinas son muy sensibles a los cambios climáticos y ambientales, especialmente si los mismos tienen influencia sobre la disponibilidad de las especies de presas que constituyen su alimento (Furnes & Monaghan, 1987). Es por eso que aspectos como la abundancia y la distribución de estas aves no necesariamente permanecieron estables durante los últimos miles de años.

No es posible pensar que las asociaciones de fauna que observamos hoy sean las mismas que en el pasado se encontraban en diferentes latitudes. Las comunidades son producto de la superposición de los rangos de los diferentes taxones que las integran, y cambian debido a la variación individual del rango de cada taxón en función de sus umbrales de tolerancia frente a las variaciones climáticas (Delcourt & Delcourt, 1991; Valentine & Jablonski, 1993; Graham *et al.*, 1996). Por lo tanto, es necesario establecer si la especie o taxón que nos interesa se encontraba disponible para los cazadores humanos a lo largo de los últimos miles de años.

Al analizar el caso de las aves marinas, es necesario tener en cuenta que dependen estrechamente de la productividad de las aguas de las que se nutren (Boersma *et al.*, 1990). Esta productividad, a su vez, depende de las condiciones climáticas y ambientales prevalecientes en un determinado lapso, que son las que determinan los patrones de circulación, la temperatura y el contenido mineral del océano. En la zona subantártica relacionada con América del Sur, que incluye Cabo de Hornos, Islas Malvinas, y gran parte de Patagonia, el contenido de fosfatos y nitratos del agua es alto comparado con el de aguas de equivalente latitud en el norte, por lo que constituyen un ambiente especialmente apto para albergar una gran biomasa de aves (Murphy, 1936; Ingmanson & Wallace, 1995). Por otro lado, dado que las aves marinas también dependen de las condiciones específicas de tierra para reproducirse (Furnes & Monaghan, 1987), es necesario considerar las características de las posibles zonas de nidificación. Esto tiene especial importancia porque es en tierra en donde estas aves pueden ser apresadas más fácilmente y en mayores cantidades por los cazadores humanos.

En general, las aves marinas pueden constituir un recurso económicamente rentable para los humanos debido a que el 98% de las especies nidifican en colonias, cuyo tamaño puede variar desde unas pocas parejas reproductivas hasta más de un millón de aves (Furnes & Monaghan, 1987). Entre las aves marinas, los pingüinos como presas potenciales de los cazadores humanos reunen características que permiten pensar una intensa explotación (Lefèvre, 1993-94). Estas aves son fáciles de cazar, tienen un rendimiento económico mayor que otras aves de la región, y a pesar de que son aves marinas, se encuentran en tierra un tiempo prolongado y en un lugar predecible. A esto hay que sumar que los Spheniscidae constituyen el 80% de la biomasa total de aves marinas en los océanos del sur (Williams, 1995). Pero a pesar de estas cualidades, hasta el momento no se ha encontrado evidencia de una intensa explotación en los registros arqueológicos del sur de Patagonia, ya que son muy escasos los restos recuperados en los sitios costeros de la región.

Una de las posibles explicaciones para esta pobre explotación se relaciona con cambios en la distribución reproductiva de estas aves, especialmente en la costa atlántica de Patagonia, uno de los lugares en los que existe un mayor contraste entre la abundancia actual de pingüinos y la escasa evidencia de su explotación en el pasado. Los pingüinos son aves sumamente sensibles a las variaciones climáticas y ambientales (Williams, 1995; Cooper *et al.*, 1997). Por lo tanto, es necesario investigar la posibilidad de que, en relación con los cambios climáticos y ambientales del Cuaternario tardío, su disponibilidad para los cazadores humanos fuese diferente de la actual.

Si hubo diferencias en la distribución reproductiva de los pingüinos a lo largo del Holoceno, sería más fácil entender una mayor explotación de otros taxones cuyo rendimiento económico es menor y que presentan una mayor dificultad de caza en relación a los pingüinos. Este sería el caso de los cormoranes, de menor tamaño corporal (Rassmussen *et al.*, 1994) y que, por el hecho de ser aves voladoras, serían más difíciles de atrapar. La presencia de distintas especies de cormoranes ha sido establecida en el sur de Patagonia durante el lapso de ocupación humana (Rasmussen, 1991; Siegel-Causey, 1997). Por lo tanto, si los pingüinos hubie-

ran estado ausentes, es posible que los cormoranes fueran una de las mejores opciones, entre las aves marinas, para ser incorporada en la dieta.

En este trabajo, entonces, se plantea la hipótesis de cambios en la distribución reproductiva de los pingüinos en la costa atlántica durante los últimos miles de años, como una de las causas posibles para explicar la falta de explotación por los cazadores humanos. Para sustentar esta hipótesis, se presenta información acerca de las características biológicas de estas aves que se relacionan con los cambios climáticos y ambientales. Además, también se discute la información fósil relevante para este tema, la estimación del rango histórico de la distribución reproductiva en la costa atlántica, y el registro arqueológico en Patagonia. Aunque sobre algunos temas se considerará la información acerca de todo el cono sur, incluyendo la costa del Pacífico, esta discusión se centrará en la vertiente atlántica de Patagonia.

LOS SPHENISCIDAE Y SU SENSIBILIDAD A LOS CAMBIOS CLIMÁTICOS

La Familia Spheniscidae es un grupo de aves no voladoras, pelágicas, ampliamente distribuídas en el hemisferio sur. La familia comprende 17 especies, todas ellas altamente especializadas y adaptadas principalmente para una existencia marina. Su distribución actual incluye la Antártida y círculo subantártico, así como gran parte de las aguas templadas hasta el trópico, pero la mayoría de las especies se concentran entre los 45° y 60° LS (Williams, 1995; Cooper *et al.*, 1997). En la actualidad, sólo el pingüino de Magallanes (*Spheniscus magellanicus*) nidifica en la costa atlántica de Patagonia continental.

Los pingüinos comparten varias características con otras aves marinas: viven largo tiempo, tienen altas tasas de supervivencia de adultos, son K-selectivos, y retrasan la reproducción hasta que tienen varios años de vida. Además, son generalmente monógamos, se reproducen en colonias, y tienen una fuerte tendencia a volver a su colonia de nacimiento para reproducirse, es decir que son filopátricos (Furnes & Monaghan, 1987; Kharitonov & Siegel-Causey, 1988; Williams 1995; Cooper *et al.*, 1997). Todas estas características condicionan fuertemente su relación con el ambiente y, al combinarse, los hacen particularmente susceptibles a la disminución de sus poblaciones, incluso a la extinción (Cooper *et al.*, 1997). Los pingüinos presentan un amplio rango de adaptaciones fisiológicas que les permiten habitar y utilizar ambientes extremos, tanto terrestres como marinos, por lo que es imposible considerar la ecología de los pingüinos independientemente de su fisiología (Williams, 1995).

Los pingüinos están adaptados para sobrevivir en un ambiente variable (Cooper *et al.*, 1997). Debido a su larga vida reproductiva, su habilidad para acumular rapidamente grandes reservas de grasa y su capacidad para ayunar por largos períodos, los pingüinos pueden soportar fluctuaciones a corto plazo en la disponibilidad de alimentos. Sin embargo, las alteraciones drásticas o a largo plazo del ambiente marino pueden exceder esta capacidad para enfrentar los cambios en las condiciones ambientales. Su gran tamaño corporal los hace muy dependientes de las áreas oceánicas de alta productividad, y su gran fidelidad a sus sitios de nidificación también los hace vulnerables al deterioro de las condiciones ambientales en tierra (Williams, 1995). Es posible que los pingüinos se vean más afectados que otras aves marinas por variaciones en las condiciones oceánicas y los consecuentes cambios en la abundancia de peces y otras presas. La evidencia derivada de varias especies de pingüinos sugiere que reaccionan a los cambios a corto plazo en las condiciones ambientales con modificaciones en sus parámetros reproductivos, *mientras que responden a las variaciones a largo plazo con cambios en su distribución y abundancia* (Williams, 1995).

Esta sensibilidad a los cambios ambientales sugiere que el cambio climático local, regional y global puede tener profundo impacto sobre la distribución, la abundancia y la composición de las especies de pingüinos (Williams, 1995; Cooper *et al.*, 1997). La temperatura, la turbulencia, el movimiento del agua y la disponibilidad de nutrientes se encuentran entre los parámetros más importantes que dan cuenta de gran parte de la disponibilidad de la biomasa de peces. Estos factores son regidos por el clima. Por lo tanto, al influenciar la disponibilidad de presas, el clima determina en última instancia la distribución y abundancia de los pingüinos (Cooper *et al.*, 1997).

La información actual corrobora esta sensibilidad a los cambios climáticos. En la región antártica, varios estudios han documentado variaciones en las poblaciones actuales de pingüinos en rela-

ción con pequeños cambios en la temperatura del mar (Williams, 1995). En la costa del Pacífico, donde las condiciones oceanográficas relacionadas con el ENSO (El Niño Southern Oscillation) producen profundos cambios en gran parte de las comunidades marinas, se ha registrado la sensibilidad de las poblaciones de pingüinos a las fluctuaciones de las corrientes oceánicas (Boersma *et al.*, 1990; Williams, 1995; Boersma, 1998).

Algunas aves han respondido a estas variaciones cíclicas con modificaciones en su biología reproductiva. El pingüino de Galápagos (*Spheniscus mendiculus*) cambia sus plumas antes de aparearse, tiene un tiempo de reproducción flexible, múltiples fechas de puesta de huevos y puede tener varias nidadas. Todos estos son rasgos que favorecen la supervivencia de los adultos y la rápida respuesta a las marcadas fluctuaciones de alimento que caracterizan su ambiente, relacionadas con la mayor sensibilidad de la cuenca del Pacífico a la variación climática (Boersma, 1998). Algunos de estos rasgos tambien están presentes en otros *Spheniscus*, el africano (*S. demersus*) y el de Humboldt (*S. humboldti*). Como el de las Galápagos, estos dos pingüinos viven en regímenes que periódicamente muestran grandes variaciones en su productividad.

Las variaciones climáticas y ambientales en la costa atlántica son menos severas y drásticas que en la costa pacífica, y no producen eventos de mortalidad tan importantes como los que resultan de fenómenos ENSO. De todos modos, se han detectado fallas reproductivas asociadas con anomalías ambientales. Las fallas reproductivas en las colonias de aves marinas pueden ser causadas por diversos factores: 1) condiciones climáticas severas, 2) predación, o 3) cambios en la disponibilidad de alimentos (Frere *et al.*, 1998).

En el Atlántico sur, los pingüinos de Magallanes (*Spheniscus magellanicus*) exhiben una alta variabilidad en su éxito reproductivo, lo cual ha sido adjudicado fundamentalmente a dos causas. Por un lado, las diferencias anuales en la disponibilidad de alimentos (Boersma *et al.*, 1990). La baja disponibilidad de alimentos puede ser un resultado de la escasez de presas o de la localización de las especies de presas lejos de la colonia. Como se dijera, los *Spheniscus* del Pacífico presentan una gran flexibilidad para enfrentar estos cambios. Pero el pingüino de Magallanes, que nidifica en el ambiente más estacional ocupado por este género, no exhibe esa flexibilidad reproductiva en respuesta a la disponibilidad cambiante de alimentos (Boersma *et al.*, 1990). Es posible pensar, entonces, que éste es un factor que determinará profundamente la localización y características de las colonias de esta especie.

La segunda causa de fallas en el éxito reproductivo de la especie son las condiciones climáticas extremas. Varias especies de aves marinas pueden sufrir fallas en la reproducción en relación con condiciones climáticas extremas como el calor, el frío o vientos excesivos (Gandini *et al.*, 1997). En la colonia de Cabo Vírgenes (Santa Cruz, Argentina), por ejemplo, el factor más importante en la variación del éxito reproductivo fueron las diferencias en la deserción de los nidos durante la incubación en los años con condiciones climáticas extremas (Frere *et al.*, 1998). La mayor mortalidad se registró en años con fuertes lluvias durante noviembre y diciembre, lo que causó que algunos nidos se inundasen y se ahogasen los pichones. Además, durante momentos de condiciones climáticas extremas, la cantidad de individuos que desertan de sus nidos, tanto en Cabo Vírgenes como en Punta Tombo (Chubut, Argentina), es mayor, lo que resulta en tasas de depredación significativamente más altas (Frere *et al.*, 1998).

Las fallas reproductivas en la escala de las observaciones biológicas efectuadas hasta el presente no implican necesariamente la extinción o retracción del rango de distribución de la especie. De hecho, aunque hay variaciones en el éxito reproductivo, hay continuidad en las colonias. Cuando el éxito reproductivo es altamente variable, la supervivencia de los adultos será el determinante más importante de la supervivencia de la colonia. Las poblaciones pueden soportar un éxito reproductivo variable y fallas en la reproducción si la supervivencia de los adultos es alta, pero incluso las colonias grandes pueden ser vulnerables a la extinción si la supervivencia de los adultos se reduce. Cuando la mortalidad de adultos se incrementa, el número de pingüinos y el tamaño de la colonia pueden sufrir disminuciones drásticas (Boersma *et al.*, 1990).

Entonces, si las variaciones climáticas del Holoceno tuvieron incidencia sobre la distribución de los pingüinos de Magallanes en la costa atlántica, fue fundamentalmente a través de cambios en la productividad de las aguas cercanas a la costa, de forma tal que fuese imposible que los adultos de una colonia pudiesen garantizar su supervivencia y, por lo tanto, la continuidad poblacional. Además,

las variaciones climáticas pudieron implicar cambios en la disponibilidad de habitats para emplazar las colonias de nidificación y cría, es decir sectores de costa con las condiciones sedimentológicas y vegetacionales apropiadas. Los pingüinos nidifican bajo arbustos o excavan madrigueras, por lo que la vegetación, la topografía y las características del suelo son importantes determinantes para la localización de los nidos (Capurro *et al.*, 1988). Por último, en función de la persistencia de condiciones climáticas adversas, como un aumento en las precipitaciones, un sector pudo haber perdido su condición de apropiado para nidificar, ya que no cumpliría con los requerimientos de habitat de la especie. En aves como el pingüino de Magallanes, cuyo período reproductivo en tierra es prolongado, la conservación del hábitat de reproducción es crítica (Gandini *et al.*, 1997).

INFORMACIÓN FÓSIL, HISTÓRICA Y ARQUEOLÓGICA SOBRE LOS SPHENISCIDAE

El registro fósil

La distribución de los organismos marinos en los mares modernos está relacionada con los patrones de su distribución en el pasado, así como con las condiciones paleoambientales (Ingmanson & Wallace, 1995). En el caso de los pingüinos, las especies actuales son el remanente de una fauna más amplia que floreció entre hace 10 y 40 millones de años, y que comprendía alrededor de cuarenta especies (Williams, 1995). Todos los fósiles han sido encontrados en el hemisferio sur, en localidades similares a las ocupadas por los pingüinos actuales (Simpson 1976; Fordyce & Jones 1990). Sudamérica se separa de Antártida hace 25 millones de años, y es posible que la distribución circumpolar moderna de los Spheniscidae se haya establecido en ese momento (Williams, 1995). Esta evolución del océano también tuvo paralelos en el origen de otros vertebrados marinos, como los cetáceos y pinnípedos, que junto con los pingüinos tuvieron radiaciones adaptativas que les permitieron llenar los nichos ecológicos dejados vacantes por los reptiles marinos y otros taxones que desaparecieron durante la extinción a fines del Cretácico (Fordyce & Jones, 1990).

A pesar de que todavía existen discusiones al respecto, los datos más recientes sugieren que los pingüinos siempre habitaron aguas relativamente templadas, pero dadas las características del registro fósil de Spheniscidae, muy discontínuo geográfica y temporalmente, por el momento no es posible establecer relaciones seguras entre las temperaturas del océano y la distribución de los pingüinos en el pasado (Williams, 1995). Los cambios climáticos en el sur probablemente afectaron la evolución de los pingüinos, así como la de otros tetrápodos marinos (cetáceos y pinnípedos) (Fordyce & Jones, 1990).

Ha habido una gran discusión acerca del tamaño corporal de los pingüinos fósiles y las posibles implicaciones paleoambientales del mismo. Simpson (1976), entre otros autores, ha planteado que existe una relación entre tamaño de los pingüinos y su distribución latitudinal. Para él, esto es visible en las especies de pingüinos vivientes, y considera que es posible que esta relación también haya existido entre las especies fósiles. Esta afirmación se basa en que el gran tamaño de algunas especies pudo haber provisto una relación superficie-volumen apropiada para disminuir la pérdida de calor en las aguas templadas. Sin embargo, los pequeños pingüinos actuales pueden habitar aguas más frías que las inferidas para el Eoceno-Oligoceno, por lo que esta relación entre tamaño corporal y temperatura del agua no es tan directa (Williams, 1995). El gran tamaño pudo haber evolucionado por otras razones, por ejemplo, hidrodinámica, adaptación contra predadores, o adquisición de algún determinante de estrategias K (Fordyce & Jones, 1990). También es posible que la extinción de todos los grandes pingüinos, así como también la de varios de tamaño mediano y pequeño, que aparentemente ocurrió durante el Mioceno, pudiese haber estado relacionada con la rápida evolución y diversificación de los pinnípedos y pequeños cetáceos, con la consiguiente competencia ecológica tanto directa como indirecta (Williams, 1995).

La aparente abundancia de los cetáceos y pingüinos del Oligoceno sugiere, pero no confirma, que las aguas fueron productivas. Evidencia independiente permite afirmar que las temperaturas del mar variaron durante las fases tempranas de la historia de los pingüinos (Eoceno tardío, Oligoceno) así como durante fases más recientes (Mioceno tardío, y especialmente desde el Plioceno tardío); las temperaturas probablemente fueron más cálidas hasta el fin del Eoceno, momento durante el cual pudo haber surgido un clima más variable estacionalmente, como consecuencia de la influen-

cia del recientemente formado campo de hielo de la Antártida (Fordyce & Jones, 1990).

El registro fósil de los Spheniscidae es localmente productivo pero discontínuo en general. Las faunas del Mioceno y Plioceno temprano están bien representadas, hay pocos registros del Plioceno tardío o del Cuaternario temprano (Pleistoceno), pero hay abundante registro del Cuaternario tardío. Nueva Zelanda tiene la fauna fósil de pingüinos más diversa, y mejor estudiada, con 14 especies extintas y 3 ó 4 neoespecies reportadas para el Cuaternario (Fordyce & Jones, 1990). En la Antártida, los restos más antiguos en Isla Vicecomodoro Marambio (Seymour), son sincrónicos con algunos de los restos de Nueva Zelanda (Tambussi & Tonni, 1986).

América del Sur sigue a Nueva Zelanda en términos del número de taxones formalmente descritos (Fordyce & Jones, 1990). Los pingüinos fósiles de Patagonia provienen de los sedimentos marinos del Patagoniense, pertenecientes al Oligoceno tardío-Mioceno temprano. La mayor diversidad específica (7 especies) se encuentra en los afloramientos de la margen sur del río Chubut, entre Gaiman y Trelew, correspondientes al Miembro o Formación Monte León (Tambussi & Tonni, 1986).

Sólo recientemente, en el Plioceno tardío (hace 3 millones de años), han aparecido fósiles similares a los modernos géneros, como *Aptenodyptes* y *Pygoscelis* (Williams, 1995). Simpson ha sugerido que el *Spheniscus predemersus* del Plioceno de Sudáfrica puede ser ancestral a las especies de *Spheniscus* existentes, y los restos de dos especies fósiles de *Spheniscus* de depósitos del Plioceno en Perú tambien pueden ser referibles al género moderno *Spheniscus* (Williams, 1995).

Evidencia fósil más reciente muestra que también hubo extinción de pingüinos durante el Holoceno. En un basurero del siglo XIII (Nueva Zelanda) fueron encontrados restos de una especie actualmente extinta (Harrison, 1984). Aunque esta evidencia no cambia las ideas acerca de la distribución del taxón, indica que en el pasado hubo una mayor diversidad de formas que las asumidas previamente.

En síntesis, la información fósil permite afirmar que existió en Patagonia una fauna de pingüinos de una gran diversidad, mucha de la cual se extinguió antes del Pleistoceno final (período de interés para esta discusión). En una escala hemisférica, es posible afirmar que la extinción de especies o taxones de esta familia continuó durante el Holoceno. Además, si bien el género *Spheniscus* se ha detectado en Sudamérica con anterioridad al poblamiento humano, a partir del registro fósil conocido hasta el presente no es posible establecer la historia del taxón en la costa atlántica durante los últimos miles de años. Esto seguramente se relaciona con que son muy escasos los depósitos de sedimentos de fines del Cuaternario en la región (J. I. Noriega, comunicación personal 2000). Por último, por el momento el registro fósil no permite establecer la relación que existe entre la distribución del taxón y los cambios climáticos y ambientales acaecidos durante el lapso de existencia de los Spheniscidae.

Estimaciones de la distribución histórica en la costa Atlántica

Es muy poca la información acerca de la distribución de los pingüinos en la costa del Atlántico durante tiempos históricos. Estos limitados datos históricos sugieren que la distribución reproductiva de los pingüinos de Magallanes se ha movido hacia el norte, y por lo menos algunas de las colonias en la porción norte de la costa atlántica de Patagonia tienen un origen reciente (Boersma *et al.*, 1990). En principio, pareciera que las condiciones a lo largo de la costa argentina son mejores ahora que en el 1900 para los pingüinos, lo cual puede relacionarse con la reciente colonización de Punta Tombo, Punta Clara y la Caleta de Península Valdés. Punta Tombo, la mayor colonia continental de pingüino de Magallanes, que actualmente tiene 200.000 parejas reproductivas, ha existido por no más de 115 años. Esta población comenzó a expandirse en la década de 1920, y aparentemente se incrementó rápidamente. En los '60 los pingüinos de Magallanes comenzaron a colonizar nuevas áreas, extendiendo su rango hacia el norte en la costa argentina. Es probable que esta expansión ocurriese a causa de un incremento a largo plazo en la disponibilidad de alimentos, resultante de cambios en la condición del mar (Boersma *et al.*, 1990; Williams, 1995). Punta Tombo fue visitada en diciembre de 1876 por Durnford, quien efectuó detalladas listas de las aves presentes. Aunque la época del año era propicia para que se observasen pingüinos con sus pollitos y juveniles, no menciona a los pingüinos de Magallanes (Durnford, 1878; en Boersma *et al.*, 1990). A pesar de que estas colonias continentales en Punta

Tombo y alrededores son nuevas, hay evidencia de que nidificaban en islas a lo largo de la costa en el siglo XVI (Murphy, 1936).

También hay diferencias entre el rango histórico y el actual de otras especies de pingüinos en el sur del Atlántico. Entre ellas, *Eudyptes chrysocome* también ha incrementado su rango hacia el norte, y actualmente existe una colonia cerca de Puerto Deseado, Santa Cruz (Frere *et al.*, 1993). Se ha reportado la existencia de una colonia de esta especie durante tiempos históricos en Cabo San Pablo, Tierra del Fuego, actualmente inexistente (Schiavini *et al.*, 1998). También ha variado la distribución reproductiva del pingüino rey (*Aptenodyptes patagonica*), que hasta el siglo XIX nidificaba en Isla de los Estados en dos grandes colonias que totalizaban unos 20000 individuos y cuya extinción fue producto de la explotación humana (Schiavini *et al.*, 1999). Por último, hasta 1940 existió una colonia de *Spheniscus magellanicus* en la Península Ushuaia, Tierra del Fuego, que desapareció al construirse el aeropuerto (Rasmussen *et al.*, 1994).

El registro arqueológico

Las investigaciones tafonómicas efectuadas en la costa atlántica están poniendo en evidencia el potencial de las poblaciones actuales de pingüinos para contaminar depósitos arqueológicos (Cruz, en prensa). Por lo tanto, es necesario ser cautos al adscribir la depositación de los restos de Spheniscidae presentes en los depósitos arqueológicos a alguna causa particular. En este trabajo, por lo tanto, la información arqueológica se utilizará solamente como un medio de establecer la presencia del taxón en el sur de Patagonia, cuáles fueron las especies presentes, en los casos en que esto fuera posible, y el rango temporal representado en cada sitio. En muchos casos, esta información será la única que permitirá abordar el tema de la distribución de los Spheniscidae durante el Cuaternario tardío, lapso generalmente poco explorado por la paleontología.

En la Tabla 1 se presenta la información disponible sobre el tema en el sur de Patagonia. En ella se detallan los sitios arqueológicos en los que se han registrado restos óseos de Spheniscidae, junto a las variables consideradas con potencial para establecer la existencia de colonias de nidificación. Estas variables son: las especies u otro nivel de determinación taxonómica alcanzado, el NISP de cada muestra, la cantidad de individuos presentes, expresado como número mínimo de individuos (MNI), la presencia/ausencia de restos de juveniles en cada depósito y los fechados existentes.

En la mayoría de los casos los fechados no corresponden al taxón, sino al depósito. Si bien sería deseable contar con fechas-taxón (Borrero, 1997), los fechados disponibles son un medio para establecer de forma preliminar el lapso potencial de presencia en una determinada localidad. Para la discusión se consideraron sólo aquellos trabajos que presentan un análisis que fuese más allá de establecer la presencia/ausencia del taxón. A continuación se presenta el análisis de la información arqueológica presentada en la Tabla 1.

COSTA ATLÁNTICA DE SANTA CRUZ: Se estima que los sitios de esta porción de la costa son muy tardíos, aunque por el momento no han sido fechados. En Cabo Blanco 1 (Moreno *et al.*, 1997, 1998) existe un claro predominio de restos de cormoranes por sobre los de pingüinos, mientras que en CE 2 (Miotti, 1989) sólo hay restos de un único individuo de *S. magellanicus*. La cantidad de individuos representados en los depósitos y el hecho de que no hayan sido determinados juveniles, impiden establecer la existencia de colonias de pingüino en ambas localidades. Los restos de estas aves podrían representar su presencia ocasional en las costas. Esto ocurre actualmente con algunas especies, por ejemplo *Aptenodyptes patagonica*, que no nidifica en la zona pero cuyos restos han sido registrados en depósitos actuales de la provincia de Santa Cruz (I. Cruz, observaciones personales 2000). Si la ruta migratoria de *Spheniscus magellanicus* fue similar a la actual durante los últimos cientos de años, entonces aunque no hubiese colonias cercanas podría producirse la presencia de algunos individuos en este sector de la costa.

Otra alternativa, dada la geomorfología de Cabo Blanco, es que el depósito de Spheniscidae sea el resultado de la mayor acumulación de carcasas de pingüinos muertos en el mar en zonas salientes de la costa, tal como se ha registrado actualmente en las costas de Chubut (Gandini *et al.*, 1994). La presencia de los restos de *Spheniscus magellanicus* en CE2 puede ser explicada como producto del transporte de restos de un individuo muerto en el mar, o por algún otro factor natural que no necesariamente se relacione con la existencia de colonias.

COSTA DEL ESTRECHO DE MAGALLANES: Los dos sitios de Península Brunswick tienen

Sitio	Taxón	NISP	MNI	Juvenil	Fechados	Fuente bibliografica
Cabo Blanco 1 (Santa Cruz, Argentina)	*Aptenodyptes patagonica* *Spheniscus magellanicus*	NISP=2 NISP=150	MNI=1 MNI=11	no	s/fechados	(Moreno et al. 1997, 1998)
CE 2 (Santa Cruz, Argentina)	*Spheniscus magellanicus*	NISP=2	MNI=1	no	s/fechados	(Miotti 1989)
Punta Santa Ana (Pla. Brunswick, Chile)	*Spheniscus magellanicus* *Pygoscelis papua*	NISP=81 NISP=5	MNI=4 MNI=2	no	5.600 y 6.400 A.P.	(Lefèvre 1989a)
Bahía Buena (Pla. Brunswick. Chile)	*Spheniscus magellanicus* *Aptenodyptes patagonica*	NISP=30 NISP=1	MNI=3 MNI=1	no	5.700, 6.200 y 6.800 A.P.	(Lefèvre 1989a)
Punta María 2 (Tierra del Fuego, Argentina)	*Aptenodyptes patagonica* *Eudyptes chrysocome* *Spheniscus magellanicus,* *Pygoscelys papua*	NISP=9 NISP=22 NISP=8 NISP=1	MNI=1 MNI=2 MNI=2 MNI=1	no	300 A.P., 250 AP, 2.720± 340 AP	(Lefèvre 1989a, 1992)
San Pablo 4 (Tierra del Fuego, Argentina)	*Aptenodyptes patagonica* *Eudyptes chrysocome*	NISP=2 NISP=6	MNI=1 MNI=1	no	290 A.P.	(Lefèvre 1989a)
SG 1 (Tierra del Fuego, Argentina)	Spheniscidae	s/datos*	s/datos	no	1.070±80 A.P.	(Horwitz 1995)
MLA 3 (Tierra del Fuego, Argentina)	Spheniscidae	NISP=190	MNI=8	no	1.020± 80 A.P.	(Savanti 1994)
MLB5 (Tierra del Fuego, Argentina)	Spheniscidae	NISP=2	MNI=2	no	1.110 ±60 A.P.	(Savanti 1994)
MLS5 (Tierra del Fuego, Argentina)	Spheniscidae	NISP=1	MNI=1	no	360± 50 A.P.	(Savanti 1994)
MLS7 (Tierra del Fuego, Argentina)	Spheniscidae	NISP=6	MNI=1	no	690 ±50 A.P.	(Savanti 1994)
CTS (Tierra del Fuego, Argentina)	Spheniscidae	NISP=25	MNI=4	no	230± 50 A.P.	(Savanti 1994)
ALEPH 1 (Tierra del Fuego, Argentina)	Spheniscidae	NISP=16	MNI=3	no	330± 50 A.P.	(Savanti 1994)

ALEPH 2 (Tierra del Fuego, Argentina)	Spheniscidae	NISP=25	MNI=2	no	s/fechados	(Savanti 1994)
ALEPH 3 (Tierra del Fuego, Argentina)	Spheniscidae	NISP=71	MNI=4	no	450± 60 A.P.	(Savanti 1994)
CM1 (Tierra del Fuego, Argentina)	Spheniscidae	NISP=160	MNI=7	no	s/fechados	(Savanti 1994)
RDA (Tierra del Fuego, Argentina)	Spheniscidae	NISP=7	MNI=1	no	1.380± 70 A.P.	(Savanti 1994)
RD7 (Tierra del Fuego, Argentina)	Spheniscidae	NISP=93	MNI=12	no	1.500 ±50 A.P.	(Savanti 1994)
Bahía Crossley 1 (Isla de los Estados, Argentina)	*Spheniscus magellanicus* *Eudyptes chrysocome* Spheniscidae	NISP=4299 NISP=1542 NISP=1306	MNI=156 MNI=64 MNI=45	no	2.000±70 A.P., 2.180±130 A.P., 2.480±80 A.P., 2.730±90 A.P.	(Lanata et al. 1992)
Lancha Packewaia (Canal Beagle, Argentina)	*Spheniscus magellanicus* *Eudyptes chrysocome*	NISP=290 NISP=3	MNI=48 MNI=2	si	4.215 ±305, 4.020±70, 1.590±50, 1.120±50, 1.080±100, 455±85, 410±75, 280±85 A.P.	(Rassmussen et al. 1994)
Túnel 1 (Canal Beagle, Argentina)	*Spheniscus magellanicus* *Eudyptes chrysocome*	no publicados	no publicados	si	6.980±110 A.P.	(Rassmussen et al. 1994)
Túnel VII (Canal Beagle, Argentina)	*Spheniscus magellanicus* *Eudyptes chrysocome*	s/datos* MNI=2	MNI=7	no	100±45 A.P.	(Estevez Escalera 1996)
Sitios de Cabo de Hornos y Seno Grandi (Chile)	*Aptenodyptes patagonica* *Eudyptes chrysocome* *Spheniscus magellanicus*	NISP=12 NISP=3 NISP=57	s/datos	no	6.120±80; 1.410±50; 680±60 A.P."	(Lefèvre 1993-94)
Bahía Colorada (Chile)	*Spheniscus magellanicus*	NISP=7	MNI=1	no	5.500 ±70 A.P.	(Lefevre 1997b)
Punta Baja (Mar de Otway, Chile)	*Spheniscus magellanicus*	NISP=450	MNI=17	no	270 A.P.	(Lefèvre 1989b, 1997b)
Sitios de Seno Skyring (Chile)	*Spheniscus magellanicus*	NISP=3	MNI=2	no	3.410 AP, 3.790 AP, 1.040 AP, 1.290 AP, 1.760 AP, 1.215 AP	(Lefèvre 1997a)
LE 2 (Isla Morhuilla, Chile)	*Spheniscus humboldti*	NISP=1902 **	MNI=125	no	4.600-4.900 A.P.	(Quiroz et al. 1998)

TABLA 1

Registro arqueológico de Spheniscidae en Patagonia. Detalle de especies u otro nivel taxonómico determinado, número de especímenes identificados (NISP), número mínimo de individuos (MNI) representado en el registro óseo, presencia/ausencia de juveniles y fechados de los depósitos. *sólo se reportan valores de % NISP; ** no se consideraron en los cálculos los cráneos, vértebras, costillas ni esternones.

fechados muy antiguos, atestiguando la presencia de varias especies de pingüinos desde hace 6000 años. En Punta Santa Ana se determinaron dos especies, ambas con un MNI muy bajo (Lefèvre, 1989a). También en Bahía Buena son muy escasos los restos de Spheniscidae, que incluso son mucho menos abundantes que los de Punta Santa Ana (Lefévre, 1989a). La escasez de restos y la ausencia de juveniles no permiten establecer la existencia de colonias a partir de este registro óseo.

COSTA ATLÁNTICA DE TIERRA DEL FUEGO: En estos sitios también se observa el predominio de otras aves sobre los pingüinos, sitios Punta María 2 y Cabo San Pablo 4 (Lefèvre, 1989a, 1992). En San Genaro 1, los huesos incluídos por Horwitz (1995) en la categoría "aves voladoras" son más abundante que los de Spheniscidae. San Pablo 4 y Punta María 2 son sitios muy tardíos, en los que el MNI de Spheniscidae es también muy bajo. La presencia de individuos de *E. chrysocome* en Cabo San Pablo podría relacionarse con la existencia de la colonia de esta especie mencionada anteriormente (ver *Estimaciones de la distribución histórica...*). Sin embargo, la evidencia arqueológica no permite afirmarlo, debido a la baja cantidad de restos recuperados y a la inexistencia, o imposibilidad de determinación, de juveniles en la muestra (Lefèvre, 1989a). De hecho, la presencia de los restos de todas las especies de pingüinos puede ser explicada por las razones mencionadas para la costa de Santa Cruz.

COSTA ATLÁNTICA SUR Y CANAL BEAGLE: En los sitios de Península Mitre se ha registrado un amplio espectro de especies de aves, en depósitos correspondientes a los últimos 1500 años (Savanti, 1994). Con respecto a los Spheniscidae, junto a los cormoranes son los taxones más representados, aunque con valores bajos de MNI en ambos casos. En los sitios MLA3, CTS y CM1, hay un leve predominio de individuos de pingüino. De todos modos, la representación es muy baja, por lo que no necesariamente corresponden a la explotación de colonias. Esto sería concordante con que, en la actualidad, los Spheniscidae no nidifican en la zona (Schiavini *et al.*, 1998).

En Isla de los Estados cambia el panorama, ya que en Bahía Crossley 1 hay un claro predominio de restos de Spheniscidae, en cantidades que podrían interpretarse como la explotación de una colonia. Los valores permanecen altos incluso cuando se los discrimina por capa (ver Lanata *et al.*, 1992: cuadros 3, 4 y 5). Lamentablemente, no se ha determinado la presencia de restos de juveniles en los depósitos, por lo que no puede contarse con esta variable para afirmar la existencia de colonias. Los fechados de este sitio son más tempranos que los de los anteriormente mencionados, y es posible que impliquen que las especies representadas en el registro arqueológico, y actualmente presentes (Schiavini *et al.*, 1999), nidificaban en la isla hace unos 2500 años.

En el canal Beagle, en Lancha Packewaia (Rasmussen *et al.*, 1994) y en Túnel VII (Estévez, 1996) se han registrado restos de Spheniscidae, aunque predominan los de cormoranes. El material óseo de Túnel I aún no ha sido analizado (L. Orquera, comunicación personal 2000), pero a partir de un análisis preliminar es posible afirmar que allí también predominaron los cormoranes (ver Rasmussen *et al.*, 1994). En Lancha Packewaia se han determinado restos de juveniles de Spheniscidae, pero la presencia de pingüinos es explicada por los autores como la caza de individuos que se desplazan por el canal o que se encuentran presentes en la costa (Rasmussen *et al.*, 1994).

Túnel I y Lancha Packewaia se encuentran entre los sitios más antiguos de la costa patagónica, y permiten discutir la presencia de los taxones durante el Holoceno medio y tardío. En Lancha Packewaia la cantidad de individuos representados es mayor que en los sitios de la costa atlántica o que en Península Mitre. Sin embargo, si se discrimina el MNI por fechado (ver Rasmussen *et al.*, 1994: apéndice), efectivamente la cantidad de individuos es poca en cada caso. Por lo tanto, tal como plantean los autores, esta no es una variable que permita establecer la existencia de colonias.

CABO DE HORNOS Y SENO GRANDI: Estos sitios en conjunto abarcan un amplio período, y en ellos hay una abrumadora presencia de restos de Phalacrocoracidae. Aunque hay restos de Spheniscidae, son mínimos y no se presentan datos detallados de las propiedades del depósito (Lefèvre, 1993-94). Sin embargo, a partir de estos registros Lefèvre planteó como un problema a resolver la poca explotación de pingüinos, dada la abundancia actual y la existencia de colonias de nidificación en la zona. Según esta autora, la presencia de juveniles de cormorán indicaría su captura en colonias de nidificación. Dado que la estación de cría de los cormoranes se superpone en parte con la del pingüino de Magallanes, esto permitiría establecer la presencia humana en la zona durante el período reproductivo de estos últimos.

MAR DE OTWAY, SENO SKYRING Y ÚLTIMA ESPERANZA (PACÍFICO SUR): En todos los sitios del mar de Otway predominaron los cormoranes. En los sitios de Seno Skyring también predominaron abrumadoramente los cormoranes, entre los cuales hay restos de juveniles, que son relacionados por Lefèvre (1997a) con la presencia de colonias. Los restos de *S. magellanicus* son muy escasos en Bahía Colorada (un individuo) y en los sitios de Seno Skyring (dos individuos), mientras que en Punta Baja aumenta relativamente la cantidad de individuos representados. En ninguno de los sitios se han determinado huesos de juveniles. Por lo tanto, los restos de estos sitios no presentan evidencias que permitan afirmar la existencia de colonias de nidificación, y pueden representar la presencia ocasional de individuos de la especie en la localidad.

COSTA DEL PACÍFICO: En LE 2, Isla Morhuilla (Quiróz *et al.*, 1998), predominan los restos de *Spheniscus humboldti*, de los que se han determinado por lo menos 125 individuos, entre los cuales no se han reportado restos de juveniles. La cantidad de individuos permite pensar en la explotación de una colonia, que sería una opción económicamente favorable y no necesariamente acotada temporalmente, dadas las características reproductivas de esta especie.

En síntesis, es poca la evidencia concluyente que por el momento brinda el registro arqueológico. Fundamentalmente, permite establecer en la región la presencia de varias especies de Spheniscidae desde el Holoceno Medio, y en algunos sitios es posible especular la relación con alguna colonia de nidificación. La propiedad general más importante del conjunto de Spheniscidae en Patagonia Meridional es la escasez de restos y, por consiguiente, los pocos individuos representados. Sólo dos excepciones, Bahía Crossley 1 y LE 2 presentan un MNI que es acorde con la deposición de restos esperable para una colonia. Es posible que esto también esté reflejando un problema de muestreo en dos escalas. Primero, que los restos analizados en cada sitio sólo constituyan una porción infima del depósito; y segundo, que los sitios con que contamos actualmente sean insuficientes para discutir este tema.

CONCLUSIÓN Y PERSPECTIVAS

Los registros fósil y arqueológico disponibles sólo permiten discutir la presencia de los Spheniscidae de forma temporalmente discontínua. A partir del registro fósil se puede afirmar que el taxón existía en la costa patagónica antes de fines del Pleistoceno. Pero la escasa información, la poca resolución de los registros y el hecho de que no existan depósitos accesibles del Pleistoceno tardío-Holoceno temprano, impide establecer la historia de estas aves durante el período de exploración y colonización de Patagonia por *Homo sapiens sapiens*. La evidencia disponible en escala hemisférica tampoco permite esclarecer aspectos como variaciones en el rango de distribución y su relación con los cambios ambientales de los últimos miles de años.

El registro arqueológico tiene el potencial de brindar información de mayor resolución respecto de estos temas, y como tal ha sido utilizado para establecer posibles variaciones en el rango de distribución de otras aves (Siegel-Causey & Lefèvre, 1989; Tambussi & Tonni, 1984). Sin embargo, presenta dos problemas relacionados con el tema de discusión de este trabajo. Primero, tanto en la costa atlántica como en otros sectores de la costa de Patagonia sólo se dispone de registros desde el Holoceno medio, por lo que queda un vacío temporal que no es posible conocer. Segundo, debido al sesgo que implica la interpretación de un depósito acumulado principalmente por un predador específico, en este caso los humanos, no siempre es posible establecer la *presencia* y *abundancia relativa natural* de los diferentes taxones de una localidad o región. A partir de los restos depositados por los humanos sólo se está estableciendo cuáles fueron los taxones sobre los cuales se predó y el grado en que lo fueron. La relación existente entre los parámetros de la explotación y los de la abundancia natural debe establecerse en cada caso, a través de líneas de evidencia independientes.

Un aspecto que no ha sido tratado en este trabajo, la historia de los cambios climáticos acaecidos en la región desde el Pleistoceno final, será el que permita contextualizar al registro fósil en un marco ambiental más amplio. Por ejemplo, un modelo reciente sobre la historia de la productividad primaria en los océanos del sur sugiere que la productividad de la Antártida fue menor que la actual durante el Último Máximo Glaciario, mientras que en la región subantártica no hubo cambios con respecto al presente en la concentración de nutrientes de las aguas superficiales, ni en su uso, ni en la productividad primaria (Delaney, 2000; Elderfield & Rickaby, 2000). Esto implicaría que algunas de las condiciones necesarias para la pre-

sencia de colonias de pingüinos en la costa patagónica podrían estar presentes hacia fines del Pleistoceno. Otros factores, como la temperatura de las aguas superficiales, la formación de aguas profundas en el Atlántico norte, y los patrones de circulación atmósferica y oceánica, han sufrido cambios sustanciales desde el Holoceno Medio (Steig, 1999). Estos son sólo algunos ejemplos del tipo de información que será necesaria. También deberá incluirse la historia de formación de la costa del Atlántico sur, que ha sufrido cambios importantes desde fines del Pleistoceno (Clapperton, 1993), y cuyo conocimiento es necesario para evaluar la disponibilidad de habitats aptos para el emplazamiento de colonias de nidificación.

Si bien la respuesta al tema de las posibles variaciones en la distribución de los Spheniscidae debe necesariamente basarse en el registro fósil, del taxón y de los ambientes, la interpretación de este registro debe nutrirse de dos líneas de investigaciones actuales. Por un lado, aquellos aspectos de la ecología y biología de las poblaciones actuales de pingüinos que puedan relacionarse con los cambios climáticos y ambientales en escala local, regional y global. A partir de estos estudios se ha constatado la marcada sensibilidad de estas aves a los cambios climáticos, y se han definido los parámetros ambientales a considerar para evaluar las posibles variaciones en el rango de distribución.

Otro tipo de información actual, la tafonómica, es también de especial importancia para abordar el tema de las paleodistribuciones de pingüinos. A partir de las observaciones actuales se pueden conocer y definir las propiedades de los conjuntos óseos que resultan de una colonia de nidificación. Esto constituye una herramienta apta para interpretar el registro fósil y orientar la búsqueda de depósitos.

Las investigaciones paleontológicas y arqueológicas que aquí se han discutido no estuvieron destinadas a establecer las variaciones en la distribución reproductiva de los Spheniscidae. Sus objetivos eran otros, por lo que la búsqueda, análisis y presentación de la evidencia no necesariamente responden a los requerimientos que plantea este tema. Si en el futuro se busca investigarlo, se deberán tener en cuenta las características de la información que debe generarse, para lo cual sería necesario:

a) Buscar depósitos de huesos de pingüinos del Cuaternario tardío, preferentemente independientes de los registros arqueológicos.

b) Afinar la resolución de los depósitos, a partir del análisis sedimentario y de fechados. Ajustar el análisis de los conjuntos óseos a los paquetes temporales definidos, buscando establecer la cantidad de individuos y las clases de edad representadas en cada uno de ellos.

c) Obtener fechas-taxón (*sensu* Borrero, 1997), para descartar la contaminación de los depósitos y establecer más ajustadamente la presencia del taxón en una determinada localidad y período.

d) Efectuar un análisis exhaustivo de la historia local de conformación de la costa, con especial énfasis en los aspectos sedimentarios, geomorfológicos y cronológicos.

e) Asimismo, establecer las características de la vegetación en cada localidad, que podría constituir un factor importante para la localización de las colonias.

f) La evaluación de líneas paleoambientales y paleoecológicas que permitan establecer la existencia de las condiciones requeridas por los pingüinos, es decir aspectos como la productividad oceánica o la presencia de presas.

g) Profundización de los estudios tafonómicos que permitan comprender la naturaleza y dinámica de los depósitos de restos óseos de pingüinos, incluyendo los que resultan de colonias de nidificación.

h) Estudios de mayor escala temporal acerca de la ecología de los pingüinos en relación con los cambios climáticos y ambientales, especialmente en la costa atlántica, en donde las investigaciones son más recientes que en otros puntos de la distribución de estas aves.

Esta primera aproximación a las posibles variaciones en la distribución de los Spheniscidae en la costa patagónica deberá ser profundizada con el análisis exhaustivo de las líneas de evidencia que aquí se proponen, evaluando en cada caso la información local, que finalmente deberá ser puesta en una perspectiva regional, la escala apropiada para plantear este problema.

Los arqueólogos han planteado reiteradamente la necesidad de comprender la relación entre disponibilidad y explotación para discutir cuáles fueron las decisiones económicas de las poblaciones humanas del pasado. En muchos casos, esto requiere el abordaje de temas como el que aquí se ha tratado y que tradicionalmente han sido considerados fuera de la órbita de las investigaciones arqueológicas. Sin embargo, dada la escala tempo-

ral implicada y la necesidad de contar con depósitos de resolución muy fina, es improbable que sean encarados por investigadores de otras disciplinas. La presencia de una colonia de nidificación de pingüinos en un punto del paisaje utilizado por los cazadores-recolectores tiene implicaciones para entender su economía y organización social, tanto si fue explotada como si no lo fue. Entonces, dedicar esfuerzos para comprender mejor la conformación de las comunidades, y por lo tanto la disponibilidad de taxones entre los cuales los humanos eligieron sus presas, es una opción que deberá incluirse dentro del espectro de interés arqueológico en el sur de Patagonia.

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Aplicación del estudio de la cementocronología a materiales de los niveles magdalenienses de la Cova de Les Cendres y la Cova del Parpalló: metodología y primeros resultados

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RESUMEN: Este artículo presenta los resultados de la aplicación de la cementocronología al estudio de dientes procedentes de la Cova de les Cendres y la Cova del Parpalló. Se estudia la validez del método y su utilidad en los análisis de estacionalidad. Los resultados indican que el método es válido, pero hay que proceder con mucha precaución en la valoración de los resultados.

PALABRAS CLAVE: CEMENTO DE LOS DIENTES, LÁMINA DELGADA, INCREMENTOS DE CRECIMIENTO, BANDA CLARA, BANDA OSCURA, ESTACIONALIDAD

ABSTRACT: This paper comments on the results of the applications of the cementumchronology to the study of the teeth from two archaeological sites: Cova de les Cendres and Cova del Parpalló. The validity of the method, as well as its use on seasonal studies, is discussed. The results evidence that this is a valid method provided one proceeds cautiously when interpreting its results.

KEY WORDS: TOOTH CEMENTUM, THIN SECTIONING, CEMENTUM INCREMENTS, TRANSLUCENT BANDS (GROWTH BANDS), OPAQUE BANDS (REST LINES), SEASONALITY

INTRODUCCIÓN

El estudio de las edades de los animales para conocer los procesos de selección debe de ser valorado dentro de las proposiciones antropológicas de la escuela norteamericana. La publicación en los años 50 y 60 de una serie de trabajos paleoeconómicos centrados en el estudio de poblaciones neolíticas planteó la necesidad de conocer las pautas de selección y del aprovechamiento de los recursos animales, valiéndose de las analogías etnográficas (Reed, 1960, 1969; Perkins, 1964; Perkins & Daly, 1968). De la mano de la Nueva Arqueología, este tipo de estudios adquirieron un gran empuje (Binford, 1978, 1981). Paralelamente, la escuela de Cambridge desarrolló diversos proyectos de investigación sobre comunidades ganaderas tradicionales, preferentemente en el ámbito mediterráneo, en los que uno de los temas centrales sería la elaboración de un método de determinación de edad a partir de la erosión de los dientes.

Por otro lado, la valoración del comportamiento humano de épocas prehistóricas dió lugar a los trabajos de Sturdy (1975), quién proponía la movilidad del sistema cazador/recolector, según los modelos de organización territorial de Vita-Vinzi y Higgs, confeccionados en términos de modelo energético, asumiendo el modelo de Lee y De Vore desarrollado en 1968. Speth (1983) marcó un hito

en la aplicación metodológica del estudio del yacimiento de Garnsey en el que estudió diversas variables para la interpretación del registro óseo, en especial la selección de los bisontes por edades. Spiess (1979) combinó los estudios del comportamiento biológico del reno con su aprovechamiento, según la estación, edad y sexo, utilizando el método de la cementocronología. Con todo ello, estableció el modelo de cambio residencial estacional, que suponía el desplazamiento de grupos humanos entre las residencias de invierno (cuevas del Périgord) y las de verano (La Quina, Charente). Consecuentemente, en estas investigaciones se abría paso a la utilización de un método fiable para la determinación de la edad y, más aún, de la estacionalidad. El nuevo método fue desarrollado en el campo de la biología y Speth constató su validez para los estudios arqueozoológicos.

Los primeros estudios de la cementocronología fueron llevados a cabo en Alemania en la década de los 30 por Eidman y von Marienfried para el ciervo. En las décadas de los años 50 y 60 conocieron un gran auge en el campo de la biología, especialmente en los Estados Unidos, y se aplicaron tanto a los ungulados como a los carnívoros (Gordon, 1993). Los objetivos antropológicos de la Nueva Arqueología eran muy amplios y por ello los métodos de investigación de otras disciplinas eran aplicados a la investigación arqueológica, entre ellos los métodos de edad a partir del recuento de los incrementos del cemento, que ofrecían mayor precisión que otros métodos.

A partir de estos momentos, los estudios de la cementocronología llegaron a ser el fundamento básico de la construcción de modelos arqueológicos. Los trabajos de Gordon (1988) se centraron en el suroeste de Francia y a partir de la información estacional que ofrecía el cemento de los dientes del reno junto con el estudio del comportamiento migratorio del caribú norteamericano, asentó el modelo de la teoría de la caza del seguimiento migratorio del reno, establecido de norte a sur (entre los Pirineos y la Dordoña y la Gironda), construída según el modelo energético del forrageo óptimo de Sturdy.

Trabajos posteriores, utilizaron la cementocronología para el estudio de los dientes de caballo (Burke, 1995) y el ciervo (Pike-Tay, 1991) para esta misma zona geográfica, dando consistencia a la teoría del cambio estacional, que confirmaba los postulados de Bouchud (1966) y Delpech (1987).

Recientemente en Francia los estudios de estacionalidad a partir de las bandas del cemento están iniciándose en diversos yacimientos arqueológicos (Martin, 1995; Griggo & Pubert, 1999).

La importancia que este método está adquiriendo en la arqueozoología nos ha motivado a profundizar en su estudio para conocer si realmente su información es fiable y si merece la pena ser aplicado en la arqueología. Para su validación es imprescindible el contar con una muestra de referencia actual y para ello disponemos de la inestimable cooperación de la Estación Biológica de Doñana.

Este trabajo forma parte del proyecto Tecnología, Economía y Medio Ambiente en la Región Central del Mediterráneo Español entre el Tardiglaciar y el Holoceno medio, del Programa Sectorial de Promoción General del Conocimiento PB95-1087, y el material arqueológico analizado proviene de dos importantes yacimientos de la región central del Mediterráneo peninsular, la Cova del Parpalló (Gandía, Valencia) (Pericot, 1942; Fullola, 1979; Davidson, 1989; Aura, 1995) y la Cova de les Cendres (Moraira, Alicante) (Villaverde & Martínez, 1995; Villaverde *et al.*, 1998).

La importancia de los niveles de cronología magdaleniense en los dos yacimientos y la escasa distancia que media entre ambos, a penas unos 40 kms en línea recta, pero en medios relativamente distintos, hacían interesante la aplicación de este método de determinación de la estación de abatimiento a una de las especies dominantes en el registro del Paleolítico medio y superior de la región mediterránea, el *Cervus elaphus*. Parpalló ofrece una composición faunística para los niveles del Magdaleniense superior en la que el dominio de los restos de ciervo convive, sin embargo, con una elevada proporción de restos de *Capra pyrenaica* (Davidson, 1989). Cendres, por el contrario, ofrece en esos momentos un perfil claramente decantado hacia el ciervo, que llega a representar el 80% de los restos de herbívoros documentados en esos niveles.

Precisar, en la medida de lo posible, la estación de ocupación de estas cavidades resulta un requisito necesario para el avance en la comprensión de los modelos de ocupación del territorio por los grupos cazadores del magdaleniense regional.

Después de esta visión general, es necesario presentar los fundamentos metodológicos del método, sus problemáticas y su aplicación al material arqueológico que ha sido objeto de estudio.

BIOLOGÍA DEL CEMENTO

El conocimiento de los fundamentos del método conlleva la realización de un planteamiento general de la biología del cemento.

Éste se encuentra en la raíz de los dientes. Está constituído por un componente orgánico, mayoritariamente colágeno, y un componente mineral, normalmente hidroxiapatito. El cemento no es vascular y por ello crece formando un frente mineralizado, en forma de incrementos concéntricos alrededor de la raíz. Se deposita contínuamente a lo largo de la vida de un diente.

Su función es la de anclar la raíz a la encía. El cemento dental está compuesto por dos tipos de fibras de colágeno. Las extrínsecas, llamadas fibras de Sharpey, son sintetizadas por los fibroblastos de la membrana periodental, que tienen como función anclar la raíz del diente al ligamento periodontal y mantener la corona en posición oclusiva. Las fibras intrínsecas, producidas por los cementoblastos alrededor de las fibras de Sharpey y especialmente en la región apical de las raíces, sobre todo en los dientes más viejos, no juegan un papel en el sistema de soporte del diente (Lieberman & Meadow, 1992; Lieberman, 1994; Burke, 1995; Pike-Tay, 1995).

El cemento se divide en dos importantes categorías histológicas, el cemento acelular y el celular, según la presencia o ausencia de células. A su vez, ambas pueden subdividirse sobre la base de composición del colágeno del tejido, según sea éste intrínseco, extrínseco o mixto.

1. El cemento acelular (llamado también primario), está constituído mayoritariamente por fibras extrínsecas (fibras de Sharpey). Se deposita de un modo lento y regular en proporciones constantes por los cementoblastos que, al permanecer en la superficie del cemento, no quedan embebidos en el tejido y por ello no incorporan cementocitos y lagunas, resultando una mineralización alta. Generalmente tiene unas proporciones elevadas de fibras de colágeno extrínseco y pocas de colágeno intríseco. Las fibras de Sharpey se orientan perpendicularmente a la superficie de la raíz. El cemento acelular se localiza en la zona de unión del esmalte con el cemento y se extiende hacia la parte apical de la raíz. Su función principal es la de anclar la raíz al ligamento periodontal.

2. El cemento celular (o secundario) contiene cementocitos, cementoblastos que han quedado atrapados en la matriz de cemento que con el tiempo se deterioran y mueren, formando lagunas. Su formación es más rápida y menos mineralizada. Tiene una cantidad mayor de fibras de colágeno intrínseco que el cemento acelular. Se encuentra en el extremo de la raíz, y es de mucho mayor espesor que el cemento acelular. Su función no se conoce totalmente, pero probablemente sirve para rellenar los espacios que quedan entre la raíz del diente y el ligamento periodontal, minimizando el movimiento del diente durante la oclusión. La proporción y la cantidad de la deposición del cemento celular está probablemente relacionada con el grado de erupción, la cantidad del desgaste de un diente y el tamaño total del mismo (Lieberman & Meadow, 1992; Lieberman, 1994; Burke, 1995).

LAS BANDAS DE CRECIMIENTO

El crecimiento del cemento se manifiesta ópticamente por medio de bandas, tanto en el cemento acelular como en el celular, que se caracterizan por la alternancia de una banda estrecha ("*annuli*", "*rest line*") y otra más ancha ("*cementum growth*"). En las muestras descalcificadas y teñidas, la banda estrecha es de una coloración más oscura y la ancha de coloración más clara. En las muestras obtenidas a partir de láminas finas y pulidas la apariencia es diferente, la banda estrecha se muestra opaca con la luz transmitida polarizada mientras la ancha aparece traslúcida. La formación y evolución de las bandas está conectada con el cambio estacional anual (Grue & Jensen, 1979; Klevezal & Pucek, 1987). La banda estrecha se forma durante el periodo de reducción del crecimiento de los tejidos, que ocurre en invierno; se deposita lentamente y su densidad es alta por el elevado grado de mineralización; mientras la ancha se deposita en los momentos de rápido crecimiento, durante la primavera y verano, con una mineralización más baja (Gordon, 1993; Liebermann, 1994; Burke, 1995).

La naturaleza óptica de las bandas resulta de la disposición y orientación de las fibras del colágeno. Los "*annuli*" son anisótropos porque las fibras de colágeno están orientadas regularmente y se corresponden con la estructura laminar del hueso; por el contrario, las zonas de crecimiento son isótropas por la variabilidad de la orientación de sus fibras. Aunque el material fósil pierde el colágeno por procesos diagenéticos, el componente mineral

del tejido mantiene su orientación, preservando la estructura de las bandas (Burke, 1995).

La lectura de las bandas del cemento acelular es útil para estimar la edad y la estación de muerte debido a que sus incrementos son constantes y regulares. Por el contrario, las del cemento celular pueden servir para estimar la edad pero no la estacionalidad debido a que sus incrementos son irrgulares tanto en su forma como en su distribución (Lieberman, 1994).

Las estimaciones de estacionalidad se establecen a partir del estado de la última banda del cemento. Gordon (1988) tomó como muestra de referencia 62 molares de caribú de edad y estación conocida y a partir de ella estableció que en primavera el incremento de la banda ancha de crecimiento estaba formada un 25% sobre la anchura máxima de la banda anterior. En el verano alcanzaba un 50% y en otoño un 75%. En invierno se formaba la banda estrecha y oscura. Ahora bien, la apreciación visual de las muestras introduce un grado de subjetividad que puede determinar imprecisión en las determinaciones de edad y estacionalidad. Para obtener una mayor precisión, las imágenes obtenidas en el microscopio pueden ser digitalizadas y convertidas en gráficos que facilitan el recuento de las bandas y la formación de la última de ellas para estimar la estación de muerte (Lieberman, Deacon & Meadow, 1990; Burke, 1995). Adicionalmente, otro buen método es la preparación de muestras para ser observadas en un microscopio electrónico para las estimaciones de edad y de estacionalidad. Los resultados son similares a los obtenidos con muestras para ser observadas en una luz polarizada (Burke, 1993).

CAUSAS DE LA FORMACIÓN DE LAS BANDAS

Se han descrito distintos factores que han podido incidir en la creación de las bandas, tales como el clima, la nutrición, el ciclo sexual y el ciclo hormonal, pero no hay una certeza en que dichos factores sean la causa directa de la formación de las bandas del crecimiento del cemento (Grue & Jensen, 1979; Stallibrass, 1982).

Recientes estudios experimentales parecen demostrar que las bandas se originan por las variaciones de la mineralización relativa del cemento y por las variaciones de la orientación del colágeno. Bajo un periodo con una dieta baja en nutrientes, los animales no ganan peso y el cemento está más mineralizado. En esta situación de stress nutricional el cemento se deposita en una proporción más baja que en periodos de buena nutrición de acuerdo con el proceso de la cementogénesis. La mineralización del cemento es precedida por el depósito de la matriz de colágeno, cuyo crecimiento sufre variaciones según el estado nutricional; en los momentos de stress la fase orgánica sufre una detención en el crecimiento; no así la fase de mineralización que se desarrolla en unas proporciones constantes, independientemente de los estados nutricionales, resultando por ello un cemento más mineralizado en los momentos de escasez alimentaria. Esta exposición explica la formación particular de la banda estrecha y oscura. Todo lo contrario ocurre con la banda ancha, cuya formación coincide con la época de crecimiento (Lieberman & Meadow, 1992; Lieberman, 1994).

Las bandas del cemento también se explican por la actuación de las fuerzas biomecánicas que intervienen en la masticación y que son responsables de la orientación del colágeno. Las dietas duras determinan que las fibras de Sharpey se orienten más verticalmente con respecto al borde de la unión del cemento con la dentina para hacer frente a los mayores esfuerzos de la masticación. Con dietas blandas las fibras de Sharpey se orientan menos verticalmente (la diferencia de la orientación del colágeno según las dietas es de unos 20 grados). La microestructura mineral de la disposición de las fibras se manifiesta por medio de bandas claras y opacas bajo la luz polarizada a causa de la birrefringencia de la estructura mineral del colágeno (Lieberman, 1994; Burke, 1995).

Tanto la mineralización del cemento como la orientación del colágeno determinan las bandas del crecimiento. Los momentos alimentarios de stress afectan al cemento celular y esta circunstancia explica la formación de las bandas en esta región. Sin embargo, en el cemento acelular las situaciones de stress se combinan con la orientación de las fibras de Sharpey, de modo que la hipermineralización de la banda estrecha se combina con la orientación del colágeno. Este aspecto ha sido observado en estudios de dientes de gacela actual en Israel; desde septiembre a febrero tiene lugar la estación lluviosa y con ella se produce un cambio en la dieta de la gacela; de una alimentación dura basada en el ramoneo se pasa a otra blanda basada en la ingesta de herbáceas de calidad alimenticia inferior a la del ramoneo. Estas dos circunstancias inciden en la formación de la banda estrecha y oscura de otoño/invierno (Lieberman, Deacon, & Meadow, 1990; Lieberman, 1994).

METODOLOGÍA

La determinación de la cronología de las bandas y la interpretación estacional de la última de ellas deben de estar suficientemente contrastadas con material actual para poder proceder correctamente al estudio de los dientes arqueológicos y tener las suficientes garantías de una interpretación correcta. Por ello, contamos con una muestra actual de dientes de ciervo que procede de la Estación Biológica de Doñana. Dicha muestra fue elaborada en el laboratorio de la Estación Biológica y en el laboratorio Matson (Milltown, Montana), por encargo de la propia Estación Biológica, por el procedimiento de la descalcificación, según el protocolo normalizado por sus respectivos laboratorios. La muestra estudiada es de 124 cortes, de los cuales 9 son del mes de octubre, 1 de diciembre, 94 de enero y 22 de febrero.

Toda ella cubre las estaciones de otoño, invierno y principios de la primavera. Faltan los cortes correspondientes a la primavera final y el verano. Asímismo es necesario aumentar el tamaño de la muestra correspondiente a las otras estaciones. A pesar de la provisionalidad de los resultados, hemos podido seguir la formación de la banda oscura y la evolución, aunque incompleta, de la clara. El crecimiento de la banda clara aparece completo en noviembre y en alguna muestra aparecen los primeros indicios de formación de la banda oscura. En enero la banda oscura está formada. En febrero la banda ancha y clara comienza a destacar. Este proceso de formación y evolución de la banda oscura y clara constituye la base de referencia para fijar la interpretación estacional de la última banda de los cortes arqueológicos.

Es necesario resaltar que las lecturas de las bandas son difíciles de realizar en algunas muestras porque no son constantes, desaparecen en algunos tramos del cemento y la última de ellas debe de ser seguida en todo el recorrido para hacer constar su presencia. Esta circunstancia es una llamada de advertencia para que al efectuar la lectura sobre material arqueológico se busque el contraste con otros cortes de un mismo diente y se lleve a cabo a lo largo del recorrido del cemento.

PREPARACIÓN DE LAS MUESTRAS ARQUEOLÓGICAS

Como paso previo, primero comprobamos la viabilidad de la utilización del método de descalcificación con material arqueológico. Para ello, enviamos dos muestras, un incisivo y un molar de ciervo de la Cueva de les Cendres, procedentes de material revuelto y consecuentemente sin nivel, al laboratorio de la Estación Biológica; una fue tratada con el ácido perceptivo y el diente desapareció; la otra fue tratada con la mitad del ácido y quedó bastante dañado; esta circunstancia puso de manifiesto la total ausencia de colágeno en los dientes arqueológicos. Por todo ello, optamos por la obtención de láminas finas, procesadas en el laboratorio del Departamento de Arqueología y Prehistoria de la Universidad de Valencia. Para ello seguimos el protocolo indicado por Lieberman (Lieberman & Meadow, 1992; Lieberman,1994), que en términos generales coincide con el de Gordon (1988).

Antes de aplicar este último método sobre material arqueológico con nivel, realizamos varias pruebas en piezas dentarias que procedían de un material revuelto. Constatamos las posibilidades del método y decidimos aplicarlo a dientes situados en niveles arqueológicos; se seleccionaron y se cortaron un total de 20 dientes de ciervo de los niveles magdalenienses de la Cova de les Cendres y 23 dientes de la Cova del Parpalló.

Los dientes de la Cova de les Cendres seleccionados para este trabajo corresponden a los niveles XIB (capas 46 a 49) y XI C (capas 50 y 53). Se trata de etapas industrialmente relacionadas con el Magdaleniense superior mediterráneo, con dos dataciones para el nivel XI C de13.690 ±120 y 13.840 ± 45 BP, que coinciden con evidencias de una importante ocupación de la cavidad (en el nivel XI C se localizan las mayores densidades de material lítico y óseo de toda la secuencia obtenida hasta la fecha en el yacimiento). El nivel XI B no tiene dataciones absolutas, pero su cronología viene dada por la datación obtenida en el nivel XA, que con un resultado de 13.320 ±170 BP incita a considerar que su cronología no diferiría mucho de la obtenida en el nivel XIC.

Los dientes de la Cova del Parpalló provienen también de los niveles relacionados con el Magdaleniense superior, aunque incluyen algunos que pudieran corresponder al Magdaleniense medio (Villaverde *et al.*, 1999). La única datación del Magdaleniense de este yacimiento proviene precisamente de esta última fase, con una fecha de 13.800 ±380 BP, obtenida en el tramo que incluye de 1,50 a 1,70 m de potencia, resultando muy próxima al inicio del Magdaleniense superior de la Cova de les Cendres.

El ámbito cronológico resulta, por tanto, más amplio e impreciso en Parpalló y ello tanto por la elevada potencia de las capas de las que se ha extraído el material, como por la amplitud cultural y cronológica a la que corresponden esos niveles, pero en esta primera fase de la investigación el objetivo se centraba en evaluar las posibilidades de aplicación del método a los dos yacimientos, siendo conscientes de que es necesaria en el futuro una mayor precisión en la correlación estratigráfica y cronológica entre los dos yacimientos, sujeta a un análisis de los procesos tafonómicos que pudieran limitar la interpretación de los datos que se obtengan.

El procedimiento siguió distintos pasos. En primer lugar inventariamos los dientes, asignando a cada uno de ellos un número correlativo del 1 al 20. Realizamos su análisis osteométrico, así como el registro del desgaste dental mediante dibujo y fotografía.

Como la técnica de análisis es destructiva, realizamos moldes de cada pieza dentaria utilizando silicona RTV y resina SP system.

A continuación, consolidamos los dientes para poder cortarlos mediante el proceso en frío de resina Epoxy (20ml resina / 5 ml endurecedor) empleando cubiletes de plástico de diferentes tamaños.

También utilizamos otro tipo de resina (SP 106 SYSTEM 5ml/1ml endurecedor) con la que conseguimos el mismo resultado. En este proceso intentamos que las coronas de los dientes no estuvieran cubiertas por la resina para poder salvaguardar esta parte.

El paso siguiente consistió en cortar los dientes para preparar láminas, utilizando la cortadora de precisión ACCUTOM-2. Los cortes se efectuaron en sentido longitudinal.

Una vez obtenido el corte deseado, éste era colocado en un porta utilizando cera caliente. A partir de aquí, la técnica para obtener la lámina delgada consiste en pulir la muestra con la pulidora de agua Labo-Pol S, utilizando discos de pulido de diferente grosor (320-500-800-1200-2400-4000), regulando la velocidad en cada uno de ellos desde 500 a 100 rpm. Finalmente, las láminas obtenidas eran pulidas en seco en la máquina DAP. V a 100 rpm utilizando DP-Cloths, HG/seco.

Una vez preparada la lámina delgada y con el fin de verificar el estado de conservación del cemento, las muestras se observaron previamente en una lupa binocular. Para tener una idea aproximada de la configuración de las bandas y una lectura previa de las mismas, las muestras se llevaron a un microscopio de luz reflejada. Posteriormente se procede a la observación de la muestra en un microscopio de luz transmitida polarizada.

RESULTADOS

Los resultados con el material arqueológico han sido muy desiguales. Los procesos diagenéticos que han intervenido en los depósitos sedimentarios de la cueva del Parpalló pueden haber incidido en la conservación y alteración de la propia estructura del cemento. Pero no estamos seguros si además de esta circunstancia otros motivos han intervenido en su estado final, como los efectos de las inundaciones del año 1956, que anegaron los almacenes del Museo de Prehistoria de Valencia, y los correspondientes traslados del material para su secado y nuevo almacenamiento. Consecuentemente, la lectura ha sido imposible de realizar en la mayoría de los casos; sólo en unas muestras hemos podido efectuar algunas estimaciones de edad, pero con muchas dudas. No obstante, queda por averiguar si la conservación es adecuada en otros estratos o en otros paquetes, que estuvieron más protegidos y no sufrieron las consecuencias de la situación anteriormente mencionada.

Por el contrario, el material procedente de la cueva de Cendres muestra una escasa alteración en la estructura del cemento y sus lecturas se han podido llevar a cabo sin mayor problema; el inconveniente que presenta es que la gran mayoría de los molares se encuentran aislados y la pérdida del cemento ha imposibilitado algunas lecturas.

El número de dientes cortados del yacimiento del Parpalló fue de 35. Sólo obtuvimos lectura en 5 dientes y además con muchas dudas. Consiguientemente, hemos preferido no ofrecer los resultados.

Con respecto a la Cova de les Cendres, fueron cortados 20 dientes de los cuales 3 no han ofrecido lectura alguna. Todos ellos pertenecen al ciervo. Los resultados se ofrecen en la Tabla 1, donde se indica el nivel de procedencia de los restos, el número de inventario, el desgaste dental, los resultados del análisis de cementocronología y finalmente las medidas de los dientes analizados.

Antes de abordar el análisis de los cortes de este último yacimiento, procedimos a establecer una

Nivel	Nº	Diente	Desgaste	Análisis de cementocronología		Medidas
				Nº incrementos oscuros	*Final incremento*	
cc 46-7	1	M^2		**6**	**a**	L:23.7 A:23.4 Alt:14.02
cc 50-1	2	M^3		**4**	**b**	L:24.5 A:19.7 Alt:16.2
cc 46-7	3	M^1		**7/8**	**B**	L:20.9 A:19.03 Alt:10.6
cc 46-7	4	P^4		**8/9**	**?**	L:15.6 A:20.06 Alt: 13
cc 46-7	5	P^3		**6**	**B**	L:17.1 A:15.3 Alt:10.9
cc 46-7	6	M^2		**6**	**a**	L:22.6 A:20.3 Alt:11.2
cc 48-9	7	D^2		**2**	**B**	L:16.4 A:11.4 Alt:5.62
cc 44-5	8	M_3		**Lectura nula**		L:20.6 A:12.6 Alt:14.7
cc 48-9	9	M_3		**5**	**B**	L:31.4 A:13.1 Alt:24.6
cc 50-1	10	M_3		**6**	**B**	L:30.1 A:13.9 Alt: 22.6
cc 48-9	11	M_3		**5**	**c**	L:34.3 A:13.6 Alt:25.9
cc 48-9	12	M_2		**Lectura nula**		L:26.3 A:13.7 Alt 21.4
cc 50-1	13	M_2		**5**	**A**	L:24.2 A:13.7 Alt:18.8
cc 52-3	14	M_2		**5**	**B**	L:24.2 A:13.7 Alt:18.8
cc 50-1	15	P_4		**6**	**a**	L:18.7 A:11.7 Alt 16.05
cc 50-1	16	P_3		**6**	**B**	L:17.3 A:8.9 Alt: 13.3
cc 50-1	17	P_4		**5**	**c**	L:19.3 A:11.5 Alt:16.08
cc48-9	18	P_3		**Lectura nula**		L:11.3 A:10.4 Alt:9.7
cc 50-1	19	P_4		**4**	**B**	L:18 A:12 Alt:14.7
cc 50-1	20	D_4		**1**	**c**	L:24.7 A:10.7 Alt:6.46

TABLA 1

Resultados del recuento de los incrementos del cemento. En el análisis indicamos el recuento de las bandas oscuras y el estado final de la última banda. Las letras mayúsculas hacen referencia a las características de la banda oscura: A= formación inicial; B= formación completa. Las letras minúsculas indican el estado de la banda clara; a= formación inicial; b= formación avanzada (mitad aproximada) y c= formación completa.

edad relativa a partir del método de desgaste molar mandibular (Marriezkurrena, 1983). Obtuvimos de este modo la siguiente relación:

– En el nivel 46-7, cinco dientes que pueden pertenecer a dos individuos adultos con una edad superior a los 32 meses.

– En el nivel 44-5, hay un diente, donde el desgaste corresponde a un animal adulto mayor de 32 meses.

– En el nivel 48-9, cinco dientes de tres individuos, uno de ellos con un desgaste de 8 a 20 meses y los restantes de animales adultos con una edad superior a los 32 meses.

– En el nivel 50-1, ocho dientes que pertenecen a un individuo entre 8-20 meses y a dos animales adultos con una edad estimada superior a los 32 meses.

– En el nivel 52-3, un diente cuyo desgaste se ha estimado como perteneciente a un individuo adulto mayor de 32 meses.

La descripción de los cortes es la siguiente:

–Lámina nº 1: Se observan seis bandas oscuras, que corresponden a seis inviernos. La última es clara y tiene un desarrollo inicial.

–Lámina nº 2: Podemos observar cuatro bandas oscuras. La última banda es clara, que no está totalmente formada.

–Lámina nº 3: Observamos siete/ocho bandas oscuras. La lectura del último incremento es una banda oscura completa.

–Lámina nº 4: Podemos observar ocho/nueve bandas oscuras. La banda final ofrece dudas.

–Lámina nº 5: La lectura ofrece seis bandas oscuras. La banda final es oscura y completa.

–Lámina nº 6: Podemos observar siete bandas oscuras. La última banda es clara y presenta un desarrollo inicial.

–Lámina nº 7: Se observan dos bandas oscuras. La última banda es oscura completa.

–Lámina nº 8: Al no conservarse bien el cemento no hemos obtenido ninguna lectura.

–Lámina nº 9: Muestra cinco bandas oscuras. La última es oscura completa.

–Lámina nº 10: Se pueden observar seis bandas oscuras. La última banda es oscura completa.

–Lámina nº11: Podemos observar cinco bandas oscuras. La última banda es clara completa.

–Lámina nº12: No podemos ofrecer una lectura de esta lámina, debido al mal estado de conservación del cemento.

–Lámina nº13: Se observan cinco bandas oscuras. La última banda es oscura en un estado de desarrollo inicial.

–Lámina nº14: Se observan cinco bandas oscuras. La última banda es oscura completa.

–Lámina nº15: Podemos observar seis bandas oscuras. La última banda es clara en un estado de desarrollo inicial.

–Lámina nº16: Observamos seis bandas oscuras. La última banda es oscura completa.

–Lámina nº17: Podemos observar cinco bandas oscuras. La última banda es clara completa.

–Lámina nº18: El mal estado de conservación del cemento no permite realizar la lectura.

–Lámina nº19: Podemos observar cuatro bandas oscuras. La última banda es oscura completa.

–Lámina nº20: Observamos una banda oscura. La última banda es clara completa.

VALORACIÓN DE LOS RESULTADOS

El resultado global del estado de la banda final lo hemos sintetizado en la Tabla 2, detallando el nivel de procedencia de cada diente.

Los datos indican que en los dos niveles existe una concentración de dientes en los momentos correspondientes a la plena formación de la banda oscura, que se situaría en el invierno. No obstante, la existencia de dientes en otros momentos estacionales induce a pensar que la intermitencia ocupación/desocupación podría tener lugar en el mismo año, siendo incluso factible sostener que algunos miembros del grupo humano permanecieran en la cueva. Estos datos, provisionales tanto por el número de restos analizados como por la reducida extensión de la zona excavada o la falta de una adecuada valoración tafonómica en relación con el tiempo de formación del nivel y la escala temporal a la que los resultados van referidos, apuntan en una dirección que resultaría coincidente con los resultados obtenidos por Pike-Tay (1991) y Burke (1995) que postulan para las zonas más septentrionales movimientos estacionales de corta distancia a lo largo del año con el fin de explotar los recursos de cada lugar, cazando el reno, el caballo o el ciervo según la disponibilidad

		INCREMENTO FINAL				
		A	B	a	b	c
Número de dientes	Nivel XI B	-	4	2	-	1
	Nivel XI C	1	4	1	1	2

TABLA 2
Frecuencias correspondientes al estado del último incremento.

y la conveniencia del momento. Se trata, por tanto, de un modelo distinto al formulado en su día por Gordon (1988) y que contradice la alta movilidad propuesta por este autor para los cazadores de renos del SW francés.

En el caso de la Cova de les Cendres, la abundancia de conejo a lo largo del año es un factor que introduce garantías de estabilidad a los grupos cazadores, cuyo recurso central en estos momentos de la secuencia se centraría en la caza del ciervo en el entorno de la cueva durante la estación de máxima disponibilidad de esta especie y probablemente de la cabra en los desplazamientos estacionales hacia las áreas de montañas medias del interior, tal y como sugiere el registro faunístico de los niveles contemporáneos del yacimiento del Tossal de la Roca (Pérez & Martínez, 1995).

Recordemos, por otra parte, que el estudio de las edades de abatimiento de los ciervos presenta en estos dos niveles de Cendres un perfil definido hacia la caza especializada de ejemplares de tres años, con predominio del sexo masculino, asociada a un intenso procesado de sus restos (Villaverde & Martínez, 1995), una circunstancia que no parece entrar en contradicción con los datos que ahora aportamos y que resulta coherente con la idea de que las poblaciones de esta etapa mostraban una alta especialización en la caza de las dos especies, el ciervo y la cabra, que resultan más abundantes en la zona y disponibles a través de cortos movimientos de carácter estacional entre las llanuras litorales y las elevaciones montañosas del inmediato interior.

CONCLUSIONES

Hemos pretendido comprobar la eficacia de un nuevo método de trabajo, que sea útil y fiable para los estudios arqueológicos en un apartado tan importante como el estudio de la estacionalidad. A pesar de que los resultados han sido positivos en el material de la Cova de les Cendres, la prudencia en la validación del método debe de presidir cualquier estudio de estas características, como la demuestra la dificultad de lectura de las muestras actuales y las de procedencia arqueológica. Además, es difícil proceder con dientes sueltos, por la posible pérdida parcial o total del cemento, como así lo indica el material de la Cueva del Parpalló, pero también a esta circunstancia se une el estado de conservación del propio material por los procesos diagenéticos que han intervenido y que han podido afectar a los dientes. Por otro lado, es necesaria la utilización de un número mayor de muestras de dientes actuales, que puedan ser contrastadas tanto por el método de descalcificación como por el de obtención de láminas finas, con el fin de disponer de una base sólida de referencia actual.

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Micromammal Taphonomy in the Site of Ohalo II (19 Ky., Jordan Valley)

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ABSTRACT: Micromammals are readily used to reconstruct the paleoenvironment of prehistoric and geological sites. Taphonomic analysis is crucial to remove biases due to differential deposition and accumulation processes. The submerged site of Ohalo II, Jordan Valley (radiometrically dated to 19400 BP) was chosen as a case study for micromammal taphonomy research in an open-air Early Epipaleolithic site. The excavated remains include brush huts, several hearths and a human burial. Preservation of *in-situ* organic remains is excellent. Remains of five micromammal species were found at the site: *Microtus guentheri* (social vole), *Meriones tristrami* (Tristram's jird), *Mus* cf. *macedonicus* (house mouse), *Rattus rattus* (black rat) and *Erinacaeus europaeus* (European hedgehog). The taphonomic study suggests that post-depositional process such as trampling altered the assemblage to such a degree that it prohibits the recognition of the origin of deposition.

KEY WORDS: EARLY EPIPALEOLITHIC, MICROMAMMALS, TAPHONOMY, OPEN-AIR SITES, OHALO II

RESUMEN: Los micromamíferos son frecuentemente utilizados para inferir el paleoambiente de yacimientos prehistóricos y geológicos. El análisis tafonómico resulta clave en la eliminación de sesgos debidos a procesos de deposición y acumulación diferenciales. El asentamiento subacuático de Ohalo II en el valle del Jordán (radiométricamente datado en el 19400 BP) fué seleccionado como un ejemplo donde llevar a cabo investigaciones sobre tafonomía de micromamíferos en un asentamiento del Epipaleolítico inicial al aire libre. Los restos excavados incluyen cabañas de matorral, una serie de hogares y un enterramiento humano. La conservación *in situ* de los restos orgánicos es excelente. Se recuperaron restos de cinco especies de micromamíferos en este asentamiento: *Microtus guentheri* (topillo social), *Meriones tristrami*, *Mus* cf. *macedonicus* (ratón casero), *Rattus rattus* (rata negra) y *Erinaceus europaeus* (erizo común). El análisis tafonómico sugiere que fenómenos post-deposicionales, caso del pisoteado, alteraron la asociación hasta tal punto que resulta imposible reconocer el origen de los depósitos.

PALABRAS CLAVE: EPIPALEOLÍTICO TEMPRANO, MICROMAMÍFEROS, TAFONOMÍA, ASENTAMIENTOS AL AIRE LIBRE, OHALO II

INTRODUCTION

Micromammals (defined here as mammals with live weight of less than 3 kg) have been used extensively in paleoclimatic and paleoenvironmental reconstructions (Tchernov, 1968, 1975, 1986, 1988; Jaeger & Wesselman, 1976; Avery, 1977, 1990, 1992; Brain & Brain, 1977; Wesselman, 1982; Denys, 1985, 1986). Of the various taxa, rodents and other small mammals are perhaps one of the better groups to study in this aspect because they occupy distinct niches and environ-

ments. They are highly evolving taxa that adapt themselves readily to new environments and are quite abundant (Chaline, 1977).

When an archaeological assemblage is retrieved from a site, it represents a mere fragment of the original micromammal community that lived in the vicinity (Klein & Cruz-Uribe, 1984; Andrews, 1990). A paleoenvironment reconstruction is based on the relative frequency of species. Species that may have been present in the living community may be disproportionately represented in the assemblage or absent altogether thus analysis based on the death assemblage may be biased. Thus, a correct analysis depends on the identification of the living community rather than the death assemblage (Andrews, 1990).

Taphonomy is the study of the burial of bones and their transition from the biosphere into the lithosphere (Lyman, 1994). It includes the study of the processes of accumulation, dispersal, breakage and diagenesis of remains. The importance of determining the taphonomic history of an assemblage is crucial if we wish to use the assemblage in paleohabitat and/or paleoecological reconstructions. Some predators are species specific and therefore insert a bias in the death assemblage relative to the living community. Thus an archaeological assemblage that was deposited by predators may include or exclude common species and thereby bias the environmental reconstruction (Andrews, 1990). Assessing the agent of accumulation can remove such biases and aid in the interpretation of the data.

Two types of prehistoric sites in the Levant were commonly used for micromammal research. Excavations in Middle Paleolithic cave sites such as Tabun, Qafzeh, Hayonim and Kebara (Tchernov, 1986) usually revealed large quantities of micromammal remains, which were readily studied as paleoecological indicators. Other sites are usually very large open-air excavations such as Lower Paleolithic 'Ubeidiya (Tchernov, 1988) and African sites like Omo (Wesselman, 1982) or Laetoli (Denys, 1985, 1986), but the latter are usually geological formations, spanned over both space and time.

However, Levantine open-air Paleolithic sites with *in-situ* features are not very common. Many such sites have had their fauna published with little or no reference to micromammals e.g. Ein-Gev (Davis, 1974), Neve David (Bar-Oz, 1996, Bar-Oz *et al.*, 1999), Hayonim Terrace (Henry *et al.*, 1981) and Urkan -a-Rub IIa (Hovers *et al.*, 1988).

The major cause of death in micromammals is predation by both mammalian predators (carnivores) and avian ones (raptors) (Andrews, 1990), the predators deposit micromammal remains by means of coprolite and pellets respectively. Caves are most commonly used as places of perching and as lairs. Potential predators may return to the same location over and over again, thereby increasing the quantity of micromammal remains accumulated in the site to significant amounts. On the other hand, open-air sites do not commonly posses such an environment that will induce long term return to the same location. Open-air areas serving as latrines for carnivores or trees which serve as a perch for raptors usually allow only short-term accumulation of micromammal remains in comparison to caves in which the accumulation can span tens of thousands of years.

In cave sites, the abundance of microfauna is so great that even sorting from only a small portion of the excavated sediments reveals a large enough sample for a significant inference of the paleoecology. Such results from cave sites as Hayonim and Qafzeh indicate the presence of hundreds and at times over a thousand specimens (Tchernov, 1988). Once micromammal remains are deposited in a cave, the cave structure may protect the assemblage from further dispersal events. Since open-air sites provide no such protection, an assemblage may soon be dispersed due to taphonomic processes such as trampling and water weathering, rendering it unsuitable for archeofaunal research. In open-air sites, it seems that the small size of the sample and the bad preservation state of the assemblage would probably not be worth the effort of retrieving the micromammal from the matrix resulting in fewer studies and subsequently less publications on the topic.

The scope of this study is to evaluate the potential of open-air sites in micromammal research. The taphonomic history of the case study assemblage will be studied accordingly. The site of Ohalo II, Israel, was chosen as a case study for open-air sites due to the excellent state of preservation of small bones such as bird and fish as well as botanical remains. This study deals with results from the 1989-1991 seasons of excavation.

Ohalo II is an Early Epipaleolithic submerged open-air site located at the south western corner of Lake Kineret (the Sea of Galilee) at - 212.5 meters

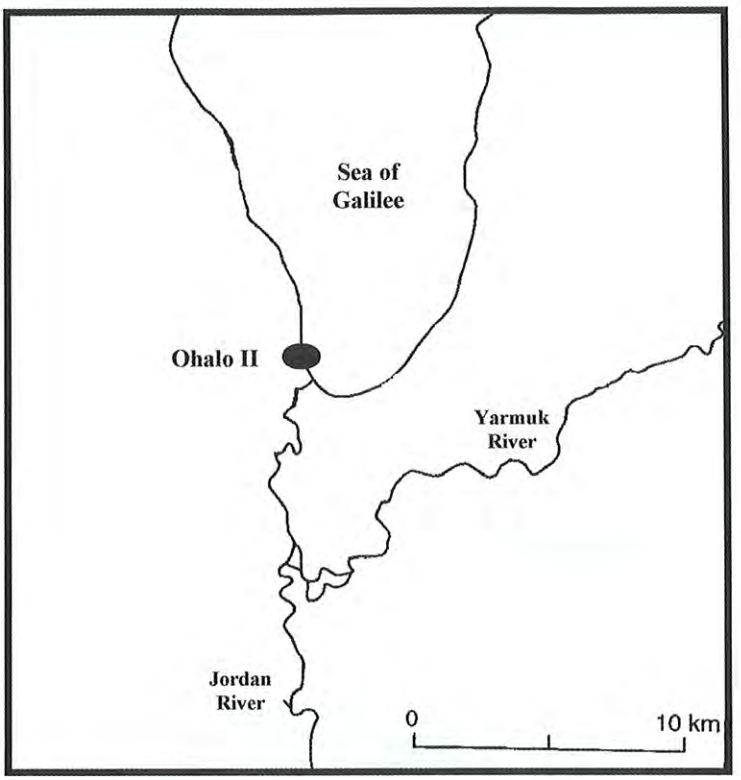


FIGURE 1
Location of Ohalo II.

below MSL (Figure 1). It was exposed as a result of the drop in water level in 1989 after several years of low precipitation.

The site size is estimated at over 2000 square meters of which ca. 400 were excavated to bedrock. The excavation was executed using a 1x1-meter grid subdivided into 4 sub-squares (Nadel, 1991, 1997). The site includes the remains of six brush huts with *in-situ* floors (Figure 2). Various hearths were found around the huts, as well as a dump area and a burial (Nadel, 1996, 1997, 2000; Nadel & Werker, 1999). There are 25 carbon 14 dates from eight loci averaging 19440 ± 770 B.P. (Nadel *et al.*, 1995). Large quantities of charred seeds, animal bones (Rabinovich, 1998a, 1998b) and flints were found on the floors and in the hearths. In several cases delicate fish bones were exposed in articulation. Concentration of bones and flint indicate the post-depositional movement of even the smallest remains was minimal (Nadel *et al.*, 1994; Nadel, 1997). The site surface includes thousands of remains of flints, animal bones, beads, seeds and which are an integral part of the site.

The reconstruction of the environment, based on botanical remains, indicates salt-water marshes at varying levels of salinity surrounded by a park-forest amidst open stands of wheat and barely (Kislev *et al.*, 1992).

MATERIALS AND METHODS

All excavated sediments were sieved through a 2 mm mesh during the first season and through a 1 mm mesh in all later seasons and was sorted specifically for micromammal remains by one of us (M. B). Specimens were observed under a stereomicroscope up to x 60 and identified to species and body part by comparison to the comparative collection of the Hebrew University of Jerusalem.

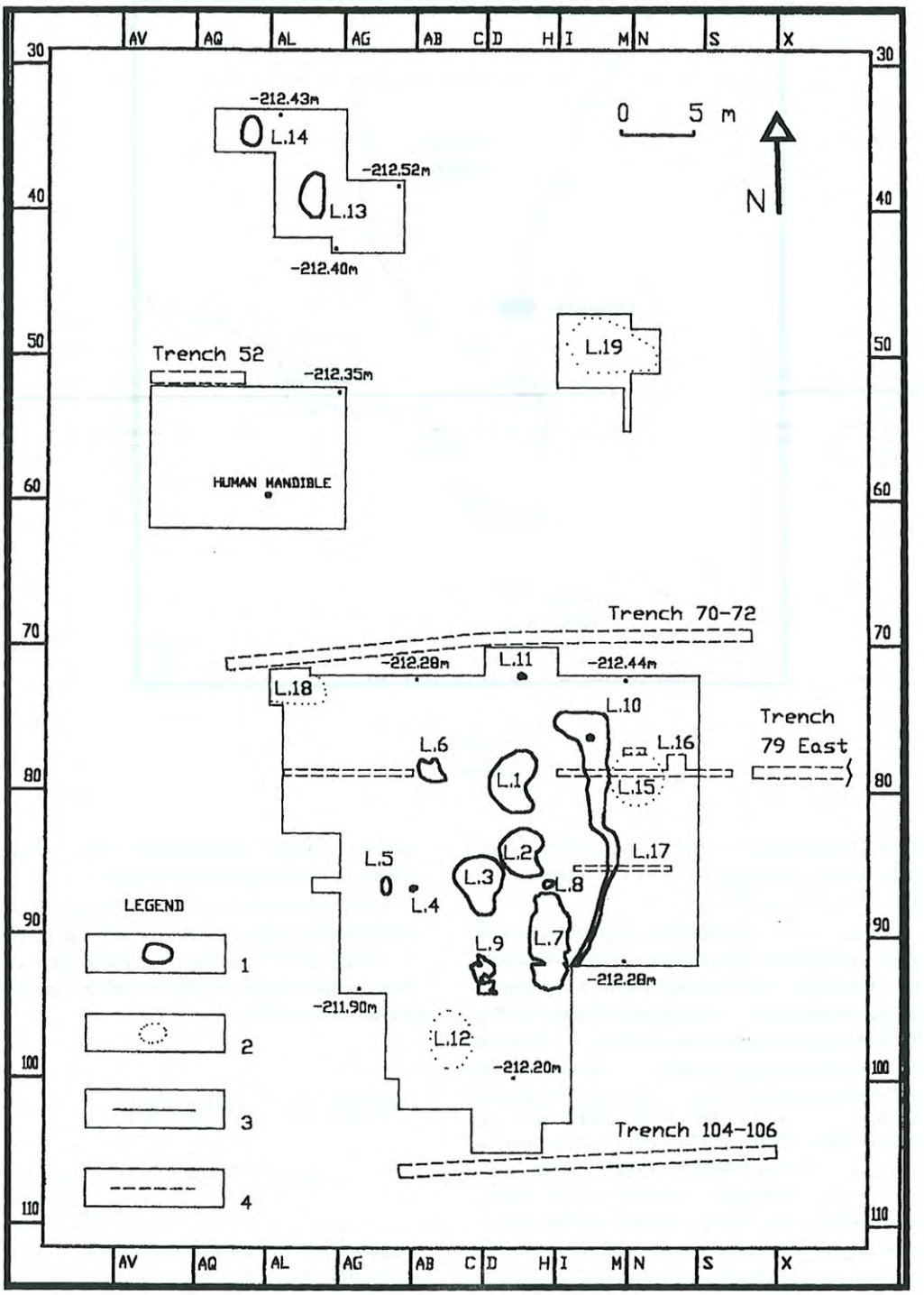


FIGURE 2
Ohalo II site plan 1989-1999.

Contrary to many microfaunal analyses, which use only cranial and dentition remains for species identification, we identified all retrieved elements found to the species level, including incisors and postcranial elements. This was found to be highly productive in increasing both Number of Identifiable Specimens (NISP) and Minimum Number of Individuals (MNI) counts.

RESULTS

Spatial distribution

Micromammals are not evenly distributed among the loci (Table 1). Ca. 20% are found in non-loci matrix in low concentration. Moreover, with the exclusion of locus 1, all other loci have similar low concentrations of micromammals. Locus 1 stands out with over 62% of the assemblage in a single brush hut. This raises the question whether the depositional agent of the micromammals in locus 1 is unique or a single agent of deposit is responsible for the entire assemblage. In this analysis we provide results for locus 1 and the entire assemblage.

Species distribution

A total of 261 micromammal remains were removed from a total of 4.2 cubic meter excavation volume for the total site and 0.82 cubic meters for locus 1. 83.9% (219 NISP) could be identified to species level. The remaining were too fragmented to enable systematic analysis but were included in the taphonomic analysis. These could be assigned to an MNI of 36. The Rodentia species were *Microtus guentheri* (social vole), *Meriones tristrami* (tristram's jird), *Mus* cf. *macedonicus* (house mouse), *Rattus rattus* (black rat) and *Erinacaeus europaeus* (European hedgehog) (Table 1).

For locus 1 (Table 1) species composition is confined to the most common three species; *Microtus guentheri*, *Meriones tristrami* and *Mus* cf. *macedonicus*, with similar NISP frequencies to those of the total assemblage.

The analysis included all Rodentia and included the 3 remains of the hedgehog.

Taphonomy

The majority of the remains are cranial remains; maxilla, mandibles, loose molars and incisors, which comprise ca. 80 % of the total assemblage. The key question here is whether predators deposited the micromammals in the site or were the micromammals part of the commensal fauna at the site. Each predator (mammalian or avian) can be diagnosed by the taphonomic indices of the assemblage it deposited. We followed the indices set forth by Andrews (Andrews, 1990) to identify the potential agent of accumulation.

A) Skeletal element proportion. The skeletal element proportions denotes the proportion of the body elements if all elements survived equally as indicated by the MNI. Thus, if the total MNI is 36 we expect to have 72 humeri (2x36) and 432 molars (12x36). Percentage is calculated per body part.

The Ohalo II micromammal assemblage is dominated by a very high proportion of cranial elements including mandible, maxilla, loose molars and incisors and a very low proportion of limb bones, with none of the smaller postcranial remains present in the assemblage (Table 2). The relative abundance in the locus 1 maintains a similar pattern. The assemblage of Ohalo II is reduced as opposed to both barn owl and fox assemblages. Different skeletal element are more similar to barn owl distributions (loose molars) whilst others are more reminiscent of the fox assemblages (loose incisors, mandibles). A majority of skeletal elements appear in frequencies much lower than those expected in predator assemblages and resemble neither.

B) Postcranial/cranial proportion. Different predators effect the preservation of proximal and distal elements differently. The determination of postcranial/cranial proportions is calculated by three indices. The first is the proportion of the proximal limbs, femur and humerus, to the cranial elements, mandible and maxilla. The second index is the proportion of distal limb elements, tibia and ulna to the proximal ones, femur and humerus. The third index is the proportion of the five limb bones representing the postcranial elements to the cranial elements including mandible, maxilla and the loose molars. This value is divided by 5/8 to correct for the different number of skeletal ele-

NISP	Total	1	2	3	7	10	11	12	13	Surface
Microtus gunetheri	155 (18)	109 (13)	2 (1)	6 (2)	2 (1)	7 (1)			4 (1)	25 (3)
Meriones tristrami	43 (8)	20 (6)	5 (3)	6 (2)		1 (1)				11 (3)
Mus cf. *macedonicus*	15 (4)	12 (3)		1 (1)	1 (1)					1 (1)
Rattus rattus	3 (1)	1 (1)						1 (1)		1 (1)
Erinacaeus europaeus	3 (2)				1 (1)					2 (1)
Rodentia gen. indet.	42 (3)	20 (2)	1 (1)	2 (1)		3 (1)		2 (1)	4 (1)	10 (1)
Total	261 (36)	162 (25)	8 (5)	15 (6)	4 (3)	11 (3)	0	3 (2)	8 (2)	50 (10)

TABLE 1
NISP (MNI) distribution for Ohalo II micromammal assemblage by species and loci.

ments in the body. All three indices are multiplied by 100 and given in percent (Andrews, 1990).

The values obtained for Ohalo II (Table 3) are similar for the entire assemblage and locus 1. Values for proportion of post crania to crania are much lower than the values given for carnivore or raptor assemblages (Andrews, 1990). Proportion of femur and humerus to mandible and maxilla are more similar to mammalian carnivore values than to those of birds of prey. The converse is true for the proportion of distal limb elements to proximal limb elements, which is similar to barn owl values.

C) Breakage of postcranial elements. Postcranial breakage patterns can be divided according to the part of the element preserved: complete, distal, proximal and shaft (Andrews, 1990). The index is calculated as the percent of each partial element from the total number of each limb bone. Results are similar for the complete assemblage and for locus 1. Complete limbs range up to 50%. Distal limb fragments range up to 84%. Proximal limb fragments range up to 50%. No shaft fragments were found (Table 4). None of the patterns could be associated with known predator assemblages.

An index of breakage was calculated in respect to portion of limb preserved without regard to part i.e. a complete limb was classified as 1, followed by 2 for half, 4 for a quarter and 8 for an eighth. Similar results (Table 5) were obtained for the entire assemblage and locus 1. The majority of limb bones were broken mid shaft, followed by fragment of eighth of a limb. Complete limbs are rare.

D) Skull and maxilla breakage. No skull remains were found in the Ohalo II assemblage.

Breakage of maxillae is scored with relation to isolated maxilla as opposed to those in skulls and the percentage of zygomatic bones present. All maxilla found in Ohalo II were isolated and without the zygomatic arches (Table 3).

Tooth loss is measured as percent of empty alveolar of the total expected. Maxillary molar loss for Ohalo II for the entire assemblage and locus 1 is ca. 15% and incisor loss is 0 (Table 3). Both values are much lower than both mammalian carnivores and birds of prey. Mandible molar loss is around 30% for both Ohalo II and locus 1 and is similar to barn owl assemblages (34%). Mandible incisor loss is ca. 40 % for Ohalo II and 70% for locus 1. This is similar to values given for red fox assemblages (75%).

The index as presented by Andrews (1990) ignores a situation, as presented at Ohalo II, of extreme breakage. In this case, many maxillae are too fragmented and thus no alveolars are present at all. This artificially decreases the number of empty alveolar, masking the results. To describe such breakage, an index of percent of alveolar present/alveolar expected is suggested. Values are similar for

	Ohalo II assemblage	Locus 1	Barn Owl Hula	Red Fox
Mandible	42.6	30.0	98.4	50
Maxilla	10.3	8.0	95	25
Incisor	63.2	55.0	24.2	68.8
Molar	22.1	20.0	15.8	31.3
Femur	29.4	24.0	68.3	100
Tibia	7.4	8.0	70	62.5
Pelvis	1.5	2.0	66.7	25
Calcaneum	0.0	0.0	15	25
Talus	0.0	0.0	13.3	12.5
Humerus	11.8	12.0	66.7	75
Radius	0.0	0.0	55	25
Ulna	4.4	6.0	63.4	37.5
Scapula	0.0	0.0	51.7	12.5
Ribs	0.0	0.0	23.6	8.3
Vertebra	1.3	0.4	44.2	23.4
Metapodial	0.0	0.0	21.8	28.9
Phalanges	0.0	0.0	10.2	20

TABLE 2

Relative abundance values for Ohalo II, locus 1 and selective modern assemblages. Modern assemblage data after Andrews (1990).

	Ohalo II assemblage	Locus 1	Barn Owl Hula	Red Fox
% postcrania/crania/(5/8)	45.71	50.63	251	183
% femur+humerus/mandible+maxilla	77.77	94.73	93	233
% tibia+ulna/femur+humerus	28.57	41.66	105	50
Skull breakage % complete	0	0	218	0
% maxilla with zygomatic	0	0	262	0
% maxilla molar loss	14.29	16.67	27	67
% maxilla incisor loss	0	0	26	100
Mandible breakage % complete	0	0	78	0
% inferior border broken	65.5	60	3	100
% mandible molar loss	23.0	33.3	34.00	58.00
% mandible incisor loss	41.4	70.6	3.00	75.00
% isolated molars	73.17	61.22	96	75
% isolated incisors	128	145	56	225
% molars broken *in situ*	36.36	48.77	0	0
% isolated molars broken	35.56	33.33	0	83.3
% incisors broken *in situ*	63.64	100	0	n.a
% isolated incisors broken	70.93	69.09	0	80
% molars digested *in situ*	6.061	5.88	1.1	54.5
% isolated molars digested	60.00	60.00	0.6	83.3
% incisors digested *in situ*	0	0	3.6	100
% isolated incisors digested	40.698	43.636	10.9	87.5
% total molars digested	45.528	48.052	1	70
% total incisors digested	36.082	40.678	5	90

TABLE 3

Taphonomy indices for Ohalo II, locus 1 and selective modern assemblages. Modern assemblages data after Andrews (1990).

locus 1 and the entire assemblage and average 50% for molar alveolar and 25% for incisor alveolar (Table 6).

E) Mandible breakage. No complete mandibles were found. Similar results were obtained for the entire assemblage and locus 1 (Table 3). Ca. 25% have the ascending ramus missing while ca. 60% have the inferior border broken. These values are higher than most birds of prey that range less than 15% and similar to mammalian carnivores which average over 75%.

Tooth loss calculated using only the percent of empty alveolars of those present. Mandible molar loss is similar for the entire assemblage and locus 1 and is ca. 30%. This resembles barn owl values (34%) for this index. Incisor loss is 40% for Ohalo II and 70% for locus 1. This is more similar to red fox assemblages (75%).

F) Tooth loss and breakage. Percent of isolated molars and incisors is calculated as percent of loose teeth of those of those expected (Andrews, 1990). Values for both molars and incisors are similar for Ohalo II and locus 1 (Table 3). Percent isolated molars for Ohalo II is ca. 70% and resembles the red fox assemblage (75%). Loose incisor values, average ca. 130% is an intermediate value between red fox (225%) and barn owl (56%).

Breakage of teeth is measured as the percent of broken to complete teeth. Breakage percentages for both *in situ* and isolated molars are in a similar range for the entire assemblage and locus 1 (Table 3). These values are higher in comparison to various modern raptors but lower than mammalian carnivores. Incisor breakage for both *in situ* and isolated incisors range between 70–100%. This is closer to the mammalian carnivores (80%) but much higher than birds of prey (0%).

Limb	Breakage	Ohalo II assemblage	Locus 1	Barn Owl Hula	Red Fox
Humerus	Complete	0.0	0.0	99	0
	Proximal	12.5	20.0	0	8
	Shaft	0.0	0.0	0	9
	Distal	87.5	80.0	1	83
Ulna	Complete	33.3	50.0	97	0
	Proximal	33.3	50.0	3	67
	Shaft	0.0	0.0	0	33
	Distal	33.3	0.0	0	0
Femur	Complete	5.6	0.0	97	0
	Proximal	88.9	90.9	1	53
	Shaft	0.0	0.0	2	21
	Distal	5.6	9.1	0	26
Tibia	Complete	33.3	0.0	98	0
	Proximal	33.3	50.0	1	67
	Shaft	0.0	0.0	1	33
	Distal	33.3	50.0	0	0

TABLE 4

Limb breakage for Ohalo II, locus 1 and selective modern assemblages. Modern assemblages data after Andrews (1990).

G) Digestion. Signs of digestion were observed on ca. 44% of the postcranial remains, 60% of isolated molars and 40% of the isolated incisors. Although very low values of digestion were found in *in situ* molars and incisors (5 and 0% respectively). Similar results were obtained for the complete assemblage and locus 1 (Table 3). Values for *in situ* digestions are more similar to barn owl assemblages while isolated teeth digestion values are inter mediate between mammalian carnivores (80-100%) and birds of prey (<5%).

When digestion categories are analyzed for loose molar digestion (Table 7), over 80% of the teeth are digested very slightly. This makes it difficult to conclude that the rounding of edges and destruction of dentine is digestion rather than mechanical damage and water weathering.

DISCUSSION

All species found at Ohalo II are Mediterranean species and correlate with the paleoenvironmental reconstruction suggested by the botanical remains (Kislev *et al.*, 1992).

	Category	Ohalo II	Locus 1
Humerus	1	0	0
	2	62.5	60
	4	12.5	0
	8	25	40
Ulna	1	33.33	0
	2	33.33	50
	4	0.00	0
	8	33.33	50
Femur	1	11.11	0.00
	2	55.56	63.64
	4	27.78	27.27
	8	5.56	9.09
Tibia	1	20.00	0.00
	2	40.00	50.00
	4	40.00	50
	8	0	0

TABLE 5

Postcranial breakage pattern for Ohalo II and locus 1

Quantitatively speaking, the NISP and subsequently MNI found at Ohalo II are larger (over 50%) than those found in other Epipaleolithic open-air sites. This is also true if one excludes the postcranial remains that were added to increase the NISP of the assemblage. Many publications concerning contemporaneous sites do not mention any micromammal remains. There are no published microfauna remains from the Kebaran site of Ein-Gev (Davis, 1974); the Geometric Kebaran site of

	Ohalo II	Locus 1
Molar alveolar present	52	29
Molar alveolar expected	114	57
% Molar alveolar present	45.61	50.88
Incisor alveolar present	19	10
Incisor alveolar expected	76	38
% Incisor alveolar present	25.00	26.32

TABLE 6
Mandible and maxilla breakage for Ohalo II and locus 1.

Digestion categories	Ohalo II	Locus 1	Ohalo II %	Locus 1 %
None	36	44	40.0	55
None to very slight	3	2	3.3	2.5
Very slight	9	8	10.0	10
Slight	27	16	30.0	20
Moderate	12	9	13.3	11.25
Heavy	3	1	3.3	1.25
Total	90	80	100.0	100

TABLE 7
Loose molar levels of digestion for Ohalo II and locus 1. Levels of digestion follow Andrews (1990).

Neve David has only few micromammal remains (Bar-Oz, 1996; Bar-Oz *et al.*, 1999). In Hayonim Terrace (Geometric Kebaran A, Natufian), only *Sciurus* and *Spalax* are mentioned although quantities are not given (Henry *et al.* 1981). Open-air sites from the Natufian site of Jebel Es- Saaide (Churcher, 1994) and Einan (Rabinovich, Personal communication), showed total NISP numbering few ten's compared to over one hundred of Ohalo II. Nevertheless, the quantity of micromammal remains at Ohalo II is small in comparison to the large quantities of Middle Paleolithic cave sites in the Southern Levant.

When the taphonomic data of Ohalo II is compared with the data obtained from modern pellet and scat assemblages, there is no specific predator species that the archaeological assemblage resembles with values commonly falling between the extreme values of the barn owl and red fox. The Ohalo II assemblage can be characterized in general as broken and fragmented, many elements are missing, and those present are broken. When observing the element proportion found at Ohalo II, the large percentage of loose teeth relative to other postcranial elements differs from modern comparative assemblages obtained from pellets and scats in which postcranial elements are usually over 50% compared to the 8% at Ohalo II. This could be the result of the unique accumulation, which was biased against limb bones. Such bias could be predator related or preservation bias, which may have eliminated limb bones and preserved the more endurable enamel coated dentition.

The results from the different taphonomic indices are conflicting. Some indices resemble barn owl assemblages while others are more similar to mammalian carnivores.

The increase destruction of proximal elements is more typical for mammalian carnivores than for avian ones (Andrews, 1990). Other indices that support mammalian predator for the assemblages are absence of cranial remains, a high proportion of broken limb bones, broken maxillae and mandibles and high isolated teeth broken. Indices that are more similar to the barn owl assemblages are the postcranial to cranial ratio, molar loss and *in situ* digestion levels.

Although many indices point to a carnivore origin for the assemblage, there are several other factors in which the Ohalo II assemblage differs from that of predators, both mammalian and avian, thus questioning a predatory origin all together. These include the extreme mandible and maxillae breakage beyond what is known for any predator and the absence of shaft fragments.

How can these seemingly contradictory results be explained? The assemblage could have been accumulated by causes other than predation (i.e. entrapment in pits or disease) or could have been accumulated by a predator not yet identified. The opposing model put forth is that post-depositional taphonomic processes may have altered the assemblage such as to render it unidentifiable by the given indices.

Such an activity may have been trampling. To mimic the effect of mechanical breakage and tram-

pling, modern barn owl pellets from the Hula valley were trampled for several minuets. All skull fragments were broken beyond recognition. Maxillas were all isolated from the skull and did not retain the zygomatic arch. Mandibles were less broken and could be categorized as levels B and C of Andrews (1990). Most maxilla and mandible fragments included 1-2 molar alveolars of the three expected. Postcranial elements were broken mid shaft. No shafts were present. The limb bones were most commonly broken in half or in eighth. Smaller postcranial elements processes. The origin of the assemblage cannot be discerned using modern controls. Moreover, the great similarity between the entire assemblage and locus 1 suggest that the two cannot be distinguish from a taphonomical point a view. Trampling would have produced similar assemblages from different depositional agents.

It is interesting to note those preliminary observations on the micromammal assemblages of two Paleolithic open-air such as 'Ubeidiya and Gesher B'not Ya'acov, were also dominated by teeth rather that postcranial elements. Albeit, that these sites are very different in nature from Ohalo II, this may suggests that trampling may be a phenomenon related to the attributes of an open-air site in comparison to cave site. Nevertheless, we would like to stress that although trampling processes maybe be present in other open-air sites, the origin of the Ohalo II assemblage might not be indicative of open-air sites as a rule, but rather a unique case of Ohalo II. Further taphonomic research in other sites will indicate if this is the case.

CONCLUSIONS

The open-air site of Ohalo II revealed significant amounts of micromammal remains. The agent of accumulation cannot be discerned due to post depositional processes that altered the assemblage. The taphonomic history of micromammal assemblages may differ in open-air sites as opposed to cave sites notably with an increase in trampling.

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Estimating Fish Size from Archaeological Bones within one Family: a Detailed Look at three Species of Labridae

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ABSTRACT: The allometric relationships between bone dimension and live fish size (fork length and ungutted weight) are examined in detail for three species of the Labridae family which are common in temperate New Zealand waters. These fish are not able to be identified more precisely than to family level using the five paired cranial bones normally used for identification. This suggests that we may be forced to use regression equations based on the three species combined together to estimate live fish size. It was found that some allometric relationships are very similar in all three species, but others are not. Regression equations were calculated for each species (N=122, 138, 126 respectively), and then for all species combined (N=386). These equations are then used to estimate the fork length and weight of a collection of Labridae fishes from an archaeological site at Waihora in the Chatham Islands (N=3,095). Although the four catch size-frequency diagrams are superficially similar, the estimated mean fork length and mean fish weight are significantly different from one model to another. Total meat weight varies by 10% depending on which model is employed. Although in the meantime we may have to accept this level of imprecision, we also suggest a method by which the combined fish catch can be separated into its three components so that the approximate contribution of each species to the total can be estimated.

KEY WORDS: ARCHAEOZOOLOGY, NEW ZEALAND, FISH, LABRIDAE, ALLOMETRY

RESUMEN: Se examinan en detalle las relaciones alométricas entre dimensiones del hueso y tamaño del individuo (longitud en la horquilla y peso eviscerado) en tres especies de la familia Labridae frecuentes en las aguas templadas de Nueva Zelanda. Estos peces no es posible identificarlos por debajo del nivel familia utilizando los cinco huesos pares craneales que normalmente se utilizan en su identificación. Todo ello sugiere que podríamos vernos forzados a utilizar ecuaciones de regresión basadas en datos combinados de las tres especies para realizar las estimaciones de tamaño del pez en vivo. Se comprueba que algunas relaciones alométricas son muy semejantes en las tres especies pero esto no es así en todos los casos. Se calcularon ecuaciones de regresión para cada una de estas tres especies (tamaños muestrales de 122, 138 y 126 casos) y posteriormente para una muestra combinada de las tres especies (N=386). Estas ecuaciones son posteriormente utilizadas para inferir la longitud en la horquilla y el peso en una muestra de lábridos procedentes de un yacimiento arqueológico en Waihora en las islas Chatham (N=3095). Aunque los cuatro diagramas de frecuencias de tallas capturadas son superficialmente parecidos, las longitudes medias en la horquilla y los pesos medios de los peces son significativamente diferentes entre los distintos modelos. El peso cárnico total varía hasta en un 10% en función de qué modelo es utilizado. Si bien de momento no quede otro remedio que aceptar estos márgenes de imprecisión en el trabajo se sugiere un método con el cual la captura combinada de peces puede ser desglosada en sus tres componentes de tal suerte que las contribuciones aproximadas de cada especie al total puedan ser mejor estimadas.

PALABRAS CLAVE: ARQUEOZOOLOGÍA, NUEVA ZELANDA, PECES, LABRIDAE, ALOMETRÍA

INTRODUCTION TO THE PROBLEM

The establishment of methodologies for estimating live fish size (fork length and ungutted weight) from archaeological bone dimensions with an acceptable level of accuracy is an important step in studying past fishing behaviour and the effects of human predation on fish populations. It enables us to compare the size frequency distribution of catches of particular species through time. It is also an essential step in estimating the meat weight contributed by particular fish to the diet of particular human communities.

We are fortunate that most of the fish commonly captured by pre-European Maori in the temperate waters of New Zealand have no close inshore relatives and we can therefore be confident that we are dealing with the bones of a single species. In the case of labrids, however, there are three common inshore species with very similar bones but somewhat different size ranges and habitats. If we cannot reliably distinguish the bones of the three species, what are the implications of using regression relationships based on the pooled bones to estimate fish size? In this paper we explore in detail the allometric relationships between bone dimension and fish size of the three species and discuss the implications of using pooled bones.

THE LABRIDAE FAMILY IN NEW ZEALAND

Sixteen species of labrids are found in the temperate New Zealand waters (Ayling & Cox, 1982: 251). They range in size from the small crimson cleaners (*Suezichthys* sp.) which are about 15 cm long and weight about 30 g to the large banded wrasse (*Pseudolabrus fucicola*) which can be up to 60 cm long and weigh about 3 kg. Only three species occur commonly; the others are either very rare or only occur in the most northern sub-tropical waters in outlying areas, such as the Poor Knight Islands.

In archaeological sites, bones of labrid fishes are especially common in central and southern New Zealand and in the Chatham Islands to the east of the mainland. We are fairly sure that most if not all of these bones belong to the three common species, mainly on the grounds of their modern distribution. These common species are the spotty (*Notolabrus celidotus*), the scarlet wrasse (*Pseudolabrus miles*) and the banded wrasse (*Pseudolabrus fucicola*). The size range of these three species is rather different; this is illustrated in Figure 1. From this it will be observed that the banded wrasse is by far the largest, but the lower end of its size-frequency distribution overlaps with the upper end of that of the scarlet wrasse. There is a smaller overlap between the scarlet wrasse and the smallest of the three species, the spotty. We have carried out several archaeological studies of the bones of these fish with mixed fortunes as far as separating the three species using either qualitative anatomical features or osteometric measurements is concerned (Leach & Anderson, 1979; Leach *et al.*, 1997, 1999).

SIMILARITY AND DISPARITY IN BONE ALLOMETRICS

In our first major osteometric study of the labridae fishes in New Zealand (Leach *et al.*, 1997), our comparative collection consisted of 122 modern specimens of scarlet wrasse, 18 of spotty, and no banded wrasse. In order to examine the problem of differentiation in more detail the first requirement was to collect and process a much larger sample of all three species in question. We therefore collected a total of 386 specimens, boiled them down and prepared the five cranial bones for measurement. The new sample consisted of 122 scarlet wrasse, 138 spotty, and 126 banded wrasse. We took 30 measurements on the bones. Together with the live fork length and weight, this provides a database of 12,352 measurements. We believe this is now sufficient to explore the osteometric issues thoroughly.

Figure 2A shows the fork length plotted against the ungutted weight of the three species. Open circles are the spotty at the small end of the size range, triangles are the scarlet wrasse in the middle size range, and squares represent the banded wrasse at the large end of the size range. It is virtually impossible to distinguish the different symbols, because they overlap so much.

It is obvious that the allometric relationship between body length and body weight is very similar for the three species. This is further reinforced when one bone dimension is plotted against another. In Figure 2B the width of the pharyngeal grinding mill is plotted against the pharyngeal tooth

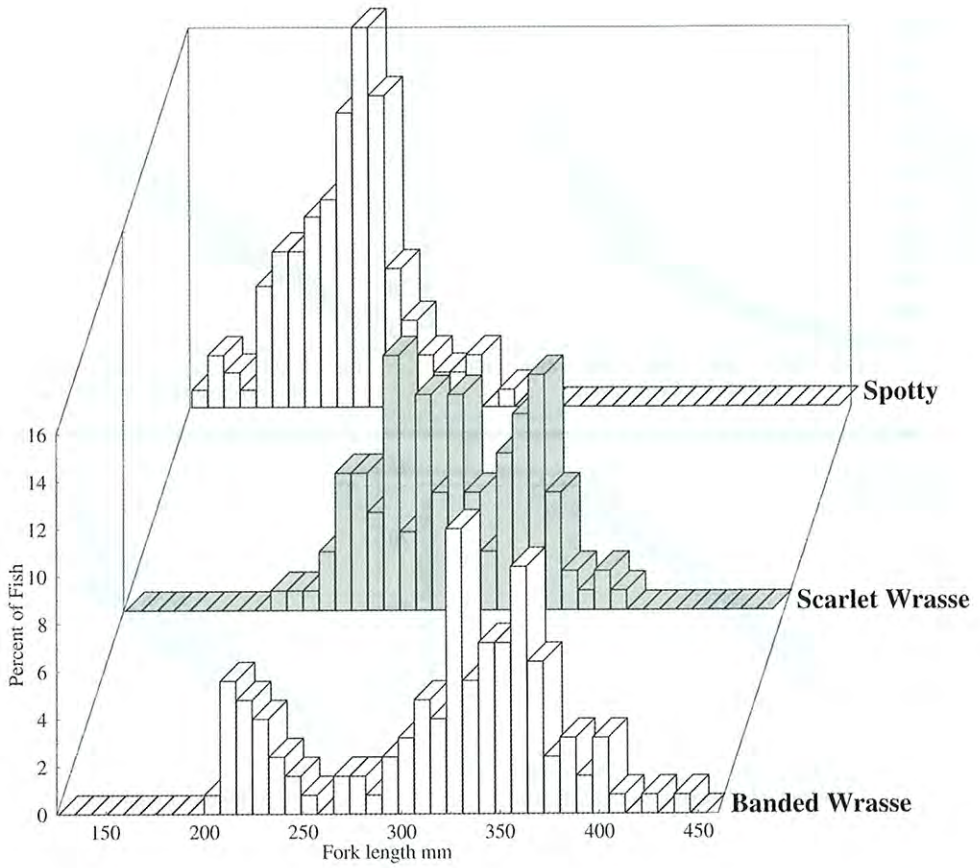


FIGURE 1

Size-frequency diagrams of three common species of Labridae in New Zealand: spotty (*Notolabrus celidotus* N=138), scarlet wrasse (*Pseudolabrus miles* N=122), and banded wrasse (*Pseudolabrus fucicola* N=126).

row. Each species follows a very similar allometric relationship with increasing size. It may be noted that there are two outliers in this graph. When these bones were checked it was found that there were errors in the original measurements. They have been left in this illustration to show how closely the allometric relationship is followed by these three species, enabling error outliers to be easily recognised.

Again, when the maximum length of the premaxilla is plotted against its height (Figure 2C) it is clear that all three species follow the same type of allometric relationship for this bone also. However, it might be noted that there is increasing variability amongst the larger specimens.

When the articular length is plotted against height (Figure 2D) we begin to see signs of allometric difference. Almost all of the banded wrasse, represented by the squares, plot out above the scarlet wrasse, represented by the triangles, and the spotty lies in between these two. In this case, the regression lines for these three species are quite different.

In the case of the maxilla (Figure 2E), the opposite pattern is observed. Here the banded wrasse plot out below the regression line for the scarlet wrasse. The triangles are on the top and the circles and squares below. This shows that although the bones may be hard to distinguish from one species to another, their relative dimensions are slightly different, and therefore their relationship to body size and weight is different too.

The final example is of the dentary (Figure 2F). Here we can see that all of the banded wrasse plot

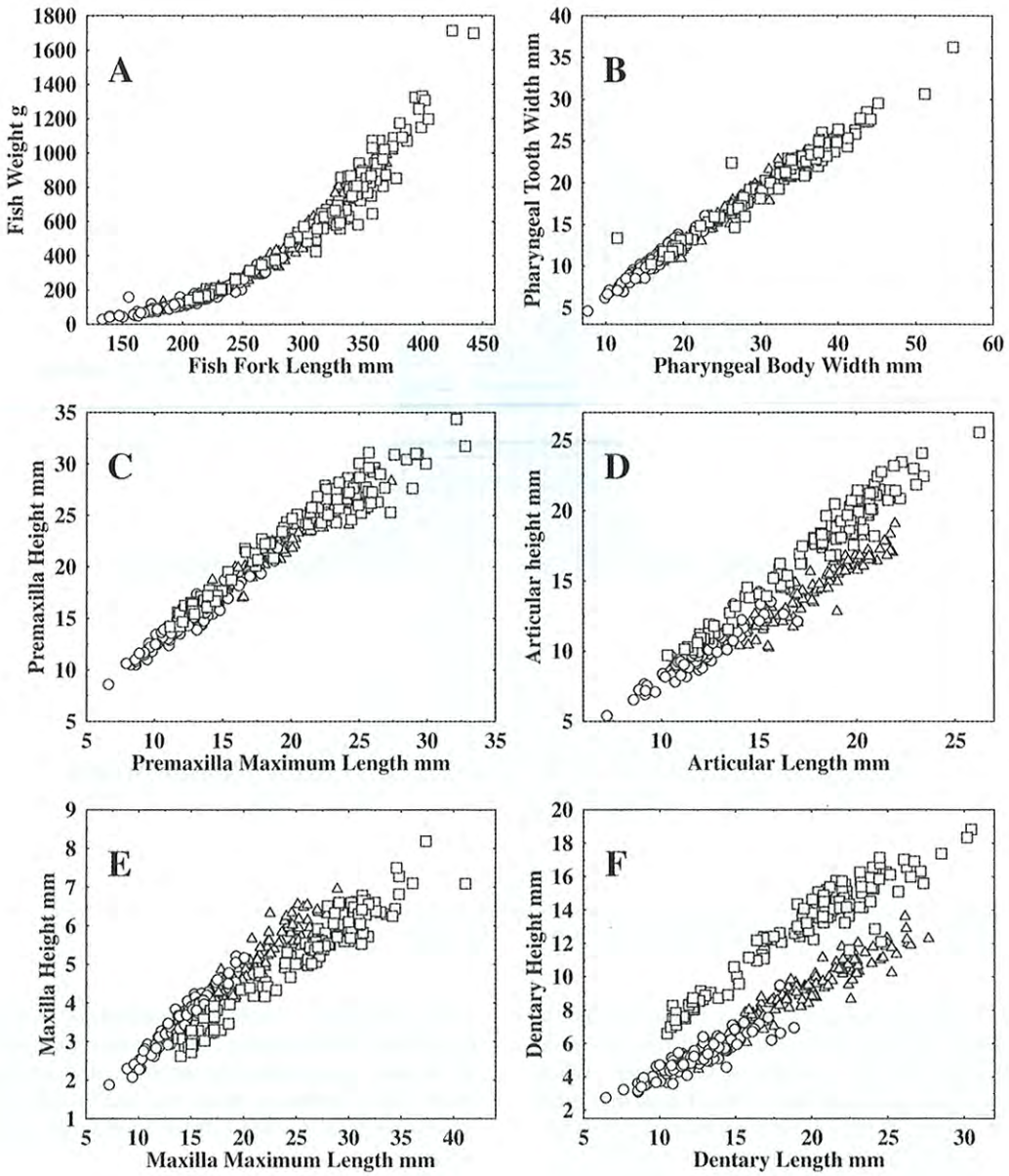


FIGURE 2

Scatter plots of various bone dimensions showing the extent of overlap between the three species. The open circles are the spotty at the small end of the size range, the triangles are the scarlet wrasse in the middle size range, and the squares represent the banded wrasse at the large end of the size range.

out well above the other two species. This is cause for some alarm, because if we attempt to reconstruct the live fork length or weight from these measurements without taking into account what species the bone belonged to, we may introduce unacceptable errors.

AN ARCHAEOLOGICAL EXAMPLE — DIFFERENT MODELS

It is useful to try and trace the possible effects that such pooling might have on archaeological studies. A suitable test case for this purpose is the fish remains from an archaeological site known as Waihora in the Chatham Islands. This is an extensive collection and contains a sizeable number of labrids (see Table 1).

We were able to measure 69% of the labrid bones (3,095 of the 4,509 present). This provides a suitable database with which to trace the possible effects of assuming that one set of regression equations is acceptable for this family of fish, regardless of species.

There are four possible regression models which could be followed in cases such as we have here.

Model 1: We could base the model only on the species of labrid known as spotty in the modern comparative collection. Thus, we would derive equations for each bone appropriate to spotty and then assume that *all* the specimens in the archaeological site *were* spotty.

Model 2: We could base the model only on scarlet wrasse, etc.

Model 3: We could base the model only on banded parrotfish, etc.

Model 4: We could base the model on all three species combined, etc.

When we do this, we obtain four different catch-frequency diagrams, which are illustrated in Figure 3. At first glance, these size-frequency dia-

Family	**Common Name**	**MNI**	**NISP**
Mugiloididae	blue cod	2547	10301
Odacidae	greenbone	1701	5582
Labridae	spotty, etc.	1509	4509
Gempylidae	barracouta, etc.	273	477
Latrididae	blue moki, etc.	183	295
Cheilodactylidae	tarakihi, etc.	180	360
Nototheniidae	Maori chief	179	293
Moridae	red cod, etc.	81	108
Congridae	conger eel	72	88
Anguillidae	freshwater eels	48	54
Balistidae	leatherjacket	33	33
Percichthyidae	groper	22	39
Ophidiidae	ling	20	21
Chondrichthyes	sharks, etc.	19	26
Carangidae	trevally, etc.	18	38
Scorpaenidae	scarpee, etc.	14	17
Triglidae	red gurnard	4	4
Pleuronectiformes	flounder, Sole etc.	2	2
Aplodactylidae	marblefish	1	1
Merlucciidae	hoki	1	1
Total	-	**6,907**	**22,249**

TABLE 1

Fish MNI from the Waihora sites in the Chatham Islands.

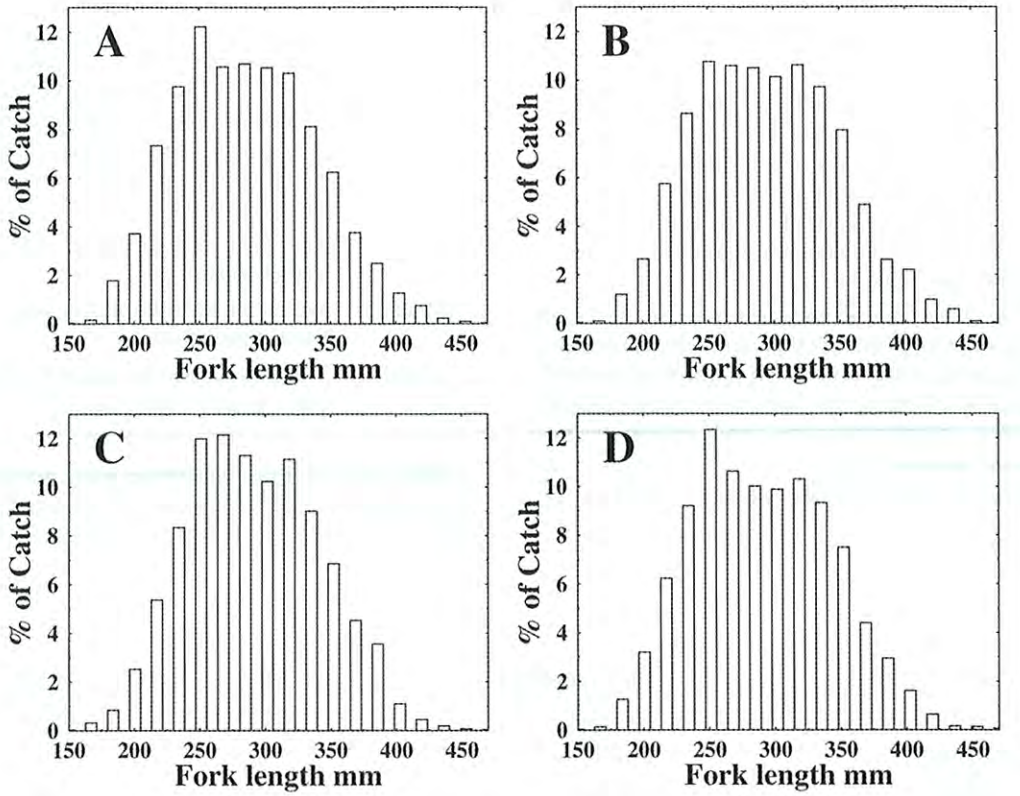


FIGURE 3

Size-frequency diagrams for the labrid fish catch at the site of Waihora in the Chatham Islands (N=3,095), using four different regression models for estimating fork length. A = based on spotty, B = based on scarlet wrasse, C = based on banded wrasse, and D = based on all three species combined.

grams all look rather similar. Careful inspection of the dispersion statistics is warranted. There is very slight positive skewness in all four histograms, with values ranging from +0.18 to +0.27, but these are highly significant ($p<.001$). There are somewhat greater signs of negative kurtosis, with values ranging from 2.5 to 2.6 (expected 3.0), and once again these are all highly significant ($p<.001$). Thus, we can conclude that as far as the shape characteristics of these four alternative catch-frequency diagrams are concerned, it matters very little which model is employed. This is important, because the shape of the catch-frequency diagram provides evidence for a number of useful aspects of fishing behaviour, such as the use of different gill net mesh sizes, the catch of different age grades, and changes through time following particular catch strategies, such as the targeting of large specimens. We can be confident that from this point of view it does not matter what model is used.

However, the shape of the size-frequency curve is not the only thing which matters, we also need to consider the possible effects which the choice of model might have on the mean and standard deviation of the fork length and live weight. These statistics are given in Table 2, and plotted out in Figure 4.

In Figure 4A the X-axis is the mean fork length, and the Y-axis is the standard deviation. Each of the four models is plotted. The error bars represent the standard errors in each case. It is clear from this that there is wide discrepancy. The models based upon the spotty and the scarlet wrasse, for example, are more than four standard errors apart. It will be seen in Table 2 that the range of results across the four models is ± 1.4, 5.2% of the mean

	Fork Length mm		Weight g	
Model	**Mean**	**SD**	**Mean**	**SD**
Spotty	286.1 ± 0.94	52.5 ± 0.67	496.8 ± 5.5	303.2 ± 3.9
Scarlet	294.9 ± 0.96	53.5 ± 0.68	546.8 ± 5.8	325.8 ± 4.1
Banded	292.1 ± 0.91	50.6 ± 0.64	524.4 ± 5.3	297.1 ± 3.8
Combined	290.5 ± 0.94	52.5 ± 0.67	520.3 ± 5.6	308.8 ± 3.9
Mean	**290.9 ± 1.4,5.2%**		**522.1 ± 4.8%**	

Total weight labrid fish in site kg

Model	**Weight**
Spotty	1538
Scarlet	1693
Banded	1623
Combined	1611
Mean	**1616 ± 4.8%**

TABLE 2
Basic statistics for fork length and weight, for the four models.

value of the four models. This is an unacceptable spread of results. Similarly, in Figure 4B when mean fish weight is plotted out using the four different models, we again find an unacceptable range of ± 4.8% of the mean value of the four models.

Consequently, it would be difficult to use statistics relating to mean fish size to suggest changes

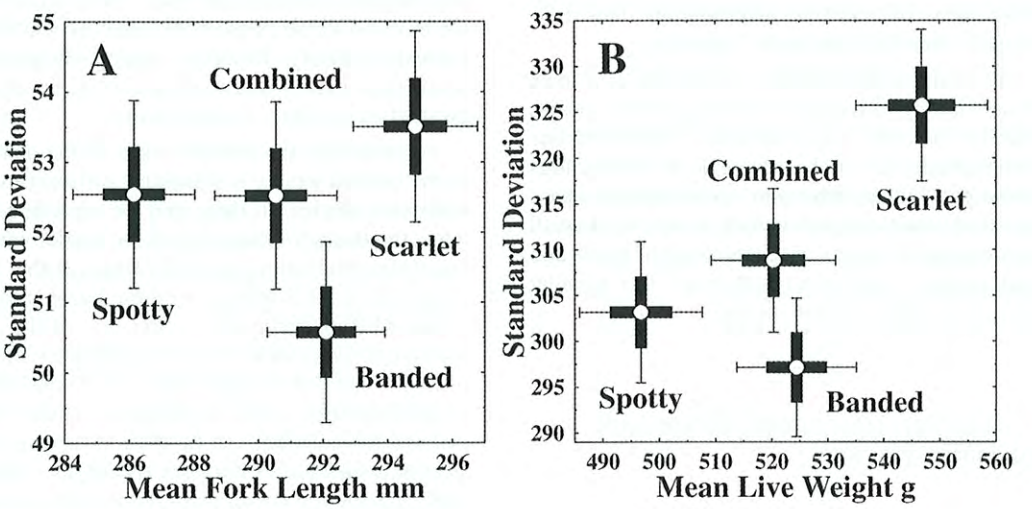


FIGURE 4
Estimated mean fork length and mean ungutted fish weight plotted against standard deviation for labrid fish from Waihora, using the four different models described in the text.

through time between one layer and another in archaeological sites. As archaeologists, we would be seeking changes which might reflect the ongoing effects of human predation on inshore stocks, or changes in population structures due to other external environmental effects, such as changes in recruitment rate with different surface sea water temperature regimes. However, any observed changes might in fact turn out to be due to changes in relative abundance of the undifferentiated species and not to these other factors at all.

The disparity in mean fish weight also has implications for dietary reconstructions based upon archaeological data on fish catches. The statistics for the four models are provided in Table 2, but the problem is more obvious when illustrated in Figure 5.

Figure 5 shows the estimated total weight of live labrid fish from these 3,095 measured bones, using the four different models. The range from one model to another is 155 kg, representing a range of 10% of the value for spotty. One has to bear in mind the purpose of doing such calculations in the first place. This is not mere tinkering with interesting facts and figures. The purpose here is to understand the nature of human economic systems in the past — and in particular, the contribution of food from different sources to the diet of prehistoric people. We aim to keep systematic errors at all stages to less than 1% wherever possible. That is a useful yardstick to follow in most areas of scientific investigation. This 10% range is therefore extremely important.

We must accept, therefore, that this is a most disappointing outcome, and that pooling species together in this way does have down-the-line implications for archaeological reconstructions about past human behaviour, environmental changes, and subsistence economics. It may be of small consequence if one is only interested in bones and mathematics, but for prehistorians, this pooling approach is not very satisfactory.

ALTERNATIVE METHODS OF SPECIES DIFFERENTIATION

This paper is primarily concerned with the theoretical issue of whether there are or are not implications for prehistoric studies of pooling closely similar species together when attempting to estimate fish size from archaeological bones. The answer must be a positive Yes. But we need to consider too, what can be done to alleviate the problem — after all, the suggestion of pooling species is not made lightly. It is made precisely because of the difficulty of identifying all relevant anatomy to species, or even to genus in some fish families.

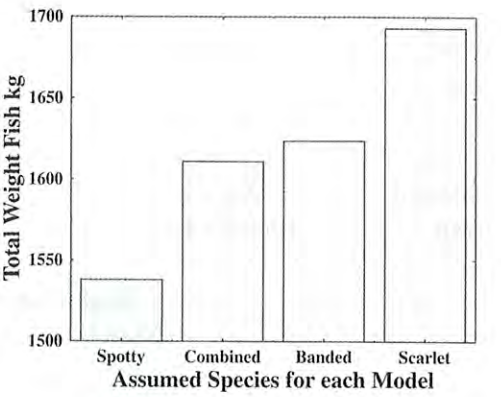


FIGURE 5

Estimated total meat weight from labrid fish at the Waihora archaeological site, using the four different models. There is a 10% range of 155 kg.

Fortunately, there may be a small glimmer of hope, at least as far as the New Zealand labrids are concerned. It was mentioned at the outset that it is not possible to distinguish these three species on the basis of all the parts of the anatomy which we normally identify. However, careful attention to detail does permit the three species to be distinguished on the basis of *some* bones.

For example, the general shape of the dentary of the banded wrasse is somewhat different to the other two species, so these may be separated out. Also, the dentary symphysis of the scarlet wrasse has clear crenellations along its length, rather like some species of Scaridae. So these bones may be separated from the spotty. In the case of the premaxilla, the banded wrasse has a distinctly curved posterior end, but the other two species cannot be so distinguished. Thus it can be seen that some parts of the anatomy can be used to estimate the relative abundance of the three species in a collection, even though not all identifiable bones may be distinguished.

There is another method by which we can estimate the relative abundance of the three species. It is possible to decompose a size-frequency diagram

where there is a mixture of components. A considerable amount has been published on the subject (Macdonald & Pitcher, 1979; Schnute & Fournier, 1980; Everitt & Hand, 1981; Titterington *et al.*, 1985; Macdonald, 1987; McLachlan & Basford, 1988). Peter Macdonald at McMaster University has developed an algorithm which is now widely used for separating age grades of fish from trawl catch data. We used his program MIX (version 3.0) to separate out the different species in the catch diagram from the Waihora site.

In Figure 1 we illustrated the size-frequency diagram of all the specimens in our comparative collection. From this collection, we can calculate dispersion statistics (such as the mean and standard deviation) for each species, which can then be used in a decomposing algorithm developed by Mcdonald. The results are presented in Figure 6.

Figure 6A shows the Waihora labrid size frequency diagram, based upon the fourth regression model (that is, all species combined). In Figure 6B we show the three species separated out using the modern dispersion characteristics and Macdonald's algorithm.

By this method, we estimate that spotty make up about 10% of the fish catch, scarlet wrasse about 65%, and banded wrasse about 23%. Separating the three species in this way may be important in studying the changing composition of fish catches in a particular place through time. Here in the Chatham Islands, for instance, we think that there was a progressive shift in the exploitation of the three labrid species through time and that this is reflected in the assemblages from three adjacent sites of different ages (Leach *et al.*, 1999).

What then can be done about the second problem identified above, that of estimating the mean weight of fish represented by the archaeological collection? This requires a different approach, whereby accurate identification to species is necessary. As pointed out above, some bones may be identified to species, but not uniformly across all parts of the anatomy. This effectively means that reliable identification of bones will result in a greatly reduced database to work with. It is also important to avoid any possibility of systematic bias. Our detailed review of anatomical differences suggested that only the dentary might be usable to distinguish these three species. Once separated into species, this bone could then be used to estimate individual fork lengths and weights, and then mean values calculated. Once this is done, the total meat weight can be estimated by adding up the products of mean weight and the appropriate MNI value for that species (0.1 x 1509 for spotty, 0.65 x 1509 for scarlet wrasse, and 0.23 x 1509 for banded wrasse).

In other words, we need a reliable method for sorting *some* of the larger sample into species, and using this as the basis of our estimating technique.

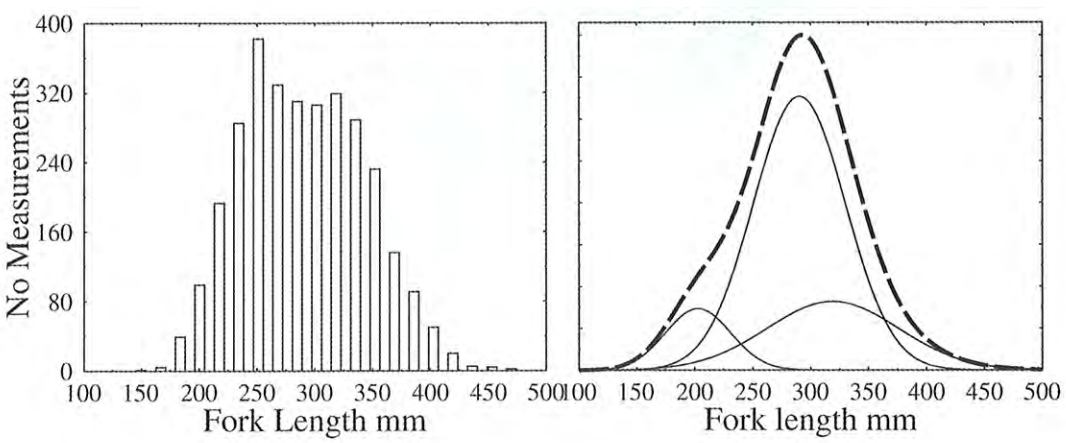


FIGURE 6

The Waihora archaeological labrid collections decomposed into its constituent three species, using the Macdonald algorithm (see text).

We could of course use the species proportions established from this smaller data set rather than the Macdonald algorithm on the larger database. Which option to choose will depend upon how large a sample one is dealing with in each case, and which is considered the more reliable in a real situation.

We should mention that multivariate statistical techniques can also be helpful in cases like this. To illustrate this, we used the data presented in Figure 2F; that is, the two measurements of the dentary on the three species of labrids considered here. We used Kovach's Multivariate Statistics Package (MVSP, version 2.1K) for this purpose.

The eigenvalues for the two components were 36.9 and 2.2, accounting for 94% and 5.6% of the variance respectively. The eigenvectors are as follows:

X = 0.806 * Dentary Length + 0.592 * Dentary Height

Y = -0.592 * Dentary Length + 0.806 * Dentary Height

The individual bones were plotted out using these eigenvectors. The results are given in Figure 7.

It can be readily seen that there is an excellent separation of all three species in the plot, with banded wrasse most distant from the other two. There is some overlap between spotty and scarlet wrasse, but it is not great.

To make use of such a separation, one would measure the two dimensions on a dentary, calculate the X and Y coordinates from the two eigenvector equations given above, and then plot the bone on the graph to see which species it belonged to. In cases where the bone plotted in the uncertain area between spotty and scarlet wrasse, it would have to

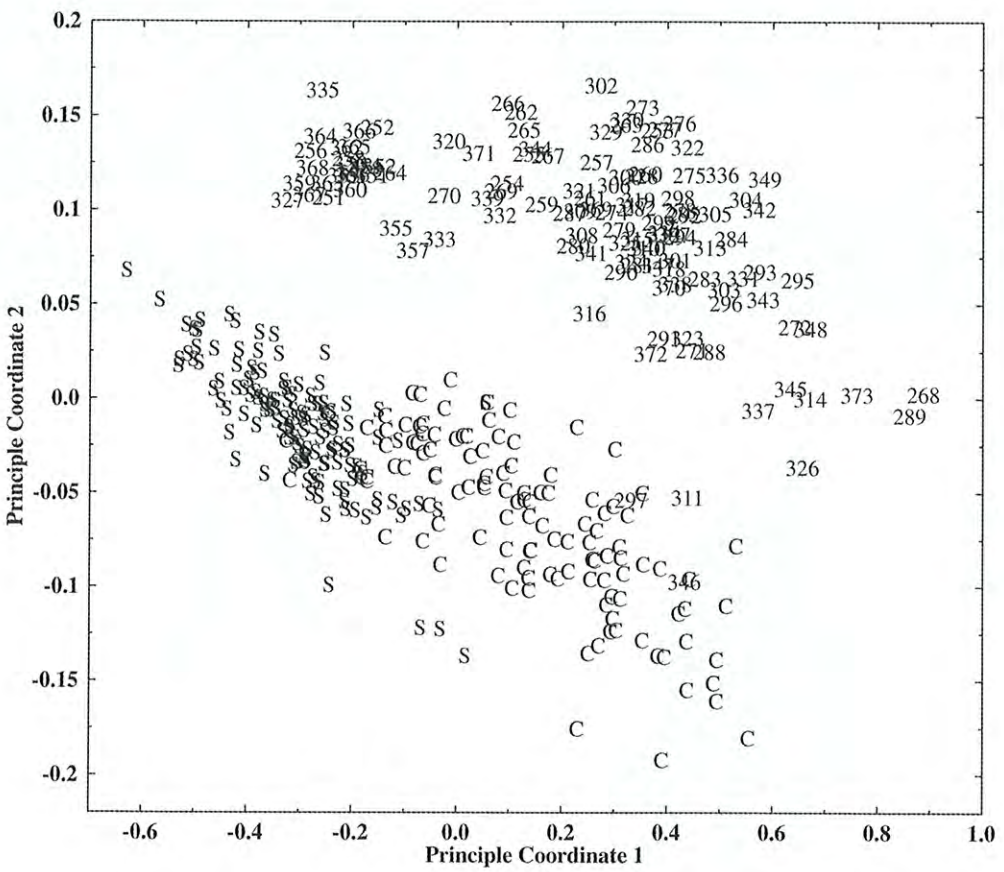


FIGURE 7

Principal coordinates analysis of dentary measurements of labridae, showing clear separation between the three different species. S = Spotty, C = Scarlet wrasse, and B = Banded wrasse.

be set aside as of uncertain species. In this somewhat laborious manner one should be able to separate at least the dentaries into the three species. This is obviously not an ideal solution, and cannot be carried out on many of the cranial bones of labridae recovered from archaeological sites. However, it would at least enable an unbiased estimate to be made of mean fork length and weight of each species in a site, even though it would be based on a much smaller sample size than the full complement of bones.

CONCLUSION

The purpose of this intensive study of three species of labrids from New Zealand archaeological sites was to explore the possible implications of not identifying to species level when carrying out osteometric analysis. It has been shown that the shape of size frequency diagrams may not be adversely affected by using a pooled statistic. That is, skewness and kurtosis statistics appear to be reasonably stable, regardless of which regression model is used. However, it was found that mean size and standard deviation are affected by choice of model, and this has profound effects further down the line. For example, it would make it difficult to interpret any observed changes through time. Such changes might be due to different proportions of the three species being harvested, rather than to the effects of human predation on inshore fish stocks, or effects of environmental change such as fluctuations in recruitment rate. The potential range of error of not separating species is about 10% of the observed mean values. This represents a substantial problem in attempts to reconstruct aspects of subsistence economics using meat weights to estimate the contribution of protein and fat from different food resources.

The problems identified in this study should not be taken as a counsel for despair. On the contrary, we see them as contributing greater clarity when we interpret osteological collections from archaeological sites. It is all too easy now, with such ready access to computer facilities, to throw osteometric data into regression procedures and believe at face value the printed out standard errors. It is only by paying careful attention to all the potential sources of error that our interpretations of the past will be refined and become more enduring.

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Ofrendas de peces asociadas a entierros del Clásico-Epiclásico en Urichu, Michoacán, México

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RESUMEN: Durante las excavaciones efectuadas en un complejo de pirámides-plaza en el sitio arqueológico Urichu, localizado en la orilla suroeste del Lago de Pátzcuaro, en el estado de Michoacán, México, se encontró una tumba de los periodos Clásico tardío y Epiclásico (500-900 dC). Entre los objetos depositados, destacan cuatro platos trípodes conteniendo restos de peces; las fechas de radiocarbono asociadas son, para uno de los platos, 405 a 555 dC, y para los otros tres, 800 a 1000 dC. Los restos pertenecen a una sola especie, el goodeido *Goodea luitpoldi*, un pez local del Lago de Pátzcuaro. En el plato de temporalidad más temprana se encontraron siete individuos y en el otro conjunto, nueve. Los peces usados en cada caso son de talla similar, lo cual sugiere una selección de los mismos, pero difiere entre conjuntos, ya que los de talla más pequeña corresponden al periodo más antiguo. Los peces estaban completos y sin eviscerar, pero no fue posible determinar su forma de preparación. Por la naturaleza del contexto, es posible que los peces formen parte de una ofrenda alimentaria. Esta es la primera vez que se reporta una ofrenda de peces para esta región de México.

PALABRAS CLAVE: MÉXICO, MICHOACÁN, CLÁSICO-EPICLÁSICO (400-900 DC), ARQUEOZOOLOGÍA, PECES, OFRENDAS

ABSTRACT: During the excavations of a pyramid-plaza complex of the archaeological site of Urichu, located on the southwest shore of Lake Pátzcuaro (Michoacán state, México), a tomb from late Classic and Epiclassic periods (500-900 aC) was found. Among the artifacts, there were four ceramic tripod bowls containing fish remains; the associated radiocarbon dates, for one of the bowls spans from 405 to 555 aC, whereas the other three date from 800 to 1000 aC. The remains belong to one species of goodeid, *Goodea luitpoldi*, a local fish from Lake Pátzcuaro. The bowl of earlier age had seven individuals, while the others had nine fishes each. The fishes were of similar size in each of the bowls, suggesting some kind of selection, but the sizes were different for each one of the bowls. The smallest fishes are those from the oldest period. All fishes were apparently complete and ungutted, but it was not possible to determine wether any kind of preparation had taken place. Because of the context, the fish possibly represented food offerings, this being the first time that such offerings are reported for this Mexican region.

KEY WORDS: MÉXICO, MICHOACÁN, CLASSIC-EPICLASSIC (400-900 AC), ARCHAEOZOOLOGY, FISH, OFFERINGS

INTRODUCCIÓN

En el oeste de México, en la región comprendida entre los ríos Lerma-Santiago y Balsas, se dio una larga ocupación humana que culminó con el desarrollo del imperio tarasco, llamado también reino de Michoacán y que significa en lengua náhuatl lugar de pescados (Figura 1). La región se caracteriza por que ahí se localizan varios de los principales cuerpos lacustres de México, los que con su rica flora y fauna, fueron un importante factor en la subsistencia de los grupos asentados (Alcalá, 1988; Toledo & Argueta, 1993).

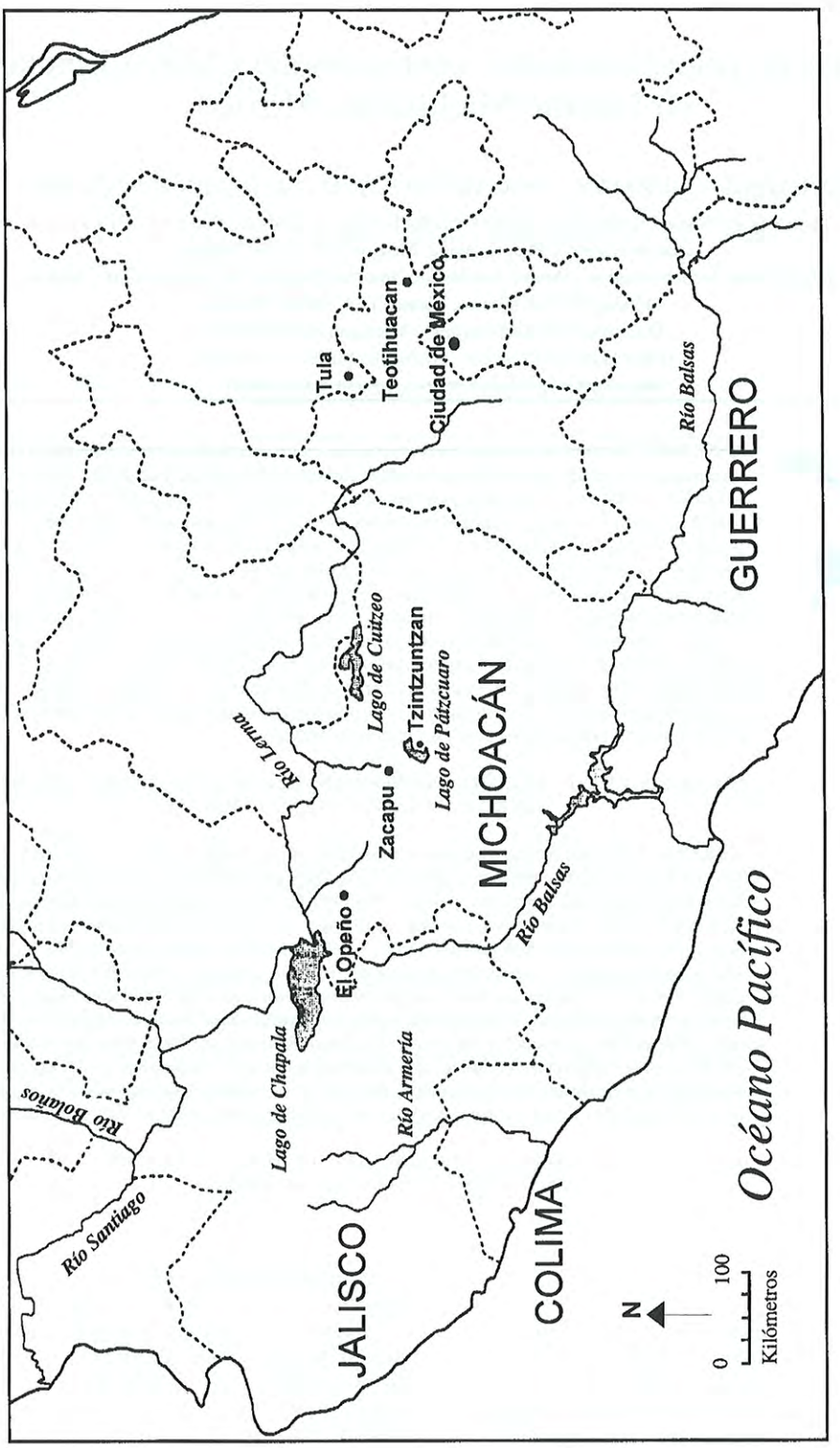


FIGURA 1

Mapa del centro-occidente de México. Entre los lagos interiores de esa área se encuentra el Lago de Pátzcuaro, en el estado de Michoacán.

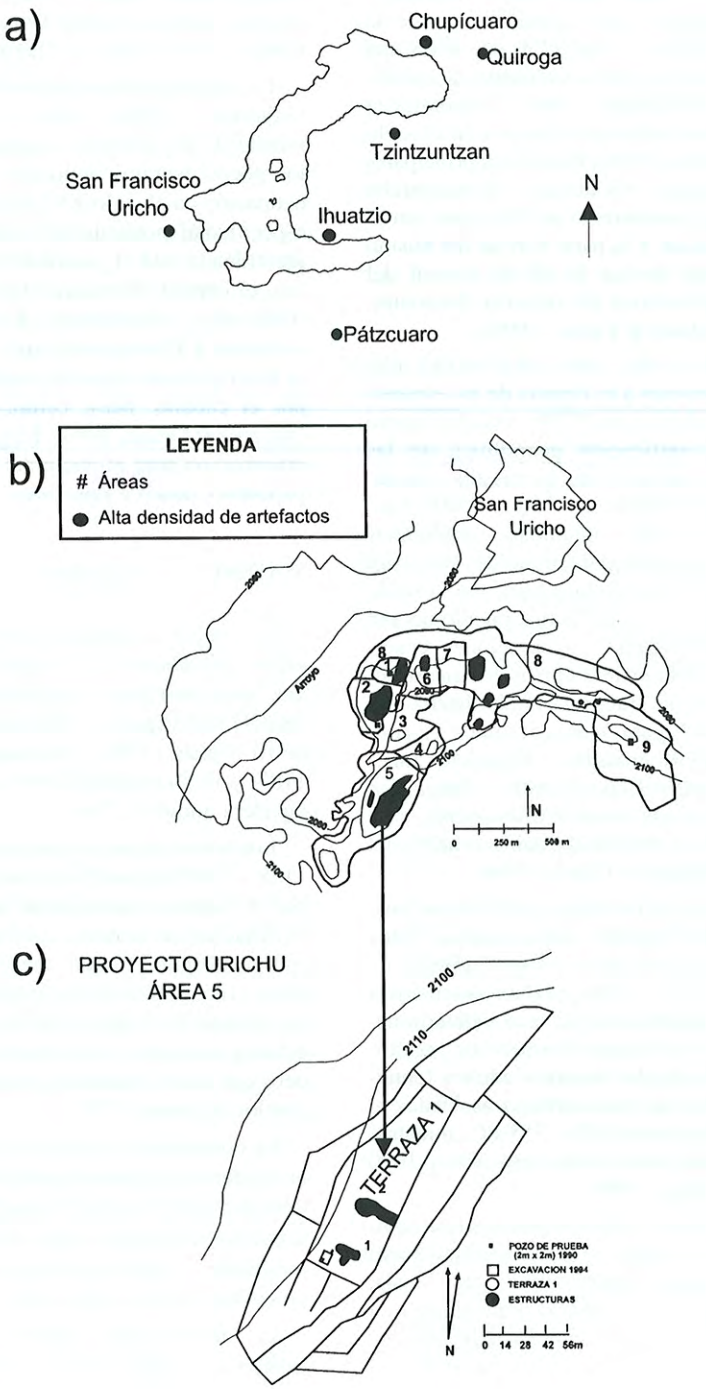


FIGURA 2

Mapa de localización del sitio Urichu: a) Lago de Pátzcuaro con algunos de los poblados que actualmente existen en el área. b) acercamiento al poblado San Francisco Uricho: se numeraron y resaltaron las áreas arqueológicas detectadas para el sitio Urichu, así como las zonas de mayor densidad de artefactos (en negro). C) Mapa de la excavación en la terraza 1 del área 5.

La ocupación del área ocurrió al inicio de nuestra era con aumentos poco significativos de la población, pero hacia el año 1250 dC se da una transformación radical por movimientos de colonización externos (Michelet, 1996), concomitante con el surgimiento del estado tarasco en el siglo XIII dC (Schöndube, 1996). Una de las principales regiones pobladas por los tarascos se encontraba alrededor del lago endorreico de Pátzcuaro, en el estado de Michoacán, y la parte noreste del mismo fue escogida para asentar la última capital del reino y centro geopolítico del imperio: Tzintzuntzan (Figura 1; Pollard & Cahue, 1999).

El imperio tarasco era, junto con el mexica, uno de los más importantes a la llegada de los españoles al centro de México en 1519 y emergió como resultado de la unificación geopolítica de las comunidades autónomas de las tierras altas centrales de Michoacán (Pollard & Cahue, 1999). Uno de los vestigios de esas comunidades autónomas corresponde a un complejo de pirámides-plaza del sitio arqueológico Urichu, localizado en la orilla suroeste del lago y al sur del actual pueblo de San Francisco Uricho (Figura 2); excavaciones recientes descubrieron, debajo de los pisos de una estructura residencial de la élite, una tumba hecha con piedras alineadas (Figura 3: área 5, tumba 1), conteniendo al menos 10 entierros y 87 objetos funerarios de los periodos Clásico tardío y Epiclásico (500-900 dC), lo que sitúa efectivamente a la tumba en momentos previos al establecimiento del estado tarasco (Pollard & Cahue, 1999).

Entre los objetos depositados en la tumba, destacan cuatro platos trípodes que contenían restos de peces (Figura 4): tres de los platos (números de registro 1185, 1187 y 1189) estaban asociados a los restos de un adolescente de sexo indeterminado (entierro 13) y el cuarto (número de registro 1178), a los restos de dos hombres adultos (entierro 21); las fechas de radiocarbono asociadas al plato 1178 oscilan entre 405 y 555 dC, mientras que para los demás platos están entre 800 y 1000 dC (Pollard & Cahue, 1999).

El uso de los peces entre los pueblos que habitaron el Lago de Pátzcuaro se encuentra bien documentado en las fuentes etnohistóricas (e.g. Alcalá, 1988); sin embargo, la evidencia arqueológica de su uso es muy pobre, ya que la única mención previa conocida para esta zona es el hallazgo de restos de pescado blanco (*Chirostoma* sp.) en el fondo de unas yácatas cerca de Tzintzuntzan (Martín del Campo, 1946; Polaco & Guzmán, 1997).

La falta de trabajos arqueológicos en la región (Schöndube, 1996) resulta en un magro conocimiento de los aspectos arqueozoológicos, ya que los pocos estudios realizados corresponden a la ocupación en el siglo XVI de la capital tarasca, en específico al momento del contacto. Entre la fauna identificada está el guajolote (*Meleagris gallopavo*), el conejo (*Sylvilagus floridanus*), el venado (*Odocoileus virginianus*), dos tuzas (*Thomomys umbrinus* y *Cratogeomys* sp.) y el perro; también se han registrado especies europeas, representadas por el caballo, buey, cerdo, borregos y cabras (Alvarez & Ocaña, 1999). En general, se carece de información para el inicio del Posclásico y de los periodos Clásico y Epiclásico.

MATERIAL Y MÉTODOS

Los peces estudiados fueron recuperados en platos descubiertos, a excepción del plato 1185 que tenía otro plato funcionando como tapadera (plato 1186: Figura 4). El diámetro de cada uno es de 10.7 (plato 1178), 21.0 (plato 1185), 23.4 (plato 1187) y 15.8 cm (plato 1189); el plato usado como tapadera midió 15.2 cm.

Los restos de peces eran evidentes en los platos 1178 y 1185 (Figura 5). En los platos 1187 y 1189, por el contrario, aparecieron pocos restos durante la flotación de la tierra que contenían, que desafortunadamente fueron mezclados con los del plato 1185; debido a que la mayor parte de los restos estaban en el plato 1185 y a que los tres platos estaban asociados a un mismo entierro, se consideró que estos materiales podían ser comparados con los del plato 1178.

El contenido se tamizó en seco, empleándose una columna de cuatro tamices de luz de malla de 0.96, 0.59, 0.215 y 0.125 mm. Se analizaron todos los restos retenidos en los dos tamices de malla más grande, y únicamente los restos identificables en los tamices de malla menor.

La identificación anatómica y taxinómica[1] se realizó por comparación con material de la Colec-

[1] Se emplea la palabra taxinomía y sus derivados, en lugar de taxonomía, siguiendo a Pasteur (1976) y Fischer & Rey (1983); el término es aceptado por el Código Internacional de Nomenclatura Zoológica (International Commision on Zoological Nomenclature, 1999; ver apartado correspondiente al francés).

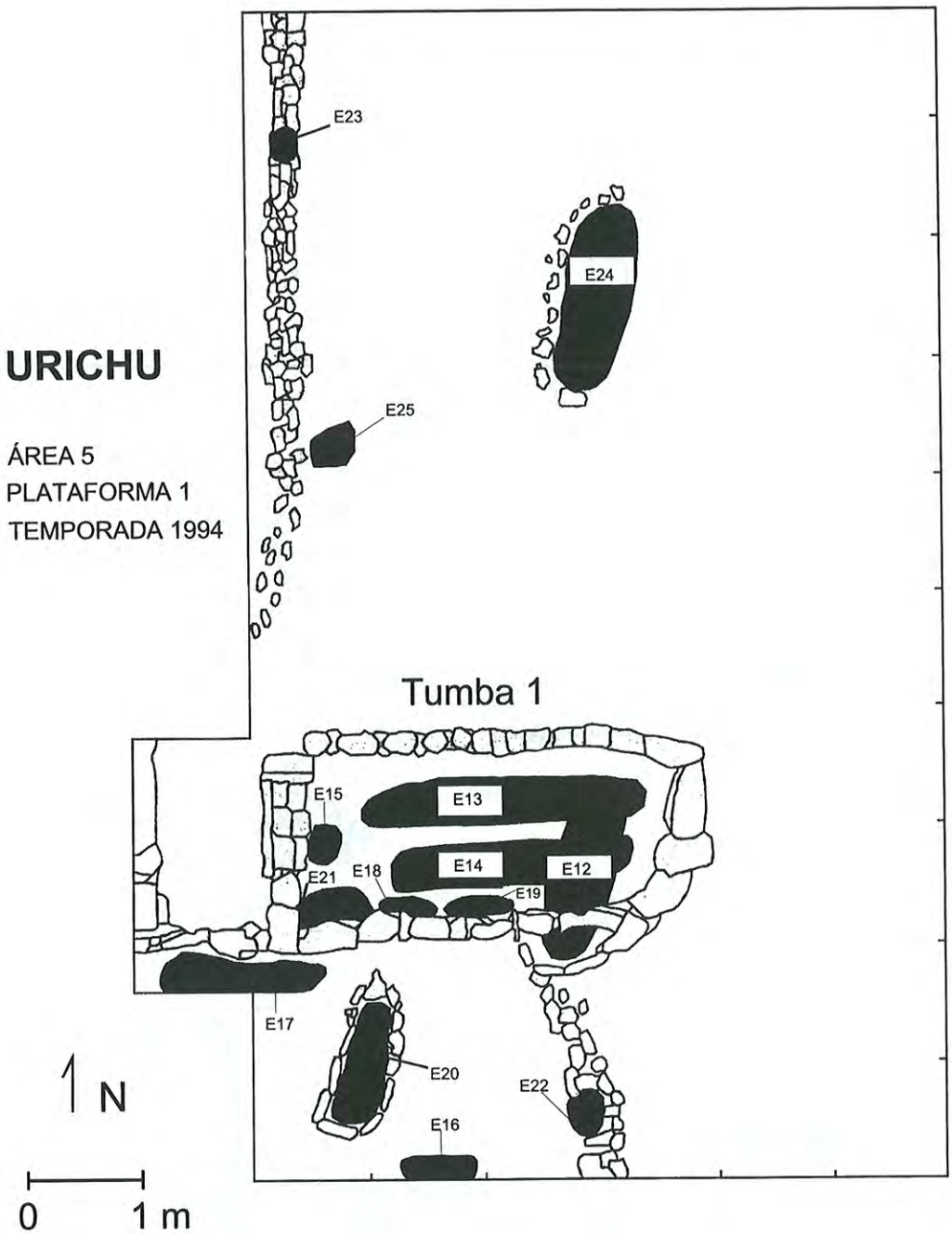


FIGURA 3

Plano de los entierros excavados en la terraza 1 del área 5. E = entierro. Modificado de Pollard & Cahue (1999).

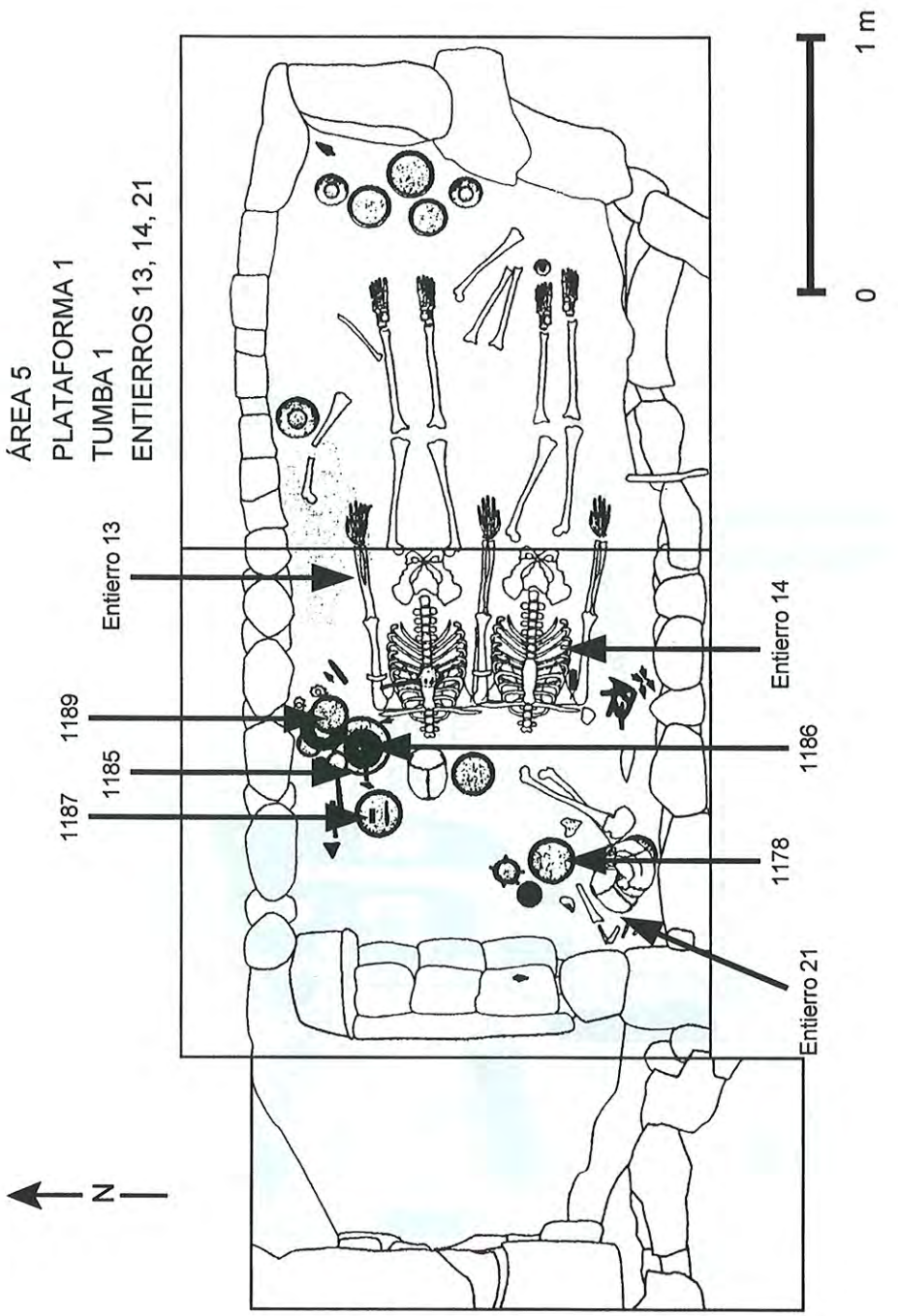


FIGURA 4

Tumba 1, terraza 1, área 5. Se señala la ubicación de los platos que contenían restos de peces. Modificado de Pollard & Cahue (1999).



FIGURA 5
Contenido del plato 1185, donde se observan los restos de peces.

ción Osteológica de Referencia del Laboratorio de Paleozoología del Instituto Nacional de Antropología e Historia.

El número mínimo de individuos depositados en cada plato se calculó por la frecuencia de las diferentes piezas anatómicas (e.g. Grayson, 1984), eligiéndose aquélla que presentó el valor más alto y que en el presente análisis fue la primera vértebra precaudal.

La talla de los peces se estimó a través de ecuaciones de regresión entre el tamaño de los huesos y la talla de los peces, las que se obtuvieron usando el material de la colección de referencia. Las medidas consideradas se basaron en Morales & Rosenlund (1979) y Béarez (1996). En la arqueoictiología se han aplicado al menos cinco tipos de ajuste para estas valoraciones (e.g. Leach & Boocock, 1995); sin embargo, debido a que en la colección son muy pocas las especies presentes con más de 10 ejemplares, no fue factible realizar un análisis estadístico riguroso para determinar el mejor ajuste que se aplicara para este caso, por lo que se decidió explorar sólo dos, el lineal y el *power curve*, por ser los de uso más común y de los que mejor explican este tipo de relación (e.g. Leach & Boocock, 1995; Béarez, 1996; Desse & Desse-Berset, 1996); de entre ambos, se seleccionó la ecuación que proporcionó un mejor ajuste y que para el presente análisis resultó ser la que relacionó, de manera lineal, la anchura de la primera vértebra precaudal (AP) con la longitud patrón o estándar (LP): LP = 29.94552 + 47.21292 (AP), r = 0.8912, error estándar de y = 6.82910, error estándar = 9.80867, t = 4.81338 y residuales = 279.81966. También se estableció el intervalo de confianza de las tallas estimadas, de acuerdo con la ecuación indicada por Daniel (1993).

RESULTADOS

Los restos de peces depositados en los platos pertenecen a una única especie, el goodeido *Goodea luitpoldi* (Steindachner, 1894), localmente

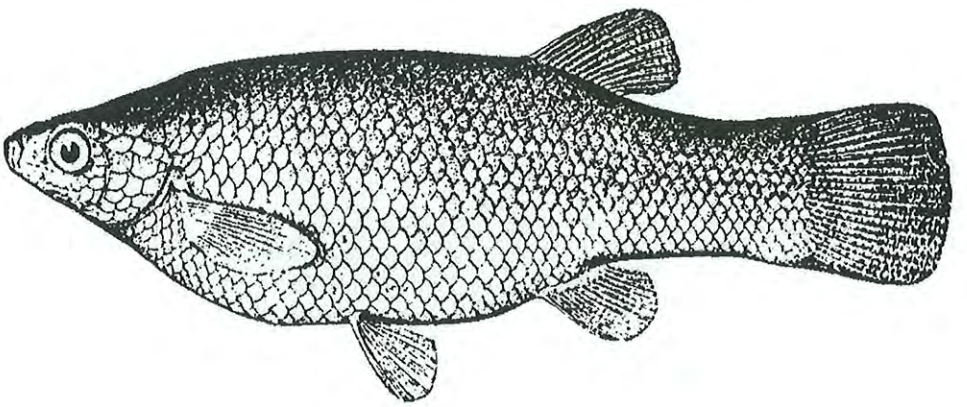


FIGURA 6
El tiro *Goodea luitpoldi*. Tomado de Meek (1904).

conocido como t'iru (en tarasco) o tiro (Figura 6). Esta es una especie lacustre que forma parte de la ictiofauna del Lago de Pátzcuaro (e.g. Álvarez del Villar, 1970; Eschmeyer, 1998), es decir, se trata de un recurso local. El tiro del Lago de Pátzcuaro ha sido referido por algunos autores como *Goodea atripinnis*, otra especie de la cuenca del río Lerma (e.g. León, 1889; Toledo *et al.*, 1980), y en particular a la subespecie *G. atripinnis luitpoldi* (e.g. Alvarez del Villar, 1970). Los trabajos de compilación más recientes sobre las especies de peces dulceacuícolas de México (e.g. Miller & Smith, 1986; Espinosa Pérez *et al.*, 1993), así como otros de carácter más general (e.g. Eschmeyer, 1998), consideran válido el nombre *G. luitpoldi*.

El análisis anatómico de los restos muestra la presencia de, cuando menos, 705 piezas de la región cefálica y troncal (columna vertebral y costillas), así como de las aletas y piel (escamas) (Tabla 1); a estas se debe agregar la presencia de un número no cuantificable, por lo fragmentado, de gastrolitos o contenidos estomacales consolidados, todo lo cual indica que los animales fueron depositados completos.

En el plato 1178 se identificaron siete individuos y en los otros tres platos, nueve (Tabla 1). La inspección macroscópica indicaba que los peces del primer plato eran más pequeños que los de los otros recipientes. Los resultados de la aplicación de la ecuación de regresión lineal demuestran que los peces corresponden a dos clases de talla (Tabla 2), los peces del plato 1178 tienen una talla comprendida entre los 53 y 68 mm de longitud patrón (intervalo de confianza entre 27 y 89 mm) y la del otro conjunto de platos entre 88 y 116 mm de longitud patrón (intervalo de confianza entre 71 y 138 mm). La prueba t-Student confirmó esta diferencia (prueba-F con $p = 0.29$; prueba t-Student con $p = 4.2$ E-08).

DISCUSIÓN

En el Lago de Pátzcuaro habitan 10 especies nativas (Figura 7), cinco de la familia Goodeidae: *Alloophorus robustus*, *Allotoca diazi*, *Allotoca dugesi*, *Goodea luitpoldi* y *Skiffia lermae*; cuatro de la Atherinopsidae: *Chirostoma attenuatum*, *C. estor*, *C. grandoculae* y *C. patzcuaro*; y una de la Cyprinidae: *Algansea lacustris* (De Buen, 1944; Espinosa Pérez *et al.*, 1993). Los peces más apreciados actualmente en la región son los aterinópsidos, también conocidos como pescados blancos y charales, y los ciprínidos o acúmaras, los que constituyen un importante recurso económico principalmente por la demanda que hacen de ellos los turistas (e.g. De Buen, 1944; Moya, 1970); actualmente se considera extintos a los goodeidos *Allotoca dugesi* y *Skiffia lermae* (e.g. Berlanga Robles *et al.*, 1997).

La Relación de Michoacán (Alcalá, 1988), fuente etnohistórica básica para esta región, menciona cinco tipos de peces en lengua tarasca o purépecha: **huacumaran**, **hurapeti**, **cuerepun**,

Elemento óseo	Plato 1178		Plato 1185	
Neurocráneo (basioccipital)	6		9	
Premaxilares	3 d	1 i	5 d	6 i
Maxilares	2 d	2 i	5 d	2 i
Dentarios	-	-	7 d	5 i
Cuadrados	3 d	3 i	6 d	7 i
Hiomandibulares	3 d	5 i	5 d	3 i
Epihiales	-	1 i	6 d	4 i
Ceratohiales	2 d	3 i	6 d	7 i
Urohiales	5		4	
Placas faríngeas superiores	1 d	1 i	7 d	7 i
Placas faríngeas inferiores	4 d	2 i	8 d	9 i
Preopérculos	1 d	3 i	7 d	5 i
Opérculos	6 d	3 i	6 d	7 i
Subopérculos	-	-	2 d	1 i
Postemporales	1 d	2 i	4 d	6 i
Supracleitros	1 d	1 i	2 d	-
Cleitros	5 d	4 i	5 d	3 i
Coracoides	-	1 i	4 d	3 i
Escápulas	-	-	4 d	3 i
Basipterigios	1 d	2 i	8 d	8 i
Radios de las aletas	numerosos		numerosos	
Costillas	numerosas		numerosas	
Primera vértebra precaudal	7		9	
Vértebras precaudales (excepto la primera)	86		116	
Vértebras caudales (excepto la placa hipúrica)	42		159	
Placa hipúrica	3		9	
Escamas	numerosas		numerosas	
Gastrolito (contenido estomacal)	presentes		presentes	
Número mínimo de individuos	7		9	

TABLA 1

Huesos identificados del tiro *Goodea luitpoldi* (d = derecho, i = izquierdo).

thiron y **charoe**; los primeros cuatro términos se asocian a las siguientes especies: *Algansea lacustris* (**huacumaran**); *Chirostoma estor* (**hurapeti**); *C. attenuatum, C. patzcuaro* y tallas medianas de *C. estor* (**cuerepun**); y *Allotoca dugesi, Goodea luitpoldi* y *Skiffia lermae* (**thiron**) (León, 1889; Toledo *et al.*, 1980; Velázquez Gallardo, 1988); los nombres tarascos representan a las tres familias de peces presentes en el lago. El nombre **charoe** no ha sido asociado con alguna especie, pero podría referirse a ejemplares y especies pequeñas de la familia Atherinopsidae (*Chirostoma* spp.), conocidos localmente como charales.

La Relación de Michoacán sugiere que se pescaban todas las especies que hay en el lago; así, cuando Cristóbal de Olid llegó en el siglo XVI al reino tarasco, solicitó pescado, entre estos **cuerepu**, **acumarani**, **urapeti** y **thiru** (los nombres cambian en la misma Relación). También era común dar presentes de pescado a los visitantes: la pesca se realizaba con anzuelos y redes y se preparaba asada, cocida o secada al sol (Alcalá, 1988). Por todo lo anterior, resulta llamativo que ni los charales ni los pescados blancos estén representados en el material arqueológico recuperado en la tumba de Urichu.

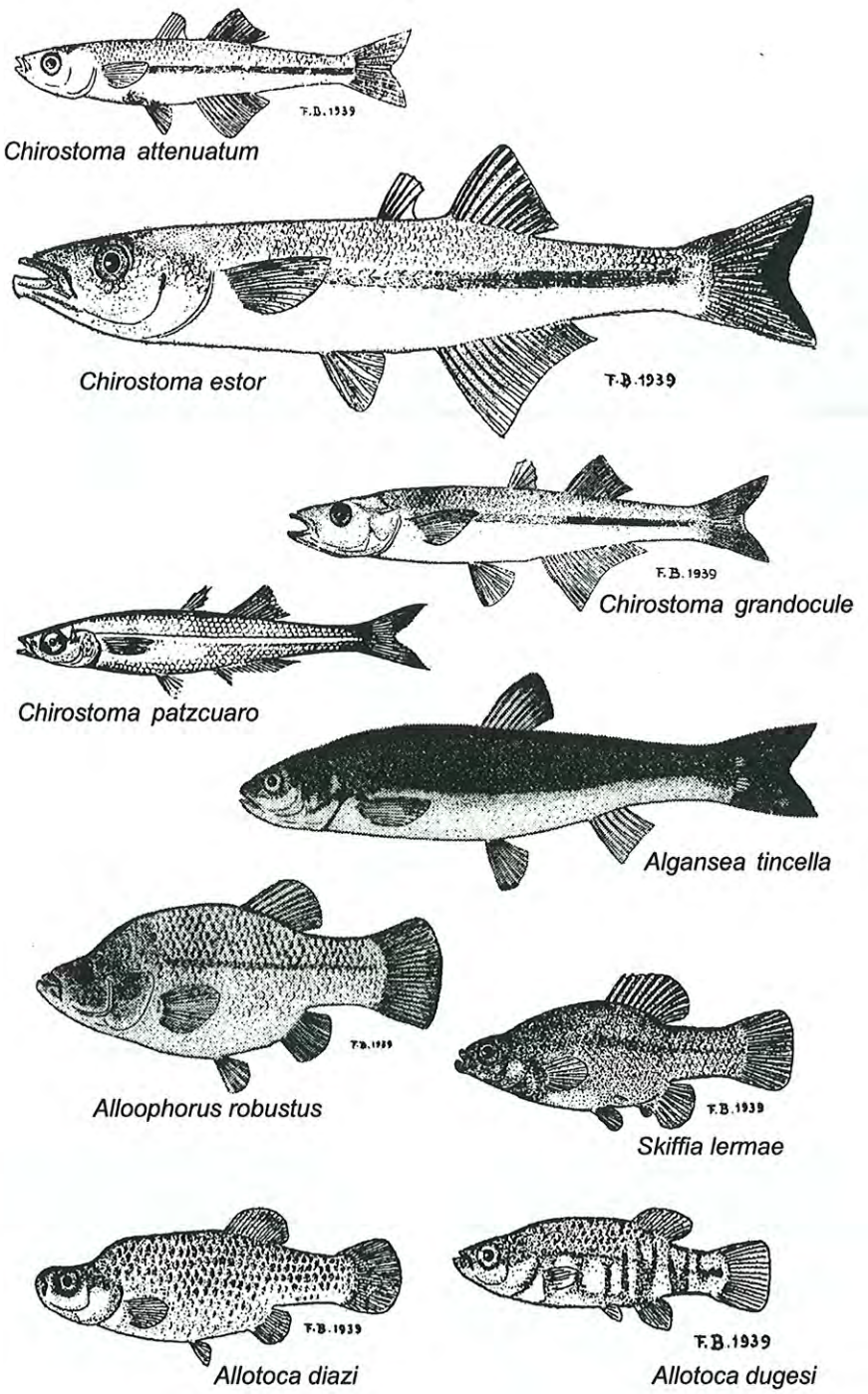


FIGURA 7

Especies nativas de peces que habitan el Lago de Pátzcuaro junto con *Goodea luipoldi*. Las ilustraciones proceden de las obras de De Buen (1940, 1941a, 1941b) y Meek (1904: *Chirostoma patzcuaro*).

Anchura de la primera vértebra precaudal (mm)	Longitud patrón estimada (mm)	Intervalo de confianza para la longitud total estimada (al 95 %) Mínimo (mm)	Máximo (mm)
	Plato 1178		
0.49180	53.16483	27.99776	78.33191
0.51639	54.32580	29.57424	79.07736
0.52868	54.90604	30.35948	79.45261
0.57786	57.22797	33.48275	80.97321
0.77458	66.51570	45.61330	87.41811
0.78688	67.09642	46.34900	87.84384
0.81147	68.25738	47.81056	88.70422
	Plato 1185		
1.25	88.96167	71.23483	106.68851
1.3125	91.91247	74.09448	109.73047
1.46875	99.28949	80.70803	117.87096
1.5	100.7649	81.94459	119.58521
1.5	100.7649	81.94459	119.58521
1.5625	103.71571	84.33928	123.09213
1.6875	109.61732	88.84641	130.38823
1.6875	109.61732	88.84641	130.38823
1.8125	115.51894	93.03746	138.00042

TABLA 2
Medidas y tallas estimadas para los tiros del sitio Urichu, Michoacán, México.

Los aterinópsidos, además del uso como alimento, tenían una relevancia cultural particular, ya que la Relación menciona que al morir el cazonzi o rey tarasco le ponían al cuello unos huesos de pescado blanco, muy apreciados entre ellos (Alcalá, 1988). Entre los pueblos de la cuenca de México, pertenecientes al antiguo imperio mexica, también tuvieron una alta estima y las fuentes documentales posteriores a la conquista frecuentemente se refieren a ellos como manjares para paladares delicados (Hernández, 1959; Sahagún, 1992).

La diferencia temporal entre los conjuntos de peces ofrendados (plato 1178: 405 a 555 dC; platos 1185, 1187 y 1189: 800 a 1000 dC), el que en ambos casos se utilizara la misma especie, que el tamaño en cada caso sea similar así como la forma de usarlos, sugiere una tradición en el uso de los peces con un mínimo de 400 años de duración. La única diferencia observada se refiere al tamaño entre los conjuntos, puesto que los peces más antiguos son los más pequeños. Esta diferencia podría estar relacionada con las dimensiones de los platos, ya que los peces más pequeños provienen del plato más pequeño (1178), y los peces de mayor talla provienen del conjunto de tres platos de mayores dimensiones (1185, 1187 y 1189). Así, a pesar de la mezcla entre estos últimos recipientes, la talla para estos peces fue similar.

Es notable la diferencia de tallas en los peces entre los platos y el tamaño más o menos homogéneo de los peces usados en cada uno; esto sugiere una selección por parte de los oferentes. El grupo con los peces de mayor talla, asimismo, está muy cerca de la talla máxima conocida para la especie (De Buen, 1946: 146 mm de longitud, probablemente sea la longitud total; Rosas Moreno, 1976: 130-150 mm, probablemente también se refiera a la longitud total) y de hecho, son mayores a la talla que comúnmente se pesca (Guzmán, 1994: 80-88 mm de longitud patrón).

A través de los restos recuperados no fue posible determinar la forma de preparación del pescado (asado, cocido, secado o ninguna). Una forma actual de preparación del tiro practicada en el poblado de Ucasanástacua, ubicado en la orilla este del lago, consiste en eviscerar el pescado utilizando los dedos de las manos y posteriormente dejarlo secando al sol; una vez eviscerado y seco, se puede consumir completo debido a que las escamas y huesos son suaves y fáciles de masticar.

Los restos recuperados corresponden a ejemplares completos y no eviscerados, como lo indica la presencia de gastrolitos. Hay dos explicaciones para esto: una, que al cerrar la tumba los peces se hubiesen colocado sin ninguna preparación, es decir, recién capturados; la segunda, que se colocasen secos. La relación geográfica de 1579 menciona que en el Lago de Cuitzeo, el "charrao" (tal vez equivalente del charoe), pescado del tamaño del dedo meñique de la mano e identificado por Acuña como un charal (*Chirostoma* sp.), "se cura al sol, sin echarle sal ni sacarle tripas; mídese por fanegas, por ser tan chico" (Acuña, 1987); no se tienen referencias históricas de ese tipo de conservación para el tiro.

Por la naturaleza del contexto en que fueron encontrados, es posible que los peces depositados correspondan a una ofrenda alimentaria, pero igualmente plausible, debido al número bajo de peces usados, es que dicha ofrenda tenga un valor simbólico, siendo entonces los peces del lago acompañantes del personaje fallecido, a la manera de la ofrenda de huesos de pescado blanco colocados al cazonzi (Alcalá, 1988). El estudio de otras ofrendas tal vez pueda aclarar estos puntos.

Debido a que *Goodea luitpoldi* no es una especie de importancia comercial a gran escala, existe poca o nula información sobre su biología, la estructura de su población y los factores que la moldean. Como los otros goodeidos de Pátzcuaro, es posible hallarla en todo el lago asociada a lugares fangosos, someros y con abundante vegetación sumergida (De Buen, 1944; Solórzano Preciado, 1955; Rosas Moreno, 1976). *Goodea luitpoli* es una especie ficófaga (Rosas Moreno, 1976) fácilmente capturada en redes, ya sean agalleras (cherémicuas o cherémecuas), chinchorros o de mariposa (guaromútacua) (De Buen, 1944; Solórzano Preciado, 1955; Berlanga Robles *et al.*, 1997).

Durante el curso de las excavaciones en el área se ha encontrado que el nivel del Lago de Pátzcuaro ha fluctuado con el tiempo, por lo que también es necesario explorar en un futuro si el uso diferencial del tiro en el Clásico-Epiclásico y del pescado blanco en el Posclásico pudiera estar relacionado con esas fluctuaciones (Pollard, en prep.).

El presente hallazgo es la primera evidencia del uso de otra especie de pez con fines diferentes a los alimentarios, por la élite de las comunidades autónomas del Clásico y Epiclásico. Con la emergencia del estado tarasco en el Posclásico, aparentemente se habría dado preferencia al pescado blanco sobre el tiro, como lo sugieren *La Relación de Michoacán* (Alcalá, 1988) y los restos encontrados en la capital tarasca, Tzintzuntzan (Martín del Campo, 1946).

CONCLUSIONES

La presencia de peces en una tumba del Clásico-Epiclásico de la región del Lago de Pátzcuaro, en el oeste de México, es la primera evidencia del uso del tiro (*Goodea luitpoldi*) en la región y es constituye el primer registro de una ofrenda de este tipo para esa área.

Los peces estaban colocados en dos conjuntos de platos trípodes, en cada caso se utilizó la misma especie, el tamaño y forma de presentación (completos y sin eviscerar) es similar: todo esto sugiere una selección de los mismos. La talla de los peces difiere entre ambos platos, aunque se desconoce la razón; los peces más pequeños y en menor número corresponden al periodo más antiguo, el Clásico.

Los peces pueden corresponder a una ofrenda alimentaria; sin embargo, el bajo número de los mismos implica considerar como posibilidad el que los peces ofrendados tuviesen una función simbólica (e. g. acompañar a los muertos).

La evidencia disponible para el área sugiere explorar la posibilidad de que la especie de pez (*Goodea luitpoldi*) ofrendada durante el Clásico-Epiclásico y con una tradición de al menos 400 años, fuera reemplazada en el Posclásico por el pescado blanco (*Chirostoma* spp.), reemplazo que podría estar ligado a su vez con el cambio de estructura política de la región.

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Archaeozoology in Germany. Its Course of Development

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ABSTRACT: Although archaeozoology in Germany has a long tradition and has been broadly embedded in the biological sciences, it is currently undergoing a difficult period of mixed support. This paper describes the varied course of development of archaeozoology from the 1940's onward. In this period, archaezoology grew from a phase of initial acceptance in universities, museums and monument protection departments to significant growth of the discipline and wide acceptance in archaeology in the 1970's and 1980's. Particular emphasis is placed on the question of whether, indeed, the politically caused separation of East and West had a major influence on archaeozoological research in the two Germanys. Following this, the development of archaeozoology after reunification, the major changes it brought to the field, and the reasons for those changes are considered.

KEY WORDS: ARCHAEOZOOLOGY, GERMANY, UNIVERSITIES, MONUMENT PROTECTION DEPARTMENTS, MUSEUMS, DEVELOPMENT IN EAST AND WEST GERMANY, REUNIFICATION, FUTURE PROSPECTS

RESUMEN: Aunque la Arqueozoología en Alemania tiene una larga tradición y ha estado intimamente conectada con las ciencias biológicas se encuentra en estos momentos en un periodo difícil con apoyos cambiantes. Este trabajo describe el variado acontecer de la Arqueozoología alemana desde los años 40. En este periodo la Arqueozoología pasó de una fase de aceptación inicial en Universidades, Museos y Departamentos de conservación del Patrimonio a una expansión de la disciplina dentro del campo de la Arqueología durante las décadas de los 70 y 80. Se ha hecho especial énfasis sobre si la separación política entre la Alemania del este y la del oeste tuvo una influencia diferencial sobre la investigación arqueozoológica. Como resultado de ésto el trabajo concluye considerando los cambios operados en el desarrollo de la Arqueozoología trás la reunificación y las razones que subyacen a dichos cambios.

PALABRAS CLAVE: ARQUEOZOOLOGÍA, ALEMANIA, UNIVERSIDADES, PATRIMONIO, MUSEOS, DESARROLLO EN LA ALEMANIA ORIENTAL Y OCCIDENTAL, REUNIFICACIÓN, FUTUROS PROSPECTOS

INTRODUCTION

The beginnings of archaeozoological research in Germany can be traced back to the 19th century. At that time individual scientists involved in various zoological disciplines began independent studies on animal skeletal remains found in archaeological contexts. These initial studies gradually led to a broad interest in prehistoric consumption residues. Yet, decades were to elapse before these sporadic undertakings were joined to form an interdisciplinary direction in research. Only after

World War II did the subject of archaeozoology as practised and taught today develop its own specific profile within the canon of humanities and sciences at German universities or at the departments of monument protection (*Denkmalpflege*). In view of this background, we, the authors, have chosen the end of the 1940s as a starting point for our description of German archaeozoology[1]. The years following the forties were marked politically by the division of the country in 1949, with the emergence of the *Bundesrepublik Deutschland* (Federal Republic of Germany) and the *Deutsche Demokratische Republik* (German Democratic Republic) and the development of different sociopolitical systems. The consequence was that during the period of the Cold War, and until the fall of the Berlin Wall in 1989, the discipline of archaeozoology followed an independent and separate course in the two Germanys. Reunification in 1990 brought about a restructuring of scientific research in the nine new German states of former East Germany and Berlin, a reorganisation which has had its effect on archaeozoological research as well. Therefore, the authors consider it recommendable to describe the development of archaeozoology separately for the area of former West Germany (C. Becker) and East Germany (N. Benecke) and conclude with a joint evaluation, summarising the situation before and after reunification[2].

ARCHAEOZOOLOGY IN WEST GERMANY

Although the country was suffering the aftermath of World War II and in a politically difficult and frugal state, institutions for research in the biological sciences were set up or organised anew in many parts of Germany through the initiative of a few individuals. These ventures set the course for archaeozoology, too. One such institution existed in the city of Kiel (Figure 1: 1), where WOLF HERRE arrived after the turmoils of the War. A student of biology and before the War assistant at the *Institut für Haustierkunde* (Institute for the Study of Domestic Animals) in Halle, W. Herre became provisional director of the Institute and Museum of Zoology in Kiel, which had been largely destroyed during the War. In 1945, with great commitment and vigorous help from students and volunteers, he initiated the rebuilding of the Institute. Shortly thereafter classes and instruction were held again. Two years later, this achievement as well as W. Herre's further efforts led to the establishment of the new *Institut für Haustierkunde* (Institute for the Study of Domestic Animals) at the Christian-Albrechts-University in Kiel (CAU Kiel). There, W. Herre could continue his initial, pre-war studies on domestic animals and their ancestral forms (e.g. Herre, 1949), work which also entailed the analysis of bone material. Together with G. Nobis, who had continued his studies in biology in Kiel immediately after the War, W. Herre built up an osteological comparative collection. The new institute drew the attention of other young scientists, like J. Boessneck (Munich) and H.-R. Stampfli (Bern, Switzerland) who came to Kiel for scientific contact. Courses in archaeozoology did not apply solely to the sites within Germany. In 1953 at the request of Kurt Bittel, a well-known archaeologists from the *Deutsches Archäologisches Institut* (DAI, German Institute of Archaeology), W. Herre travelled to Turkey to inspect the animal remains recovered in excavations at Bogazköy-Hattusa and Fikirtepe. Through anatomical and morphological comparisons, he sought to gain insight into the initial processes of domestication and the faunal history of the region. During the 1950s and 60s research in the *Institut für Haustierkunde* focussed mainly on the history of evolution of the domestic dogs, South American camelides and feral ovicaprines on the Galapagos Islands (Herre & Röhrs, 1973). In this association, attention was already directed towards questions concerning biometry, taxonomy and nomenclature of wild and domestic species (Bohlken, 1958, 1961). Archaeozoological activities in the Institute increased in 1963, when excavations were taken up again at the Viking settlement of Haithabu near Schleswig, at that time among the most extensive

[1] Our sincere thanks are extended to many colleagues, who have assisted us with valuable information, some of very personal nature. Without their contributions this article could not have been realised. We are also indebted to Emily Schalk who kindly translated the text into English.

[2] Due to the brevity of space at disposal for this article, reference can be made only to those colleagues who have been engaged with archaeozoological research over a longer period of time. Regrettably, persons who have carried out short-term archaeozoological investigations in the form of free-lance or contract-work, cannot be accredited here. Limitation has also been necessary for the accompanying list of publications.

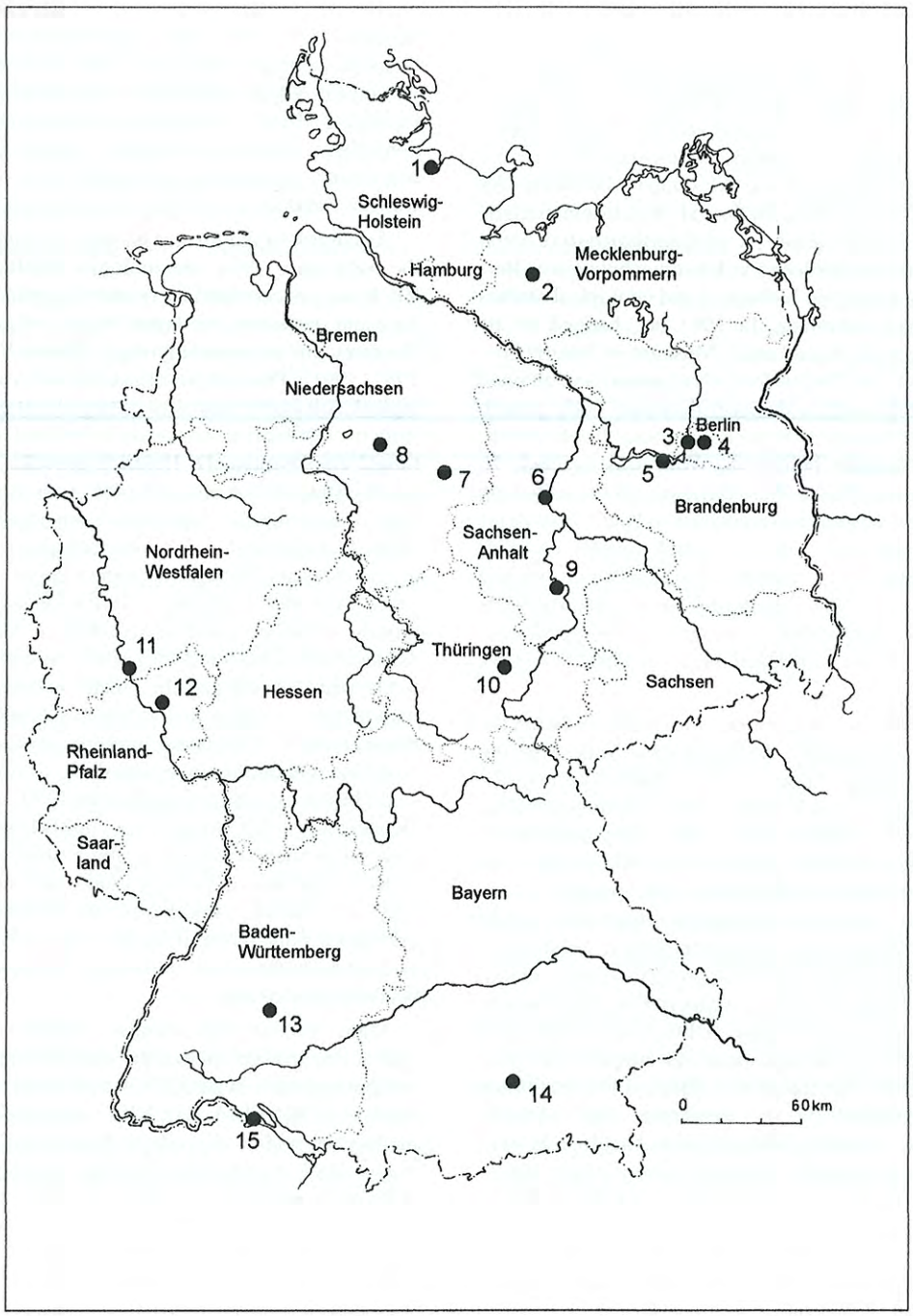


FIGURE 1

Map of Germany with the location of the German states and archaeozoological institutions, mentioned in the text. 1 Kiel, Schleswig; 2 Schwerin, 3 Berlin (Free University), 4 Berlin (DAI), 5 Wünsdorf near Potsdam, 6 Wolmirstedt/Magdeburg, 7 Braunschweig, 8 Hannover, 9 Halle, 10 Weimar, 11 Bonn, 12 Neuwied, 13 Tübingen, 14 München, 15 Konstanz (Drawing by W. Rust/DAI).

archaeological field projects pertaining to early medieval history in the whole of Europe.

Two years prior to the renewed excavations in Haithabu, HANS REICHSTEIN had entered the *Institut für Haustierkunde* in Kiel. Upon completing studies in biology, chemistry, physics and phytopathology at the Alexander von Humboldt University in East Berlin, H. Reichstein became assistant in the *Biologische Zentralanstalt* (Central Institute for Biology) in Kleinmachnow near Berlin, focussing on biological and ecological studies of small mammals. In 1961 he changed to the *Museum für Naturkunde* (Museum of Natural History) in East Berlin for a short period and attained the Ph.D. with a doctoral thesis on body growth and reproduction of the field mouse. In May 1961, three months before the Wall was erected, H. Reichstein fled to West Germany. In the following October he assumed a position in Kiel's *Institut für Haustierkunde* with a research project on skull morphology of rodents. H. Reichstein became curator in 1964 and during the next thirty years exerted great influence on archaeozoological research, at first alone and later together with Dirk Heinrich.

In 1967 an agreement was made between the CAU Kiel and the Archaeological State Museum in Schleswig (Figure 1: 1) to establish an interdisciplinary research centre, the *Archäologisch-Zoologische Arbeitsgruppe* (AZA, Archaeological-Zoological Study Group) within the premises of Schloß Gottorf in Schleswig. The spacious set-up, a large collection of mammals, later also of bird and fish skeletons, together with a good infrastructure ensured the joint project's success (Figure 2). Today the AZA is supported by the *Deutsche Forschungsgemeinschaft* (DFG, German Research Foundation) through financial support and part-time staff. The integrative effect of this institution is illustrated by the numerous and extensive reports on faunal analyses in archaeological journals, for example in *Berichte über die Ausgrabungen in Haithabu (*Schietzel, 1969-1998), or in *Ausgrabungen in Schleswig, Berichte und Studien (*Vogel, 1983-1992). In the AZA, H. Reichstein and D. Heinrich instructed students, acted as advisors for diploma and doctoral theses, and promoted research and publication of large complexes of bone material from prehistoric and early historical periods in northern Germany (for literature cf. Heinrich *et al.*, 1991). Here, particular note should be given to the encompassing works of H. Reichstein on the Viking settlement at Haithabu and the Germanic village of Feddersen-Wierde (Reichstein, 1991a, 1991b). In October 1994 H. Reichstein retired, whereupon, unfortunately, his position was not filled by a successor, but terminated.

As curator of the *Institut für Haustierkunde* and the AZA since 1974, the zoologist DIRK HEINRICH has concentrated on research in palaeo-ecology and -economy, the faunal history of northern Germany and palaeoichthyology (Heinrich, 1985, 1987, 1991). Through his efforts the AZA's osteological fish collection was enlarged extensively. With his habilitation[3] in summer 1996 and his continued employment, D. Heinrich provides fundamental support for archaeozoology in Germany. This despite the fact that aside from various students, D. Heinrich has only one technical assistant at his disposal. Through on-going intense co-operative work with a number of archaeological institutions, archaeozoological research in Kiel and Schleswig has explored all prehistoric periods in Schleswig-Holstein and the greater northern German region, as well as historic times (cf. project on Romanisation). This broad interdisciplinary coverage was conducive in establishing a course of study based on similar aspects at the CAU in Kiel. Hence, students of archaeology could choose zoology or archaeozoology as a minor subject. Conversely, students of biology could take archaeology as a minor subject and, for instance, use prehistoric bone material for their thesis. Why this arrangement deserves particular mention, will become obvious later on.

Many students and scientists have been engaged in research on prehistoric slaughter and consumption residue in the AZA in Schleswig. Among them is CORNELIA BECKER, who upon completing her studies in zoology, botany and anthropology, took coursework in archaeozoology under H. Reichstein. In addition, through research for her doctoral thesis (1975–1977) on domestic and wild pigs from the Viking settlement of Haithabu, she gained valuable experience from an archaeological perspective (Becker, 1980). This work was followed in 1978 by a research project, financed by the Canton Bern/Switzerland, on animal remains from

[3] (a second doctoral degree which enables a German scientist to achieve a professor-ship).



FIGURE 2

The Laboratory of the *Archäologisch-Zoologische Arbeitsgruppe* in Schleswig in 1980. Photo: Courtesy of the Archaeological State Museum, Schleswig.

the Swiss Neolithic lake-site of Twann. As guest colleague, C. Becker analysed this material in the well-equipped facilities of the AZA. Only through this agency and collaborative work with FRIEDERIKE JOHANNSON (now in Göteborg, Sweden) could the analysis of c. 240,000 finds have been accomplished within a 2 1/2 year time period, particularly since all documentation was hand-written and the calculation of data was also done by hand (Becker, 1981; Becker & Johansson, 1981). For her next major project, at Kastanas, a Bronze- and Iron Age tell-site in Greece (Becker, 1986), the handling of large amounts of data lead to a highly codified and systematic computerized recording system[4]. During winter-semester 1983/84 C. Becker assumed a position in the scientific staff of the *Institut für Prähistorische Archäologie* (Institute of Prehistoric Archaeology, formerly *Seminar für Ur- und Frühgeschichte*) of the *Freie Universität* (Free University) in West Berlin (Figure 1: 3). The creation of this position was achieved through the initiative of the Institute's director, Professor Bernhard Hänsel, who at that time already considered the application of archaeozoological analysis in archaeological research as indispensable. Despite initial hurtles, C. Becker built up her work facilities in the relatively small and strictly archaeologically oriented Institute. Within this sphere she has analysed animal bone material from a total of 13 projects in Germany, south-eastern Europe and the Near East. These include not only the Institute's own projects in Greece (Ajios Mamas), Serbia

[4] In 1981 Michael Gebühr, an archaeologist in Schleswig, was kind enough to develop a specific program which was particularly well-suited to the Kastanas data.

(Feudvar), Croatia (Monkodonja) and Germany (Peissen, Boyneburg), but also projects in Jordan (Basta), Syria (Raqqa, Tell Bderi, Tell Schech Hamad), Greece (Akrotiri/Thera, Platia Magoula Zarkou) and Romania (Poiana-Ampoiului, Livezile, Sarata-Monteoru, Naeni-Zanoaga) conducted by other archaeological institutions associated with the Berlin Institute (Becker, 1994, 1997, 1998a, 1999a, 1999b, 2001). In addition, scholastic coursework and instruction are a substantial part of her work. Daily encounters with archaeologists and participation in many excavations have developed a strong leaning towards prehistory (Becker, 1993, 1998b, 1998c, 2000), and joint projects have brought about a close association of archaeozoology with anthropology and botany. In view of the broad scope of material and related teaching duties associated with this position, and the potential therein, it is inconceivable that the Free University Berlin has, as of the year 2000, reclassified the position of an archaeozoologist as non-essential and may well terminate it without replacement.

During the post-war era a further 'pillar of archaeozoology' was built in Munich, southern Germany, by JOACHIM BOESSNECK (Figure 1: 14). Born in Saxony, J. Boessneck studied veterinary sciences and zoology in Kiel and Munich after World War II and completed his Ph.D. in 1951 with a dissertation on "*Haustiere in Altägypten*" (Domestic Animals in Ancient Egypt). J. Boessneck finished the habilitation in 1957 with his opus "*Zur Entwicklung vor- und frühgeschichtlicher Haus- und Wildtiere Bayerns im Rahmen der gleichzeitigen Tierwelt Mitteleuropas*" (The development of pre- and protohistoric domestic and wild animals within the context of coeval fauna in Central Europe). 1953–1965 he was on the staff of the *Institut für Tieranatomie* (Institute of Animal Anatomy) at the Ludwig-Maximilian-University in Munich. Aside from conducting coursework and instruction for students of veterinary medicine, J. Boessneck took great interest in the investigation of skeletal remains of prehistoric animals, a topic that through its cultural and historical context was fascinating to him. In 1965 he founded the *Institut für Palaeoanatomie, Domestikationsforschung und Geschichte der Tiermedizin* (Institute for Palaeoanatomy, Research on Domestication and Veterinary History). This institution represented a unique combination of subjects, a situation that would exert great influence on the direction of research in Munich. Initially, J. Boessneck concentrated research on animal bone remains from the Celtic oppidum Manching, which became the subject of a number of doctoral theses. In the following decades a total of forty large faunal complexes, most recovered from the area of southern Germany, were also investigated as part of such coursework (for example, material from the renowned Celtic site of Heuneburg on the upper Danube River). Moreover, J. Boessneck expanded the sphere of research to the Mediterranean area, including Greece, the Iberian Peninsula (cf. the series of publications "*Studien über frühe Tierknochenfunde von der Iberischen Halbinsel*", in collaboration with the DAI in Madrid, Spain), the Near East and Egypt (for an overview of the resultant literature see publications on the occasion of the Institute's 20th and 25th anniversary: von den Driesch & Schäffer, 1985; Boessneck, 1990). In addition, one of the most comprehensive collections in Europe of skeletal material from mammals, birds and fish (a total of c. 18,500 vertebrates encompassing more than 2,800 species, including c. 3,100 fish skeletons from over 750 species) was built up[5]. Besides numerous dissertations, monographs and papers, various anatomical descriptive works concerning the distinction between closely related species, starting with sheep and goat (Boessneck *et al.*, 1964), appeared. This direction in research has continued to the present, as exemplified by atlases on the distinction between one-humped and Bactrian camels (Steiger, 1990), between African and Asian bovids (Peters *et al.*, 1997; Götze, 1998) and species of pelicans (Lorch, 1992). A similar osteological treatise on fish species from the Nile is in preparation. In the Munich Institute the instruction of students of veterinary medicine in comparative anatomy and the cultural history of domestic animals took priority. Only upon completion of the Ph.D. degree they commenced with their occupation as veterinarian. Subsequently, some of them became archaeozoologists, as for instance H.-P. Uerpmann (Tübingen) and M. Kokabi (Konstanz), while others devoted their attention to the study of the history of veterinary medicine (J. Schäffer, Hannover).

[5] The scientific importance of this collection led to the establishment of the *Staatssammlung für Anthropologie und Paläonatomie des Bayerischen Staates* in the year 2000.

Together with J. Boessneck the personage of ANGELA VON DEN DRIESCH, who joined the Munich group in 1965, must be named. She too had previously studied veterinary medicine but soon found great interest in analysing prehistoric animal bones, particularly material from fish and birds. With her habilitation she continued a series of works on the development of the fauna in Spain during the Copper- and Bronze Age (von den Driesch, 1972). Methodologically seminal are her contributions on traces of butchering on bones (von den Driesch & Boessneck, 1975) and techniques in measurement (von den Driesch, 1976). Together with their students, J. Boessneck and A. von den Driesch carried out archaeozoological research in Europe, Africa (Egypt, Sudan, Tunisia and South Africa), the Near East (Turkey, Syria, Israel, Iraq, Iran, Jordan, the United Arab Emirates and Yemen) and Central Asia (Nepal and Mongolia), covering a time span from the Late Pleistocene to the Medieval period (cf. bibliography in ArchaeoZoologica IV/1, 1991, 131–141 and in the "*Festschrift für Angela von den Driesch*": Becker *et al.*, 1999: 25–36). The history of veterinary medicine profited under the new impulses as well (von den Driesch, 1989). Texts dating from the past centuries in Europe, the Orient and Asia concerning veterinary treatment were translated, unravelled and interpreted. In 1993 A. von den Driesch succeeded J. Boessneck (who died in 1991) and directed the Institute until her retirement in autumn 1999.

A few months after A. von den Driesch's retirement JORIS PETERS was named as her successor, and at that time the Institute's name was altered to "*Institut für Paläoanatomie und Geschichte der Tiermedizin*". J. Peters had studied in Gent/Belgium, where he attained his Ph.D. with the doctoral thesis "*Beitrag zur Archäozoologie von Ägypten und Sudan*". In 1987 he became scientific assistant in the Munich Institute. His particular specialisation fostered more in depth research on the African continent (e.g. Peters, 1995). J. Peters' habilitation on animal husbandry and breeding in Roman times represents a successful synthesis of archaeozoological, written and figural sources (Peters, 1998).

After four decades of existence an institution expectedly changes in appearance. In the Munich Institute time-honoured and -tested methods of work have always been employed, yet recent times have seen new approaches to research, ones that are oriented methodologically towards new trends within archaeology. In the future the Munich Institute intends to focus on questions about early domestication processes in the Fertile Crescent (Peters *et al.*, 1999). Additionally, particular zoomorphological and phylogenetic investigations on ungulates, climatic and environmental research during the late Quarternary in North Africa, as well as analyses of the fauna of Central Asia are planned. The investigation of the history of veterinary medicine will continue, and be further intensified through the engagement of specially trained scientists. Furthermore, collaborative work with anthropologists such as Prof. Dr. Gisela Grupe (Munich) has opened new areas of research. Among these are the use of histological methods in determining species, age and diagnosis of diseases as well as chemo-analytical methods using trace element- and isotopic measurements for determining the geographical origin of domestic animals and reconstructing landscapes and environments. Additional colleagues in the Munich Institute, alongside J. Peters and A. von den Driesch (who is still involved in current projects), are HENRIETTE MANHARDT (archaeozoology, cf. Manhardt, 1998) and VERONIKA WEIDENHÖFER (history of veterinary medicine). Two scientists on work contracts are also engaged in the Institute's own projects as well as the analysis of animal skeletal remains submitted by the DAI, various state offices for *Denkmalpflege*, and the archaeological departments of universities and museums. The continuation of the Institute in Munich has provided an important basis for the future of archaeozoology in Germany. Contact between archaeology and the biological sciences will continue, even though – contrary to Kiel and Tübingen – it is primarily students of natural sciences and only a few in prehistoric archaeology who are being schooled in osteology. In addition, at the Ludwig-Maximilian-University in Munich those students enrolled in archaeology can select the subject of archaeozoology for final examination, an option that has increased in popularity in recent times.

Tübingen, another pillar of archaeozoology in Germany (Figure 1: 13), is associated with the name HANS-PETER UERPMANN. His study of veterinary medicine in Munich entailed instruction in osteology under J. Boessneck and the completion of his Ph.D. (Uerpmann, 1971). Thereafter H.-P. Uerpmann studied prehistoric archaeology in Tübingen and Freiburg, concluding with a second Ph.D. (Uerpmann, 1979). From 1972 to 1988 he worked on the "*Tübinger Atlas des Vorderen*

Orients, in which, most importantly, geographical, historical and cultural distribution maps of the Near East were made. These projects resulted in several comprehensive zoo-geographical, ecological and archaeozoological oriented compilations of data covering the eastern Mediterranean and regions of bordering south-western Asia, focussing in particular on ungulates (Uerpmann, 1987), equids (Meadow & Uerpmann, 1986, 1991) and the environmental history of the Near East in general (Frey & Uerpmann, 1981). During the winter semester 1989/90 H.-P. Uerpmann received a chair as professor of archaeobiology at the *Institut für Ur- und Frühgeschichte und Archäologie des Mittelalters* (Institute of Prehistory and Early History and Medieval Archaeology) at the Eberhard-Karls-University in Tübingen. The laboratory and facilities for archaeozoology used in the SFB 19 were expanded, with emphasis on research and excavations in the Near East, especially Turkey (Troy) and the Arabian peninsula (United Arab Emirates). Today, students in all phases of study are engaged in laboratory work, co-ordinated and guided solely by H.-P. Uerpmann and his wife MARGARETHE UERPMANN, who as an archaeologist has also been engaged in the field of archaeozoology and has assisted in various projects and publications (Uerpmann, 1993; van Neer & Uerpmann, 1998). From 1994 to 2000 H.-P. Uerpmann participated in the SFB 275, funded by the *Deutsche Forschungsgemeinschaft* (DFG) on "*Klimagesteuerte Prozesse in känozooischen Geo-Ökosystemen*" (climate-oriented processes in cenozoic geo- and ecological systems). Research into climatic determinates of the size of reindeer and wild horses and on climatic indicators in the chemistry of animal bones have had predominance.

The integration of archaeozoology into the program of study in Tübingen has taken a different course than in Kiel. In Tübingen archaeozoology is incorporated into archaeological coursework from the very beginning; lectures and seminars in archaeozoology constitute an integral and basic part of the study of prehistory, and are not separated as minor subjects. In advanced stages of study more intensified work in the sphere of archaeozology is possible, such as participation in excavations and fieldwork-analyses of bone material. Therewith the study of archaeology gained a great deal from natural sciences. After H.-P. Uerpmann's retirement in 2006 the future of archaeozoology in Tübingen will depend on a competent successor. According to the plans of the School of Geosciences in Tübingen University, H.-P. Uerpmann's position should be occupied by an archaeobiologist, who is proficient in archaeozoology and/or archaeobotany.

The emergence and institutionalisation of archaeozoology in the state of Baden-Württemberg took a different path. There, osteology was integrated with the *Landesdenkmalamt Baden-Württemberg* for more than 20 years (Figure 1: 15). After his study of veterinary medicine and osteological training in Munich, MUSTEFA KOKABI was consultant for osteology and archaeozoology from 1981 to 1999. He was responsible for the scientific investigation and publication of animal remains retrieved from excavations of the *Landesdenkmalamt*, and numerous articles and works appeared under his stewardship. Particular emphasis was placed on bone material from the Neolithic period (e.g. the Michelsberg culture), the pre-Roman Iron Age, and the Roman period (Kokabi, 1982, 1988a, 1988b, 1990). Moreover, M. Kokabi organised an osteological laboratory with a bone collection for comparative studies in Konstanz as well as an osteological archive in Rottenberg am Neckar, in which excavated and analysed skeletal remains of animals and humans could be stored. Since 1994 M. Kokabi has been an honorary professor in the *Institut für Vor- und Frühgeschichte* at Bonn University. In 1993 he organised a large meeting of osteologists and anthropologists (Figure 3), and one year later the 7th International Congress of the International Council of Archaeozoology (ICAZ), both in Konstanz.

In the laboratories of the *Landesdenkmalamt Baden-Württemberg* histological analysis of bone material is carried out, along with more conventional osteological examination. This line of research has been emphasised by ELISABETH STEPHAN, who joined the laboratories in November 2000, after M. Kokabi's retirement due to illness. E. Stephan's initial field of study was in bio-engineering, followed by a further study in Tübingen in prehistory and early history with particular emphasis on archaeozoology. She completed her second university study program with a Ph.D. degree in 1998 and a doctoral thesis on oxygen isotopes in bones (Stephan, 1999). Her future duties will primarily involve the archaeozoological management and study of bone material recovered from local excavations.

A unique situation has existed for several decades with respect to education in osteology at the



FIGURE 3

Konstanz 1993. Archaeozoologists and anthropologists at the conference (on behalf of the late J. Boessneck). Photo: Courtesy of the *Landesamt* Konstanz.

Technische Universität in Braunschweig (Figure 1: 7). There lectures, seminars and practical courses are offered by the Institute of Zoology within the sphere of anthropology by the anthropologist EBERHARD MAY. E. May himself has dealt with various archaeozoological materials and authored several publications (cf. May, 1964, 1969). One of his areas of interest concerns the calculation of whithers height through statistical analysis of skeletal measurements (May, 1967).

A further example of an highly unusual development in archaeozoology in Germany is presented by the professional career of GÜNTER NOBIS. G. Nobis studied at the CAU Kiel under W. Herre, and attained a Ph.D. in 1948 with a thesis on morphological and physiological development with respect to the emergence of species. In 1949 he became scientific assistant at the *Institut für Haustierkunde* in Kiel. Later he decided to enter the field of public school education, and completed a teachering degree in 1954. At the same time, however, he accepted a teaching contract at the Kiel Institute. Despite his many activities, G. Nobis never lost interest in faunal material. From 1965 to 1968 he wrote his habilitation "*Vom Wildpferd zum Hauspferd*" (Nobis, 1971) and in 1972 he was called as extra-curricular professor to the University in Köln. Thereafter G. Nobis transferred 1977 as curator to the *Zoologisches Forschungsinstitut und Museum Alexander-Koenig* in Bonn (Figure 1: 11), where he was director from 1979–1987. In 1992 he established a research institute for archaeozoology in Pyla, Greece (Nobis, 1992). Through his professional work as an archaeozoologist G. Nobis has been active in many countries, including Jordan, Tunesia, Bulgaria and Greece (Nobis, 1976/77, 1981, 1988, 1998). In 2001 G. Nobis will celebrate his 80th birthday, and the future of archaeozoology in the larger Bonn area stands in question. It is uncertain whether or

not another zoologist will follow in Nobis' footsteps. Still, there is interest in continuing Nobis' position, for a collaborative bond has long existed between the Museum and the *Institut für Paläontologie* in Bonn, the *Institut für Ur-und Frühgeschichte* in Köln, the study group of Prof. G. Bosinski (s. below) in Neuwied and the *Kommission für Allgemeine und Vergleichende Archäologie* (KAVA) in Bonn. Since 1995 the KAVA has conducted a research project on prehistoric cultures in the Maghreb/Morocco, dating to late and middle Palaeolithic periods, with special focus on the environmental development in the Rif Oriental. The abundant faunal remains which were produced are being analysed by RAINER HUTTERER from the Alexander-Koenig Museum/Bonn together with osteologists from Morocco (Hutterer & Mouhcine, 2000).

It should be noted that there are researchers in West Germany who are concerned in particular with zoological complexes from the Palaeolithic and Mesolithic periods (*Forschungsinstitut für Ur- und Frühgeschichte im Bereich Altsteinzeit*, Neuwied; Figure 1: 12). For nearly 15 years MARTIN STREET and other specialists have conducted investigations in the Rheinland (Neuwieder Becken; Street & Baales, 1999). Osteological work in Niedersachsen follows a similar direction, where ULRICH STAESCHE has worked for several years in the *Landesamt für Bodenforschung* in Hannover (Figure 1: 8; Staesche, 1991).

It is likewise necessary to point out that archaeozoologists in West Germany are indebted for valuable, fundamental data to colleagues from the discipline of veterinary medicine, many of whom have analysed little or no prehistoric bone material. This applies for instance to KARL-HEINZ HABERMEHL from the *Veterinär-Medizinisches Institut* of the Justus-Liebig-University in Gießen, who has published two indispensable and much quoted contributions on age determination in wild and domestic animals (Habermehl, 1975, 1985).

ARCHAEOZOOLOGY IN EAST GERMANY

In East Germany, that is the area of the former German Democratic Republic, now the nine new states in Germany, the integration of archaeozoology into research and teaching took a number of varied and different paths, yet many were quite similar to developments in West Germany. This especially applies to the monument protection departments (*Landesdenkmalämter*), the universities and other non-scholastic institutions. The *Landesdenkmalämter* that now maintain or have maintained positions for archaeozoologists over a long period of time are located in Schwerin, which is responsible for the area of Mecklenburg-Vorpommern; in Halle, which covers the area of Sachsen-Anhalt; in Wünsdorf near Potsdam, covering Brandenburg; and in Weimar for Thüringen (Figure 1).

Within the area of *Mecklenburg-Vorpommern,* (Figure 1: 2), numerous investigations on animal remains from archaeological excavations were initially carried out by OTTO GEHL. O. Gehl, educated in geology, was not permanently employed at a museum, but instead accomplished his studies on the basis of work-contracts. Concentrating on material from the Mesolithic, Neolithic and Medieval periods, his most well known publications include investigations of animal remains from the early Mesolithic station at Hohen-Viecheln and the early Medieval settlement of Groß Raden (Gehl, 1961, 1981). In 1980 the Schwerin Museum created a permanent position for an archaeozoologist which was filled by URSULA LEHMKUHL. A student of geology and active for many years in the *Geologisches Landesamt*, U. Lehmkuhl was trained in archaeozoological methods by O. Gehl. In the 1980s and early 1990s she published many studies concerning bone artifacts, as well as faunal remains from settlements and graves of various chronological periods (Lehmkuhl, 1985, 1990). With the restructuring of the Schwerin Museum following reunification, the position of an archaeozoologist was unfortunately cancelled. Today, the *Landesamt* is endeavouring to establish a position for archaeozoological research. Thus, after an interruption of almost ten years, U. Lehmkuhl is once again carrying out research, although now on a contract basis.

The former *Museum für Ur- und Frühgeschichte Potsdam*, today the *Brandenburgisches Landesamt für Denkmalpflege und Archäologisches Landesmuseum* with it's head office in Wünsdorf near Potsdam, made permanent provisions for archaeozoology in 1970 (Figure 1: 5). This position was taken by LOTHAR TEICHERT, who had completed a doctorate in agricultural science and educated oncoming agriculturalists for several years. His interest in the study of animal skeletal remains was awakened by his brother, Manfred Teichert. Since the *Landesamt* did not provide suitable workspace

nor a bone collection for comparative studies, during his term of office Lothar Teichert spent most of his time in the Kühn Museum of the University in Halle where his brother was curator and where he actually resided (s. below). A primary area of L. Teichert's research was the investigation of animal cremations from Neolithic and Bronze Age cemeteries (Teichert, 1975). In addition, he worked on large complexes of material from settlement excavations such as the Mesolithic site at Friesack and the early Medieval settlements at Brandenburg and Wiesenau (Teichert, 1988, 1993). In 1996, upon his retirement, L. Teichert's position in archaeozoology at the *Landesamt* was assumed by SUSANNE HANIK, a biologist specialising in zoology and anthropology (Hanik, 1999).

The beginnings of archaeozoological research in the present *Landesamt für Archäologische Denkmalpflege Sachsen-Anhalt* in Halle (Figure 1: 9), formerly the *Landesmuseum für Vorgeschichte*, are closely associated with the name HANNS-HERMANN MÜLLER. Upon completing his study of biology in Halle (1950–1954), H.-H. Müller commenced scientific activities at the *Landesmuseum*, where his first research was on domestic animals from the *Bandkeramik* culture in central Germany. He completed this work, and published a monograph (Müller, 1964) which today is still one of the standard works on the Neolithic, for which he achieved a Ph.D. degree in 1962. Two years prior to this H.-H. Müller had already moved to East Berlin (s. below). After a break of almost twenty years the *Landesmuseum für Vorgeschichte* was prepared to engage an archaeozoologist once again. Starting in 1981, his position was occupied by HANS-JÜRGEN DÖHLE, who likewise had studied biology and osteology in Halle. Animal remains from excavations in Sachsen-Anhalt formed the primary basis of H.-J. Döhle's research. With his work on animal remains from the *Bandkeramik* settlement at Eilsleben, H.-J. Döhle received a doctoral degree in 1993 (Döhle, 1994). In recent years he has held lectures and practical courses in archaeozoology in the department of Pre- and Protohistory at the University in Leipzig.

In addition to the *Landesamt für Archäologische Denkmalpflege Sachsen-Anhalt,* a second institution based in Halle has been involved in archaeozoological research for decades. This is the *Museum für Haustierkunde* in the *Institut für Tierzucht* of the Martin-Luther-University in Halle-Wittenberg (Figure 1: 9). This prominent institution, whose history can be traced to the activities of the scientist and agriculturist Julius Kühn in 1865 to 1888, enjoys a long and varied history, associated with the names of many well-known scholars (Figure 4). In the late 1950's, after completing his studies and doctorate in agricultural science, MANFRED TEICHERT began research on animal remains from archaeological excavations in Halle. His first major project dealt with faunal remains from a Germanic sacrificial bog and lake sanctuary in Oberdorla/Thüringen (Teichert, 1974). These studies were enhanced by the *Museum für Haustierkunde's* comparative skeletal collection, which J. Kühn had initiated. The collection was later expanded, explicitly to meet the needs of archaeozoological research. Today it represents one of the renowned comparative collections of vertebrate fauna in Germany and is particularly strong in domestic species. M. Teichert focussed primarily on analysing material dating from the Bronze Age to the Roman Imperial period, and above all on finds from Thüringen, Sachsen-Anhalt and Brandenburg. In addition, he published important methodological treatises. One of these was a joint investigation on the distinguishing morphological features of sheep and goat skeletal elements, which he carried out in collaboration with J. Boessneck and H.-H. Müller; the Julius-Kühn collection, with its wealth of skeletal material, greatly augmented the study (Boessneck *et al.*, 1964). In following years, articles appeared on calculating whither heights from skeletal remains of pigs (Teichert, 1969) and sheep (Teichert, 1975). In the years prior to his retirement M. Teichert, who had completed completed his habilitation in 1966 and had been named curator of the Julius-Kühn Collection in 1970, became greatly involved with the renewal and improvement of the Kühn Museum. Using the Museum's skeletal collection, the long history of domesticated animals can be traced almost continuously, from wild progenitors to early prehistoric domesticates, through older local breeds of the 19th century to the hybrids of modern times. For several years, M. Teichert also lectured on the history of domestic animals as part of courses offered in agriculture. Since 1994 JOACHIM WUSSOW, with a Ph.D. in biology, holds the position of curator at the *Museum für Haustierkunde*. Along with his duties in the museum and instruction in courses, J. Wussow carries out a limited amount of archaeolozoological research. Because of its extensive and unique collection of animal skeletons, the *Museum für*

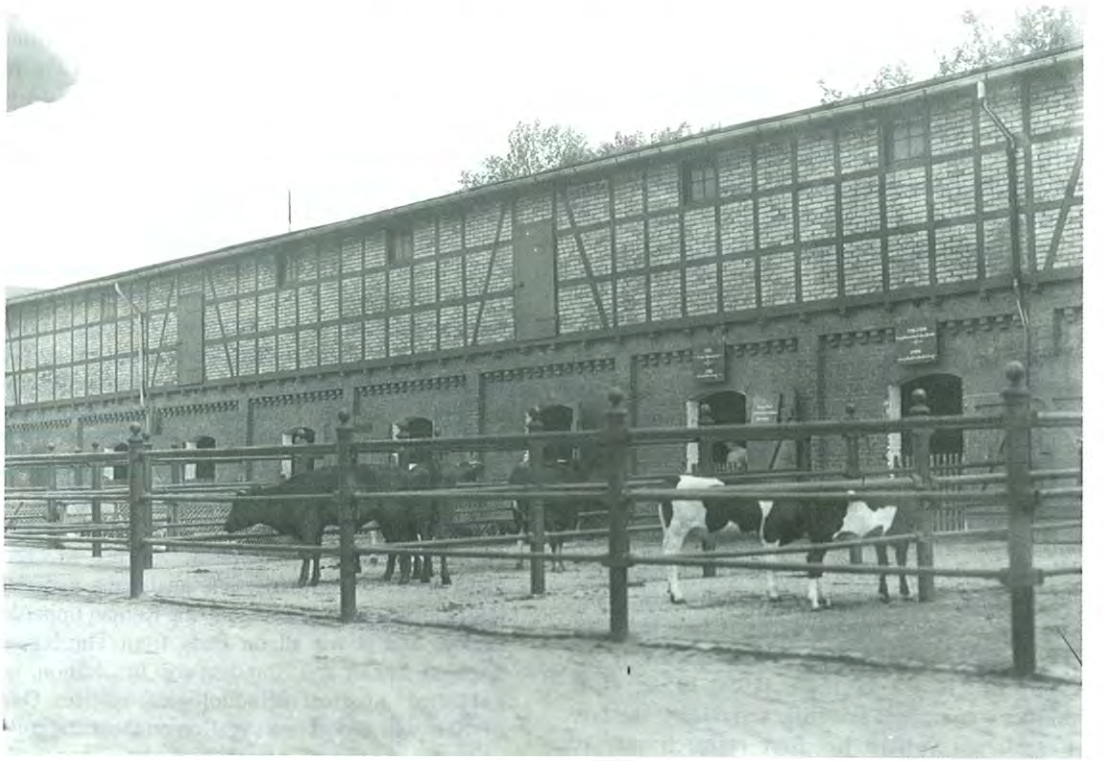


FIGURE 4

Institut für Tierzucht in Halle/Salle in 1930. In this building the *Julius-Kühn Museum für Haustierkunde* and the osteological collection is housed today. Photo: Courtesy of the Julius-Kühn Museum, Halle.

Haustierkunde is visited regularly by specialists and archaeozoologists involved in osteological studies from Germany and abroad.

In the former *Museum für Ur- und Frühgeschichte Thüringens*, today the *Thüringisches Landesamt für Archäologische Denkmalpflege*, in Weimar (Figure 1: 10), research in archaeozoology was conducted by HANS-JOACHIM BARTHEL through the 1970s and 1980s. From 1953 onwards H.-J. Barthel was responsible for excavations and later acted as conservator. These activities led to his increasing interest in animal remains, and through his contact with M. Teichert, H.-J. Barthel learned the necessary methodology for handling and analysing such finds. At first largely a hobby, H.-J. Barthel's research now began to focus on serious archaeozoological questions, to which the Museum directed increasing financial support and research facilities throughout the years until his retirement in 1987. Hence, H.-J. Barthel was able to conduct a number of investigations of faunal assemblages from various periods (Neolithic to Medieval). These are documented, for example, in his publications on animal remains from Großobringen, a settlement of the Neolithic Bernburg culture, and osteological finds from the settlements Dienstedt and Haarhausen of the Roman Imperial period (Barthel, 1985, 1987).

His primary interests were directed towards economical aspects reflected in the archaeological context. The fact that H.-J. Barthel himself excavated almost all of the faunal complexes which he later examined, afforded him an excellent working base. His research on osteological finds from Thüringen as well as those of M. Teichert led the Museum to issue its own series of publications, "*Beiträge zur Archäozoologie*" within the "*Weimarer Monographien zur Ur- und Frühgeschichte*". Regretfully H.-J. Barthel's work was not continued after his retirement, so that today archaeozoology is no longer represented in the *Landesamt* Weimar.

The *Kreismuseum* (county museum) in the town Wolmirstedt, north of Magdeburg, has intermittently provided the opportunity to carry out archaeozoological investigations (Figure 1: 6). RALF-JÜRGEN PRILLOFF, educated in museology, was active there from 1972 to 1987. While pursuring a long-distance study-program in archaeology, in the mid-197-'s R.-J. Prilloff began the examination of animal remains from excavations in Mecklenburg-Vorpommern and Sachsen-Anhalt. In 1988 he moved to the *Kulturhistorische Museum* in Magdeburg, where he held a position as co-scientist. In 1991 he obtained a doctoral degree with his studies on animal remains from Medieval settlements in eastern Mecklenburg-Vorpommern (Prilloff, 1994). Since 1994 R.-J. Prilloff has worked independently and on a contract-basis for various institutions, analysing animal bone finds from the whoe of Germany area and concentrating on the Medieval period (Prilloff, 2000).

One of the non-university institutions in the former German Democratic Republic in which archaeozoological studies were carried out was the former *Zentralinstitut für Alte Geschichte und Archäologie* (Central Institute of Ancient History and Archaeology) within the *Akademie der Wissenschaften* (Academy of Sciences) in East Berlin (Figure 1: 3). Here H.-H. MÜLLER resumed his activities and studies after leaving Halle in 1960. He was involved above all in analysing animal remains from the Institute's current excavations as well as in joint projects with other archaeological conservation offices. A great number of his studies were concerned with the history of husbandry and hunting among the Slavic tribes settled between the Elbe and Oder rivers. The results were published in several editions and in a new edition of the well-known handbook "*Die Slawen in Deutschland*" (Herrmann, 1985). H.-H. Müller also presented the first comprehensive coverage of domestic animals in the Migration period (Müller, 1980). His was particularly interested in the horse, and the systematic investigation of skeletal horse remains from Sachsen-Anhalt, Thüringen. Together with Cyril Ambros (Nitra, Slovakia) he published this work in two monographs (Ambros & Müller, 1980; Müller, 1985). During his later years of career, H.-H. Müller expanded his studies to material from the Frankish-German region. His "*Bibliographie zur Archäo-Zoologie und Geschichte der Haustiere*", published annually between 1961 and 1996, is widely renowned (Müller, 1961-1996).

In 1979 the *Zentralinstitut für Alte Geschichte und Archäologie* was able to create two positions for archaeozoologists. At this time NORBERT BENECKE began his work under the guidance of H.-H. Müller, after completing his studies in biology at the University in Halle. N. Benecke's first comprehensive undertakings dealt with the documentation and analysis of animal remains from the early Medieval settlement in Ralswiek, a study with which he attained the doctoral degree in 1984 in Berlin. In the course of time numerous archaeozoological projects connected with the Institute's activities and the archaeological conservation offices in East Germany followed (Benecke, 1988). In this position and through exchange programs between the various Academies, N. Benecke undertook several scientific journeys to Poland, Bohemia, Hungary, Russia, the Ukraine and Slovakia from 1984 to 1989. The results of these investigations were presented in his habilitation, defended at the Martin-Luther University in Halle-Wittenberg, in 1992 (Benecke, 1994a). In the same year N. Benecke published his since much acclaimed and often cited book "*Der Mensch und seine Haustiere. Eine jahrtausendealte Beziehung*" (Benecke, 1994b).

After the dissolution of the *Zentralinstitut* as a consequence of reunification, H.-H. Müller took a position, until his retirement in 1996, at the *Institut für Prähistorische Archäologie* at the Free University in Berlin, through the efforts of Prof. B. Hänsel and supported by the *Wissenschaftler-Integrationsprogramm* (Program for the Integration of Scientists). N. Benecke on the other hand transferred in 1992 to the newly created *Arbeitsbereich Ur-und Frühgeschichte* (Department of Prehistory and Early History), restructured in 1995 into the *Eurasien-Abteilung* (Eurasia Department) of the DAI (Figure 1: 4). Since then he has been engaged in archaeozoological studies in various projects of the DAI as well as other German and foreign partners. Focal points of study include Central Europe, the Black Sea area (Crimea and Thrace), West Siberia and Middle Asia (Kazakhstan). Among his larger projects in recent years are "*Archäozoologische Studien zur Romanisierung im Gebiet der rechtsrheinischen Mittelgebirgszone*" (part of a major project of the DAI from 1995–1999; cf. Benecke, 2000); "*Die Entwicklung der europäischen Tierwelt vom Spätpleistozän bis zum Mittelalter*" (joint project with A. von den Driesch and D. Heinrich, 1994–1999, funded by the DFG; cf. Benecke, 1999a, 1999b); "*Einflüsse von Kulturbe-*

ziehungen auf die Nutzung der Tierwelt durch den Menschen an der Nahtstelle zwischen Europa und Asien, am Beispiel der Siedlungsräume Drama und Kirklareli" (a joint project with the Universities of Saarbrücken and Istanbul, 1994 until present; cf. Benecke, 1998); "*Tierhaltung und Jagd bei den bronze- und eisenzeitlichen Bevölkerungen im Talgar-Gebiet und im Hochland von Turgen/Tienschan*" (a joint project with Sweet Briar College/Virginia, and the Archaeological Institute in Almaty, 1998-). Since 1992 N. Benecke has lectured as a professor at the University in Halle, at both the *Zoologisches Institut* and the *Institut für Prähistorische Archäologie,* covering the fields of archaeozoology and the history of domestic animals. The course of study in prehistoric archaeology in Halle requires that students attain certifications of achievement in the subjects of archaeozoology or anthropology.

OVERVIEW OF THE DEVELOPMENT OF ARCHAEOZOOLOGY PRIOR TO REUNIFICATION

Upon review of the above, it becomes apparent that:

1. The development of archaeozoology in Germany was marked in its beginnings by a few outstanding individuals. After World War II scientists like M. Teichert, W. Herre and J. Boessneck laid the foundations for archaeozoological research in both Germanys, in the large museum of Halle and in the universities of Kiel and Munich, respectively. From these centres strong impulses radiated to other cities and institutions. At that time the special study of archaeozoology had a much closer affiliation with the larger field of biology than today.

2. Many of the fundamental principles and methodology in archaeozoology, today used internationally, had already developed during the first decades after World War II, equally in both East and West Germany. This includes the areas of domestication, the origin of wild ancestors, the identification of species from bone residue, nomenclature, age, sex, biometry and ethology. That these early developments in German archaeozoology have had so little international recognition may be due to the fact that most of these publications were written in German, and have not been translated into in English nor are many of them commonly available in libraries outside Germany. This is all the more unfortunate, since the principles and methodologies contained in them continue to be central to the field.

3. Methodologies employed, and the research goals of archaeozoologists in the East and West followed a similar course in divided Germany, although one major difference was the rather limited possibility for travelling in the East. Thus, archaeozoologists in the former German Democratic Republic directed their attention primarily to local faunal material, while occasionally having the opportunity to work abroad in other Socialist countries. In contrast, archaeozoologists in the Federal Republic of Germany were confronted with finds from wide regions of the world from the beginning.

4. In both East and West Germany, contact between archaeozoology and archaeology was rather strong in some cases, in others hardly existent. In retrospect, it must be noted that, during this period, although large amounts of animal bone had already been excavated and given to archaeozoological institutions for analysis, the integration of archaeology and archaeozoology was the exception rather than the rule. Analyses of animal bone remains most often published as completely separate studies, or, if in archaeological reports, in the form of appendices without reference, context or interpretation in the body of the archaeological text. Productive cross-references and exchange of information were rare exceptions.

5. Between 1960 and 1970 two important institutions were established: the *Institut für Paläoanatomie, Domestikationsforschung und Geschichte der Tiermedizin* in Munich and the *Archäologisch-Zoologische Arbeitsgruppe* in Schleswig.

6. The ensuing years can be regarded as the blossoming period of archaeozoology in Germany. In both the East and West, at universities as well as in the monument protection departments, numerous positions were created and existing archaeozoological institutions were expanded. An osteological laboratory was opened in Tübingen. Thereby, the affiliation of archaeozoological research with the biological sciences gradually lessened and it's distinct place within archaeology grew, as did stronger international ties.

7. It must be stressed that over the years, scientific contact worked well between colleagues in

East and West, despite the political border and bureaucratic hindrances. This network of communication and intellectual exchange was especially maintained and promoted by conferences. The study group *Arbeitsgruppe Archäozoologie*, created within the *Biologische Gesellschaft* (Biology Society) in East Germany was focussed on inviting colleagues from the West. Beginning in 1982 there were regular meetings: in Wolmirstedt in 1982, Halle in 1983, East Berlin in 1984, Schwerin in 1985, Weimar in 1987, Halle in 1989, and finally in the reunited Berlin in 1991. Likewise, there were archaeozoological symposia in the West, which colleagues from the East were able to attend with an official invitation. These included the Kiel Symposium (Kiel, 1962), the Munich Symposium in 1967 and the international symposium on "*Domestikationsforschung und Geschichte der Haustiere*" in 1971 in Budapest/Hungary. On that occasion the International Council of Archaeozoology was founded (Matolcsi, 1973).

DEVELOPMENTS SINCE 1990

Following the reunification of East and West Germany in 1990 joint projects were continued; some colleagues changed their place of work within Germany; the German Archaeological Institute (DAI) in Berlin established the Department of Archaeozoology. The number of projects in Germany as well as the activities of German archaeozoologists abroad, in the Near East and North Africa increased; and collaborative work among archaeozoologists and with anthropologists and archaeobotanists intensified. These developments are illustrated by the 1993 conference in Konstanz, which led to the establishment of the *Gesellschaft für Archäozoologie und Prähistorische Anthropologie* in 1994, and ensuing conferences in the Saalburg (1996), Braunschweig (1998) and Halle (2000; Kokabi & Wahl, 1994, 1997; Kokabi & May, 1999). Since 1995 a joint project on the history of Holocene fauna in Europe has been conducted by the DAI in Berlin, the *Institut für Haustierkunde* in Kiel and the *Institut für Palaeoanatomie und Geschichte der Tiermedizin* in Munich. Subsequently, the results of archaeozoological analyses from all European countries have been collected in a database and made accessible for use (Benecke, 1999a). For Germany alone, this catalogue lists more than 1,100 sites at which archaeozoological researched was conducted.

At this time archaeozoology in Germany is developing towards greater independence. The range of methods and techniques applied in research has changed and broadened (e.g. trace element- and staple isotope analyses, retrieval of DNA from ancient animal tissues). Furthermore, efforts tend increasingly towards viewing archaeozoological data no longer in isolation, but in close context with all other archaeological data and, importantly, with a more critical assessment of the source faunal materials. Independent of the chronological information provided by standard archaeological methods (primarily sherds typologies, architecture or the like), direct C14-dating of bone now aids our understanding of the processes involved in the development of domestic animals and environmental history. Research involving the direct dating of faunal material are currently being carried out in Berlin, Tübingen and Köln. Long term involvement in field excavations, and direct influence on excavation techniques and the documentation of data on site have become routine for German archaeozoologists.

Yet, these efforts to use archaeozoology in answering questions concerning life in prehistoric and historic times by all means at disposal have met with several obstacles in the past eleven years.

1. The aforementioned restructuring of research in Germany following reunification has had widely felt consequences, above all drastic reductions in financial support. For example, after reunification, universities in Berlin lost about one-third of their scientific staffing. Insufficient financial support for field and research projects is but one of many consequences, that has affected archaeology, and archaeozoology in particular.

2. Moreover, it is not the general political development alone that exerts a negative effect on the future of archaeozoological research in Germany. It seems to us, the authors, that – with few exceptions – the efforts of archaeozoologists do not find earnest acceptance and integration in German archaeology, in contrast to the situation in other European countries. Even today many German archaeologists do not consider animal bone remains of equal value to other archaeological materials. Archaeozoology is little debated and is often designated as "*Hilfswissenschaft*" (an auxiliary subject). It seems symptomatic that a new German manual on archaeological methods, enti-

tled "*Prähistorische Archäologie. Konzepte und Methoden*" does not make a single reference to archaeozoology (Eggert, 2001). The absence of archaeozoology in this volume may reflect the continuing predominance in German archaeology of traditional theory and methodology although critical voices do exist (cf. Bernbeck 1997, 15ff; Schauer, 1999).

3. In recent years, the interest of archaeologists in archaeozoology seems to have decreased to the extent that new teaching and research positions have not been created and several existing positions have either not been refilled upon the occupant's retirement or have been dissolved entirely.

4. In addition, there is a lack of integration of archaeozoology into Germany's educational system, which intensifies this negative intellectual and scholarly environment. With the exception of the universities in Kiel, Tübingen and Munich, the faculties of the humanities and sciences have a relatively static, traditionally shaped organisation. Both faculties maintain strictly separate programs of study, which vary greatly in content. This includes the prerequisites (e.g. *Numerus clausus*), or mandatory courses and notes, and the requirements for and type of final degree (in archaeology: a master's degree, in the natural sciences: a diploma). In our view, this programmatic divorce is obsolete and unfortunate for the future of archaeozoology. As the programs are now configured, zoology, biology and veterinary medicine have their place in the school of sciences, while archaeology is grouped within the humanities. Cross-courses and programs are not offered, and thus it is difficult if not impossible to pursue a combined or interdisciplinary degree[6].

Nevertheless, each year a substantial number of archaeozoological theses are produced by ambitious young scientists in the few archaeozoological institutions. How and where these graduates will find future work in archaeozoology is uncertain, especially since the number of positions available in Germany is quite small. At present seven archaeozoologists are employed at German universities, only three of these with a permanent position. Another seven archaeozoologists work in institutions outside the universities, such as the DAI and *Landesdenkmalamt,* or in museums. However, only five have long-term positions. In view of this situation, it is no wonder that many archaeozoological colleagues have felt compelled to shift to free-lance work, which is also problematic in Germany, or have moved to other countries such as Switzerland. The climate of optimism that dominated the 1980s has vanished. Facit: at this point and with few exceptions, there is no foreseeably positive future for archaeozoology in Germany.

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[6] If a student wishes to enrol in both subjects, he/she must take on a "double major" which entails a longer time of study and financial burden.

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Archaeozoology in Greece: a Brief Historiography of the Science

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ABSTRACT: The archaeology of classical Greece has been the main field of concentration for research programmes and excavations during the last two centuries. The abundance of literary sources and impressive archaeological discoveries from this period, all over the Aegean, provide the reason for this orientation. Scientific investigation of civilizations without writing, using all forms of archaeological data, including faunal remains, has certainly progressed in the last four decades. In Greece, studies of the Neolithic and Bronze Age have been many, while paleolithic deposits and sites have until recently received far less attention. In addition, there has been no important tradition of zoological research in Greece, as there was in Occidental Europe in the 18th century. There is only one private natural history museum, two local state museums in Crete and Macedonia, and several comparative collections in the universities. Thus, the study of archaeozoology as a source of historical information has been slow to develop.

The study of archaeological animals bones in Greece began with the occasional work of zoologists from Germany, Hungary, France and the Scandinavian countries, and was generally limited to the determination of species and anatomical part represented. Their basic studies and methodology, plus the corpus of such studies in adjacent countries and the whole of the south Mediterranean, provided a solid framework for the studies of contemporary archaeozoologists, their successors. Major topics for English and American scientists studying Greek assemblages were the economic and ethnological interpretation of faunal remains. By the 1980's Greek scientists had also begun to study and publish in archaeozoology. These more recent studies, with the growth of scientific knowledge and methods, including those of taphonomy, theories and explanations have converged on one analytical objective, how to get more information concerning the internal history of the site. Archaeozoological papers on Greek assemblages are regularly presented and published as part of special topical Conference Proceedings. Published site reports may also present the analysis of archaeozoological data. Still, there are no Greek scientific journals which regularly publish archaeozoological reports.

Today, the challenge is to distinguish archaeozoology from paleontology (in the very recent paleolithic excavations), and to reconcile the experimental techniques, the empirical approaches of traditional archaeology, the methodology of paleozoology, and the environmental, economical, dietary and ethnological interpretations of archaeological faunal remains with the rich historical resources (both literary and archaeological) of the past in Greece.

KEY WORDS: ARCHAEOZOOLOGY, GREECE, ZOOLOGY, ARCHAEOLOGY

RESUMEN: La arqueología de la Grecia clásica ha sido un foco preferente de programas de investigaciones y excavaciones durante los últimos dos siglos. La abundancia de fuentes literarias y los impresionantes hallazgos arqueológicos de este periodo, por todo el mar Egeo, proporcionan la razón de ser de tal circunstancia. La investigación científica acerca de las civilizaciones carentes de escritura, utilizando todo tipo de datos arqueológicos incluyendo los restos faunísticos, ha progresado indudablemente durante las últimas cuatro décadas. En Grecia los estudios sobre el Neolítico y la Edad del Bronce han sido numerosos, mientras que los depósitos y asentamientos paleolíticos han recibido mucha menos atención hasta hace poco. Además de ello no existió una tradición de investigación zoológica en Grecia como se produjo en Euro-

pa occidental durante el siglo XVIII. Sólo existe un museo privado de historia natural, dos museos estatales en Creta y Macedonia y algunas colecciones comparativas en las universidades. Por todo ello el estudio de la Arqueozoología como fuente de información histórica ha sido lento en su desarrollo.

Los análisis de huesos de animales arqueológicos en Grecia comenzaron con el trabajo esporádico de zoólogos procedentes de Alemania, Hungría, Francia y los paises escandinavos y quedaron circunscritos en la mayoría de los casos a la determinación de las especies y a la representación de porciones anatómicas. Los análisis básicos y la metodología por ellos proporcionada, así como el conjunto de tales estudios en países adyacentes y en la totalidad del Mediterráneo meridional, proporcionaron un marco sólido para los estudios de los arqueozoólogos contemporáneos, sus sucesores. Asuntos claves para los científicos ingleses y americanos que estudiaban los conjuntos griegos fueron la interpretación económica y etnológica de los restos faunísticos. En los años 80 los científicos griegos empezaron a estudiar y a publicar en el campo de la Arqueozoología. Estos estudios más recientes, ayudados por el desarrollo del conocimiento y los métodos científicos que incluían la tafonomía, las teorías, así como determinadas explicaciones, convergieron sobre un objetivo analítico a saber, como obtener más información relativa a la historia interna de un asentamiento. Los trabajos arqueozoológicos sobre muestras griegas se presentan y publican con regularidad como parte de las Actas de conferencias especializadas. Informes faunísticos concretos presentan también análisis de datos arqueozoológicos. A pesar de todo ello no existen revistas científicas griegas que publiquen de modo regular trabajos arqueozoológicos.

Hoy en día el reto consiste en diferenciar la Arqueozoología de la Paleontología, al menos en las excavaciones del Paleolítico más reciente, y en reconciliar las técnicas experimentales, los enfoques empíricos de la Arqueología tradicional, la metodología de la Paleozoología y las interpretaciones ambientales, económicas, dietarias y etnológicas de los restos faunísticos arqueológicos para conjuntarlos con las ricas fuentes históricas, tanto literarias como arqueológicas, del pasado en Grecia.

PALABRAS CLAVE: ARQUEOZOOLOGÍA, GRECIA, ZOOLOGÍA, ARQUEOLOGÍA

> And yet - who knows - perhaps there where someone stands firm against all hope, perhaps there does human history begin, and the beauty of man amidst rusted iron and bones of bulls and horses, amidst the ancient tripods in which a few laurel leaves still burn and the smoke rises, vanishing into the sunset like a golden fleece.
> Yannis Ritsos, *Eleni*

INTRODUCTION

Although there are countless published archaeological studies about Greece, studies of the environment which incorporate the natural and social sciences (including archaeozoology) have been, until recently, quite rare. This has been particularly true for the Classical and later periods. Of the several interrelated disciplines that contribute to the study of the environment, I give here a critical history of the course of archaeozoology as a discipline developed during recent decades (Davis, 1987; Reitz & Wing, 1999), the problems considered by researchers studying faunal materials from sites in Greece, and the importance of archaeozoology in the development of Greek archaeology itself. In so doing, the course of archaeozoology cannot be divorced from the inquiries, methodology and dominant trends in the fields of archaeology and systematic zoology. ARCHAEOLOGY in this instance, is considered with the context of anthropology, art history, social science, ethnology and a historical discipline. SYSTEMATIC ZOOLOGY is that branch of comparative biology which contributes to understanding the complexity of living and fossil organisms, the classification of species and populations, and the creation of a clearer conception of their ecology and history (Futuyma, 1991).



FIGURE 1 A

J. Boessneck (a) and S. Bokonyi (b), two individuals who contributed to the development of archaeozoology, and the analysis of osteological materials from Greece.

Two comprehensive surveys of archaeozoological work in Greece have been published. The first, compiled in the early 1980's by Sebastian Payne, of English Heritage, (Payne, 1985) includes over 100 titles, with a summary description of the basic data provided in each study (site, region, chronological period, and vertebrate NISP, MNI, etc). However, the most important contributions of Payne's survey are in the questions he poses concerning methodology and interpretation (excavation technique, sample collection, interpretation of biometric data, etc), reflecting his own thinking and considerable experience in examining palaeozoological and modern material from the Mediterranean and Western Europe.

Ten years later, a second survey by David Reese, of Yale University (Reese, 1994), consists primarily of a bibliographical compilation of archeozoological work since 1985. These, together with several articles (most in English) on literary and iconographic evidence relating to animals, plus a listing of reports of mollusc remains, and studies of bone artifacts from many prehistoric sites, amounts to 371 titles. Reese, obviously regarding the Aegean as a geographical and cultural entity, also cites analagous studies of sites on the East Aegean coast (e.g. Troy, Miletus, Ephesus), and Cyprus. He notes that there are relatively few reports on materials later than the Bronze Age, and presents a very useful table separating materials deriving from settlements, sanctuaries and cemeteries. Since 1995, Reese has continued to collect virtually all titles concerning zooarchaeological materials (vertebrate and invertebrate); as of January 2000 these numbered around 750 items (Reese, personal communication).

An additional inventory-data base had been prepared by the Institut fur Palaoanatomie, Domestikationsforschung and Geschichte der Tiermedizin, Munich, headed by Professor A. von den Driesch. Specialized inventories have also been compiled by individuals and university cen-

tres involved with archaeozoology. An example is the University of Liege (Belgium), Groupe Interuniversitaire de contact sur l'histoire des connaissances zoologiques et des relations entre l'Homme et l'animal, headed by Professor L. Bodson - emphasis here is placed on evidence from iconography and ancient literary sources, and Greek antiquity is on of their main branche of research. Since 1986, they have also had a regular colloqium "Histoire des Connaissances Zoologiques" (e.g. Bodson, 1998).

A glance at these bibliographies reveals an uneven distribution of archeozoological studies in space and time. Western Greece, the Palaeolithic Age and the post-Bronze Age periods are less favoured topics. Moreover, very few studies deal with assemblages from sacrificial or grave contexts. In part, this is because there have been fewer excavations in Western Greece than in Macedonia and Southern Greece, and in many instances, organic remains from excavations have not been collected. Indeed, in the early 20th century, many excavation directors did not consider it necessary either to retrieve osteological material or to consult natural scientists concerning it's identification. Early exceptions were Taramelli (1897), Hatzidakis (1912), Evans (1935) and Marinatos (1932), all working on Crete, Blinkenberg (1931) on Rhodes, and Heurtley (1927-28) in Central Macedonia. In these cases (with the exception of the work of the British paleontologist Boyd-Dawkins (1902) in the Diktaian Cave in Crete, faunal analysis was limited to a list of species, or a few lines in the general text. After 1950, the proliferation of excavations at prehistoric sites, especially of the Neolithic Age, prompted the sporadic collection of osteological materials, depending largely on the site excavator's personal research goals. In addition to site specific studies (as compiled by Payne and Reese) a number of synthetic studies of animal distribution, bioarchaeology and ecology have also made use of archaeological data (cf. Yannouli & Trantalidou, 1999; Trantalidou, 2000).

THE ARCHAEOLOGICAL AND ZOOLOGICAL CONTEXT OF FAUNAL STUDIES

The course of archeozoological studies in Greece was not coincidental, but reflects the epistemology, structure, history and ideology of both



FIGURE 1 B

archaeology and zoology. ARCHAEOLOGY passed successively from the collection of rare and aesthetically outstanding objects, to the advancement of Greek antiquity as the basis of the European spirit (enlightenment, romanticism, neoclassicism) by Western dilettante, as proof of the historical population continuity and origin, and as a factor of social and national cohesion by the enslaved Greeks (Kalpaxis, 1993; Petrakos, 1998b). By the middle of the 16th century, sculptures and architectural members were removed from Greek monuments by the Ottomans to be used as building materials in various parts of their Empire, and by Europeans to grace private collections and subsequently the national museums of the West (Kalpaxis, 1990). In response, Greeks tried either individually or collectively to protect antiquities; examples of these efforts are know from as early as the 17th century. The first archaeological law was passed in 1834 (Gratsiou, 1987; Petrakos, 1998a), just four years after the protocol granting Greece independence. Concurrently, in Greece, the creation of special archaeological collections and state museums was promoted (Table 1). These now number nearly 240, not counting the collections of the foreign schools permitted to excavate in Greece, and private museums. The Greek Archaeological Society, which receives some state funding, was founded in 1837 on the initiative of



FIGURE 2

The Goulandris Natural History Museum, Athens. The new extension has been completed in collaboration with the Natural History Museum of London.

the wealthy mercant K. Belios. Because of the lack of state funding and staff for archaeology and conservation at this time, the goal of the society was to find, restore and reconstruct the antiquities of Greece.

These and other historical circumstances, plus the fact that, despite vandalism and exappropriation over the centuries, important architectural sites, and countless archaeological objects, plus literary testimonia, texts and inscriptions have survived in Greece, often relegated the collection of anthropological and environmental materials to second place. Study of the exploitation and management of the natural environment, both ancient and modern, has been at best undervalued if not dismissed completely, even to the present day. During the recent expansion of the Athens underground metro system (1993-1995), for instance, archaeological skeletal materials from historic period deposits, both animal and human, were not systematically collected and retained for analysis.

The past history of the PHYSICAL SCIENCES in Greece has been even less encouraging. During the period when modern evolutionary thought (a concept familiar to ancient Greek philosophy which, in it modern for, has it's roots in the European enlightenment (e.g. Futuyma, 1991) and the precepts of systematic biology were being established, historical circumstances precluded all scientific activity in Greece.

The first university in the modern Greek state was founded in Athens in 1837 (Table 1). Teaching of natural history and paleontology commenced in the second half of the 19th century, although excavations had been attempted earlier. The excavation at Pikermi (Attica) for instance, first started in 1835 by the British historian G. Finlay and the ornithologist Lindermayer. These excavations were extended in 1853 by the Greeks under Professor Heracles Mitsopoulos (Symeomidis & Theodorou, 1989). Until very recently, however, there was no official or legal protection for palaeontolo-

Historical Event Institution	**Date** Date of Foundation
Decree of Ioannis Kapodistrias creating the National Museum, housed in the orphanage of Egina Island	1829
Foundation of the Greek State after the War of Independence (1821-1829, 47,516 sq km)	**1830**
Royal Numismatic Treasury, later the National Numismatic Museum, Athens	1834
Archaeological Museum at Syros	1834/35
National Archaeological Museum, Athens	1836/39
Athens University	1837
Polytechnical School, Athens	1862
Annexation of the Ionian Islands (52,115 sq km)	**1864**
Archaeological Museum of Mykonos	1880
Annexation of Thessalie, Epirus in part (63,606 sq km)	**1881**
Ethnographical Museum, Athens	1883
Archaeological Museum of Olympia	1886
Archaeological Museum at Eleusis	1889/96
Greek - Turkish War (63,211 sq km)	**1897**
Archaeological Museum of Delos	1897
National Gallery, Athens	1900
Archaeological Museum of Delphi	1900
Archaeological Museum at Epidauros	1905/09
War of the Balkans (121,794 sq km)	**1913**
Byzantine Museum, Athens	1914
Greek-Turkish War of 1920 (150,833 sq km)	**1920**
Secession of Greek-Turkish War (130,199 sq km)	**1922**
Thessaloniki University	1925
Athens Academy (sections of physical sciences, political sciences, literature & art)	1926
Zoological Museum, Athens University	1850
School of Political Sciences (Panteion), Athens	1930
Local Archaeological Museums at the Acropolis, Athens; Sparta; Thebes; Volos; Herakleion; Tegea; etc	before 1930

Sources: Inglessi, 1932-1933; Haritonidou, 1978; Zapheiropoulou, 1988; Hatzidakis, 1995: 108-109; Collectif, 1998, 1999; Petrakos, 1995, 1998; National Archaeological Museum, 1999.

TABLE 1

Significant dates in Greek political history, and the founding of Public Museums, Institutions and Universities in Greece, 1830-1930.



FIGURE 3

The Institut for Mediterranean Studies, Rethymnon, Crete, which houses a small laboratory for environmental archaeology, specializing in seeds and fish.

gical sites, such as Pikermi, although its deposits of the Tertiary era which contributed specimens to a number of European Museums, including the Gallery de Paleontologie, Paris and the British Museum of Natural History, London). Instead such areas were included, through the Archaeological Laws, in protected zone as places "of outstanding natural beauty" (Journal of the Government 44, 31/01/1984). For all Greece's palaeontological wealth, no national museum of natural history was established. Rather, collection/museums were set up in the department of Geology-Paleontology and Biology-Zoology at the University of Athens, and subsequently at other universities.

The Zoological Museum of the University of Athens is 130 years old. In the middle of the 19th century, a small group of German naturalists created a Nature Society which compiled modern comparative collections of birds and minerals. These collections were brought to the central building of the University of Athens in 1850, where they became the basis for the Zoological Museum of the University. In 1868 the museum was divided into three branches, the Zoological, Mineral-Geological-Paleontological and Botanical. As was the case in archaeological museums, the Zoological Museum received frequent donations, particularly of molluscs and birds. In the beginning of the 20th century a zoological garden existed in Phaliron, but during World War I, the animals of the garden died of starvation. Some of these animals were donated to the Zoological Museum as mounted specimens. This museum was opened to the public in the 1930's, however during World War II, and the Greek Civil War it's premises were used as an army hospital. When it was able to reopen as a museum, many of the original display and study collections were found to be missing. Between 1963 and 1982, the museum was closed for restoration, opening to the public again in 1988. Also

opened to the public in 1988 was the new university buildings in Zographou (Zapheiratos, 1998). Today, with 2000 square meters of floor space, it offers research facilities in the areas of ecology, systematic biology, physical anthropology and paleoanthropology. Like many other museums and private societies (e.g. the Hellenic Zoological Society, Hellenic Ornithological Society (established 1982), etc), it maintains a publication series, archives and data bases. It has also now started a series of popular publications, under the direction of Professor A. Legakis (e.g. Adamopoulou *et al.*, 1998).

The private Goulandris Natural History Museum (Figure 2) was founded in 1964. It's collections include approximately 1300 bird specimens (95% of the avifauna of Greece), 15000 molluscs, plus collections of modern and fossil mammals (Figure 6). The Goulandris publishes an annual report (Annales Musei Goulandris) as well as books on modern Greek flora and fauna (Figure 7). Recently it has been enlarged to 13000 square meters, with new exhibition areas, an amphitheatre, library extension now housing 40000 journal volumes and over 5000 monographs, etc. The Natural History Museum of Crete, which opened in June 1998 (University of Crete, Herakleion), with 800 square meters of floor space, focuses on ecosystems of the Eastern Mediterranean and Crete, and has exhibition the Minoan environment and the everyday activities of Bronze Age Cretans. It also publishes on a small scale, exclusively for educational purposes. In all of these museums, despite their rather small size, there are also small exhibits on the evolution of man. The newly founded Museum of Natural History in Paranesti (Drama), which opened in 2001, has an exhibition space of 320 square meters, plus laboratories (Figure 9). This museum it part of a network of three facilities; the others are Stauroupoli, near Xanthi, which specializes on study of man and the environment, and Prasinada, Drama, which studyies the environment and energy sources.

The systematic collections of the "zoological museums" of the Biology Departments at the Universities of Thessaloniki and Patras, founded in the 1970's, remain small, barely covering the educational needs of their students. Moreover, none of these Universities or museums as yet have courses oriented toward the comparative study of osteological materials from archaeological assemblages. In the University of Thessaloniki, Macedonia, the Department of Biology specializes in marine biology. This university also has two museum specialities which have existed since it's foundation. One is a laboratory specializing in non vertebrate and marine avifauna, the other concentrates on the more common natural history areas of mammals, birds and mollusks (Koukouras, personal communication). The Zoological Museum in the Department of Animal Biology at Patras was founded by professor J. Ondrias in 1973, and is dedicated primarily to public school education. At present however, it has no professional or support staff, and it's functions are maintained by the volunteer time of the scientific staff. Neither of these two university museums have their own publication series (Chondropoulos, personal communication).

An additional obstacle to the creation of comparative collections is the lack of large zoological parks or gardens in Greece. Exceptions are the parks on Rhodes, where *Dama dama* are reared, the small island sanctuaries such as Theodorou off Crete which hold populations of Agrimi (*Capra aegagrus*),Youra Island in the Sporades with a population of feral goats, Delta of Evros, Nestos, Achelos, as well as a number of wetlands and lakes which are set aside as protected zones for various mammal and bird species. Attica Zoological Park near Sparta provides a natural habitat for over 300 species of birds, plus reptiles and mammals, where live observations could be made and which could supply the natural history museums with comparative osteological materials.

In the past, the need for modern comparative faunal collections was often met by either transferring the osteological materials to universities or institutions outside Greece (e.g. Cambridge, Munich, Southampton, Tennessee and the Smithsonian Institution) or by creating small local reference collections at the site of excavations (e.g. Nea Nikomedia-1960's; Akrotiri, Thera-1980's; Kavousi, Crete-1990's). In the early 1990's, thanks to the collaboration of Greek and foreign specialists, small comparative collections were set up, and are being updated, such a collection was begun in 1988 in the Fitch Laboratory (Figure 4 a, b) of the British School of Archaeology at Athens and in the Malcolm H. Wiener Laboratory (Figure 5) of the American School of Classical Studies at Athens in 1992. These collections contain osteological material from the basic suite of species common to Greece, and are meant to facilitate the study of the natural history and archaeology of Greece and neighboring regions. Newly founded archaeological units in the Institute of Mediterra-

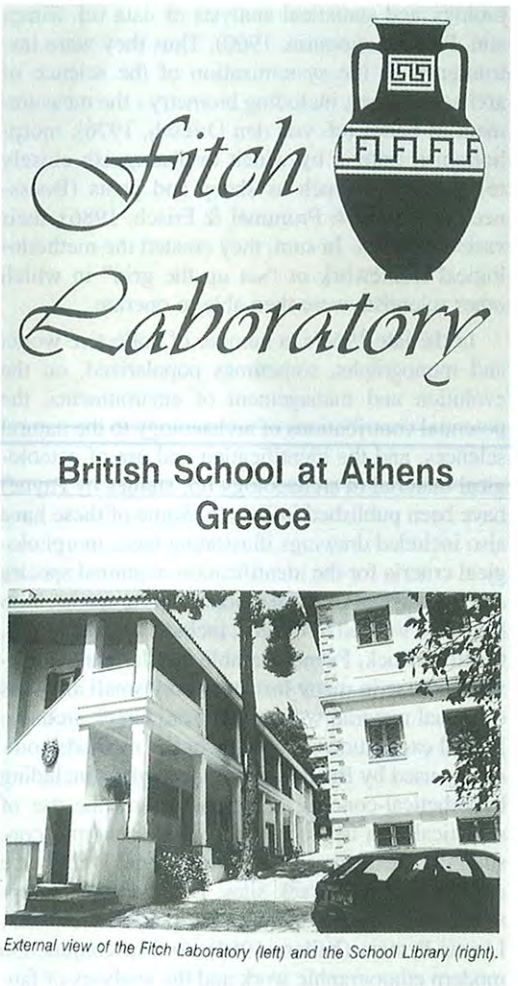


FIGURE 4 A

(a), (b) The Fitch Laboratory of the British School of Archaeology at Athens, which has a basic comparative collections of domestic mammals, fish and seeds.

nean Studies (Rethymnon, Crete) and the INSTAP (Institute for Aegean Prehistory) Study Center for East Crete (Pachia Ammos) are able to accommodate researchers and excavation materials, but do not as yet have systematic reference collections - apart from those held by individual scholars. In addition laboratories in Athens, including those at the British and American Schools, the Goulandris Museum and Democritus have facitilites for x-ray, microscopy, and trace element analysis. The Wiener Laboratory of the American School of Classical Studies also offers yearly Research Fellowships and Associateships for the study of human and vertebrate osteological materials.



FIGURE 4 B

By considering the historical processes, course and dynamic of each of the component sciences of archaeozoology in the Modern Greek State, we understand why this new synthetic science has not been amoung the options available in the university curriculum until very recently. The teaching of environmental archaeology at the University of Athens has been covered consistently by one person since the late 1980's, while the other universities, particularly Thessaloniki and Crete, now offer such classes on a rotating basis within their curriculums. The Archaeological departments of all the Greek universities are also now beginning to develop their own Environmental Units and collections.

THE EFFECTS OF EUROPEAN SCHOOLS AND METHODS ON GREEK ZOOARCHAEOLOGY

Because environmental archaeology has only recently become a course of study in the Greek

curriculum, it is natural that whatever progress was made in the study of archeozoological materials from Greek sites was affected directly by the methods and theoretical orientation of individual researchers' country of origin and scholarly background. The fact that the works of such distinguished zoologists and palaeontologists as Keller, Hilrheimer, Winge, Degerbol and Bate, who were invited to work in Greece prior to World War II, make little use of archaeologically derived materials is surely due to the limited amounts of such materials at their disposal, the descriptive manner in which the sciences treated such materials, and the routine relegation of faunal studies to appendices in archaeological publications. This holds true for Holocene as well as Pleistocene site assemblages (Trantalidou, 1996). For example, in 1936 when Bate comments on Greek fauna she makes perceptive remarks about the palaeontological material of the quarternary period of Crete, but gives minimal consideration to materials from archaeological excavations (cf. Lax, 1996 for a compilation of her works in Crete).

Detailed presentation of archaeological faunal materials began to appear in the 1950's. Trail-blazers in this respect, many of whom also worked elsewhere in the Mediterranean or Central Europe, include Boessneck, von den Driesch, Gejvall, Bokonyi, Higgs, Payne, Jarman and the French interdisciplinary team that worked on Kitsos Cave. Their studies were often published together with the other archeological materials in a single volume. For some of the larger sites, such as Lerna (Gejvall, 1969) and Kastanas (Becker, 1986) the result of faunal analysis were published in separate volumes. An important impetus for archaeozoology in Greece, and more generally Western Europe, was provided by scholars of the so-called German school studying Holocene osteological materials (e.g. Boessneck, von den Driesch, Enderle, Jordan, Amberger, Lepsikaar, Hinz, Becker). Additional scholars in this tradition include researchers from Holland (Prummel), the Scandinavian countries (Gejvall, Larje) and Central Europe (Bokonyi). A number of these researchers were able to study large faunal assemblages from sites in the Thessalian plain as well as Macedonia, Epirus and the Peloponnese (cf. Reese 1994; Payne, 1985).

In their study and publications, many of these scholars were able to draw on a background of three centuries of development in zoology and paleontology, plus the emerging theory and methodologies of population biology, comparative biology and statistical analysis of data (cf. Simpson, Roe & Lemontin, 1960). Thus they were instrumental in the systemization of the science of archaeozoology, including biometry - the measurement of bones (cf. von den Driesch, 1976), morphological criteria by which to distinguish closely related species such as sheep and goats (Boessneck *et al.*, 1964; Prummel & Frisch, 1986), their variety and sex. In sum, they created the methodological framework or "set up the grid" in which other scientists were then able to operate.

In the late 1960's, a number of collective works and monographs, sometimes popularized, on the evolution and management of environments, the potential contributions of archaeology to the natural sciences, and the identification and use of osteological material in archaeology (cf. studies by Payne) have been published in Britain. Some of these have also included drawings illustrating basic morphological criteria for the identification of animal species and their age at death. Authors of these works, who have also worked in Greece, include Watson, Higgs, Clutton-Brock, Payne, Gamble and Jarman. However, because in many instances only small amounts of faunal material were saved from Greek archaeological excavations, the many of the methods commonly used by British archaeozoologists, including hypothetical-conclusive reasoning, and the use of statistical data to reconstruct palaeoeconomy (consumption, exchange, transaction) could rarely be applied to these Greek sites. But there are exceptions, such as the literary interpretation of LBA Linear B texts (Killen, 1964) used in conjunction modern ethnographic work and the analyses of faunal materials to understand flock management and wool production in the Late Bronze Age (Halstead, 1990-91, 1992; Reese, 1994).

As in Britain, it is difficult to speak of a single school of archaeological thought in France. However, the work of a number of individuals stand at the crossroads of paleontology, zoology and the historical disciplines. These scientists developed, "in the dense shadow of Leroi-Gourhan", ethnoarchaeozoology (cf. Poplin, 1973), the ethnology of techniques in the analysis of objects of bone or tooth (cf. Poplin, 2000), and the examination of issues of zootechny, cultural anthropology, palaoclimatology, exploration of the relations between societies and the environment using an anthropological approach (Anthropozoology, sensu Poplin), the quantification of data (Ducos, 1975), osteology (Desse & Desse-Berset, 1987-1996; Helmer & Rocheteau, 1994) and the use of iconography and



FIGURE 5

The Malcolm H. Wiener Laboratory at the American School of Classical Studies at Athens, main room. The laboratory has comparative faunal, mollusk and charcoal collections, a library and databank, and publication series.

texts. The journal *Anthropozoologica*, published by the Laboratoire d'Anatomie Comparee in Paris, encourages all interdisciplinary approaches, and has published papers on Greek archaeozoology. French researchers who have worked on Greek materials include Tranier, Chaline, Julien, Mourer-Chauvire, Poplin, Desse, Helmer, Gardesein, Columeau, Taboriu/Amandry, and Chevallier.

The long tradition of non-Greeks doing archaeological research has continued to flourish, sponsored in part by the many archaeological schools and institutes established in Athens (Table 2). Since the late 1970's there has also been a marked increase in the number of zoologists, palaeontologists, natural scientists, archaeologists and historians dealing with Greek archaeozoology from North America (Day, Ducan, Foster, Klippel, Lax, Mancz, Rielly, Rucillo, Rusco, Shackleton, Sloan, Walker, Winder), Britain (Bedwin, Coote, Coy, Deith, Gamble, Halstead, Jarman, Jones, Payne, Reumer, Rowley-Conwy, Ruche, Schwartz, Wall), Germany (Becker, von den Driesch, Friedl, Lepiksaar, Nobis, Persson, Raulwing, Reisch, Schmidt, Stanzel, Thessing, Uerpmann) as well as Italy (Masseti, Sorrentino, Wilkens), Poland (Kowalski, Wojtal), Belgium (Gautier, Cordy), Holland (Prummel) and Australia (Powell).

Issues of taphonomy, the geochemical, climatological or biological events that affect the creation of archaeological deposits, have been of little concern to those studying osteological assemblages from Greece. Most studies of Greek archaeozoological materials have concentrated on the economic, ethnological or historical interpretation of site assemblages, recording the presence of cut marks, traces of burning, and the differential representation of skeletal body parts, all indicative of human use of animals for food, clothing or tool-making materials. Less attention has been paid to such issues as fracture patterns (indicating marrow extraction) or the depositional dynamic of bone after its deposition.

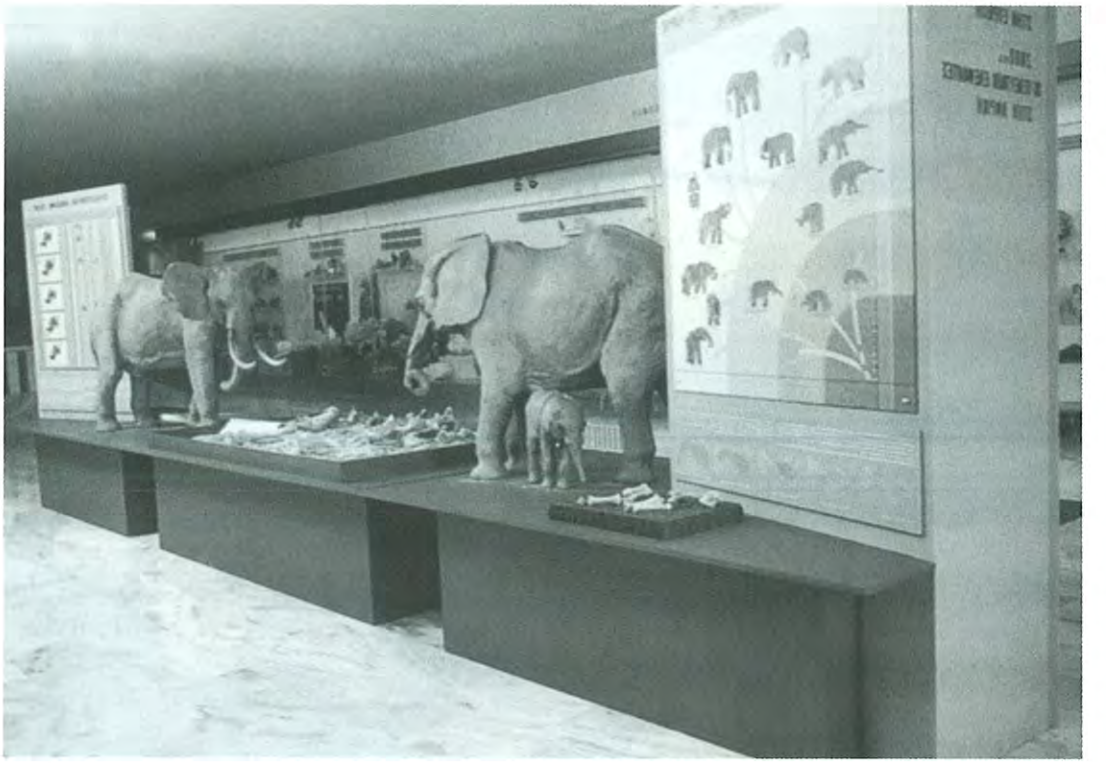


FIGURE 6

The Goulandris Natural History Museum, temporary exhibition on Telos (Dodecanese) dwarf elephants, prepared by palaeontologists, Professors N. Symeonidis and G. Theodorou.

THE CONTRIBUTIONS OF GREEK RESEARCHERS TO ARCHAEOZOOLOGY

Scholars of Greek origin began to study archaeozoological assemblages in the late 1980's. Almost of these people were trained in archaeology, with the exception of two (Koufos and Tsoukala) who are palaeontologists dealing occasionally with archaeozoological materials. All Greek archaeologists now involved with archaeozoology have higher degrees from universities in Britain (the majority) or France. At present amoung those studying Greek assemblages are Karali-Yannacopoulos, Hamilakis, Yannouli, Panayiotakopoulou, Kosmetatou and Trantalidou. Others continuing their doctoral studies (2001) include Kotzabopoulou, Myona, Isaakidou, Psathi and Kavoura, while still other students are working towards their masters degrees. Because of their varied educational and professional backgrounds, the ideological influences of each can be seen, although Greece too is experiencing the gradual globalization of the sciences.

The general lack of infrastructure in Greece results in libraries and laboratories in both the Universities and the Ephorate for Palaeoanthropology - Speleology which are still small and devoted almost exclusively to the conservation of materials. In addition, the difficulty in finding a common ground for archaeozoology between paleontology and zoology in Greek universities continues to make autonomous research and truly ground breaking experimental or analytical research difficult, and leads archaeological students to universities and research centers in Europe and the Americas. There are also, to date, in Greece no autonomous scientific journals dealing specifically with archaeozoology, as there are for the more general field of archaeology (cf. *Archaiologiki Ephimeris* [1837-], *Praktika tis Archaiologi-*

Institution	Date of Foundation
French Archaeological School	1846
German Archaeological Institute	1879
American School of Classical Studies	1881
British School of Archaeology	1886
Austrian Archaeological Institute	1908
Italian Archaeological School	1909

Source: Petrakos 1995, 1998.

TABLE 2
Foundation dates for the first foreign Archaeological Schools in Greece.

kis Etaireias [1837-], *Archaiologikon Deltion* [1915-], *To Ergon tis Archaiologikis Etaireias* [1954-], *Archaiologia* [1981-], *Archaiologikon Ergon sti Makedonia ke ti Thraki* [1987-], etc.) or paleontology (cf. *Annales Geologiques des Pays Helleniques* [1942-], Figure 8). Consequently, Greek archaeozoologists publish primarily in these Greek journals, the journals of the foreign schools in Greece, international archaeologial journals, site monographs and the proceedings of local or international archaeological conferences. Two monographs have also recently been published, one devoted to paleontology and archaeozoology in Greece (Reese, 1995), the other specifically to zooarchaeology in Greece at the end of the 20th century (Gamble *et al.*, 2001).

CONCLUSIONS ON THE HISTORY AND FUTURE OF GREEK ARCHAEOZOOLOGY

Today, in Greece and the Mediterranean, scientists are focusing their studies on the reconstruction the palaeoenvironment and past everyday life through the association and interpretation of osteological remains and archaeological context in order to understand the use of habitat and palaeoeconomy of the sites. The linking of zoological evidence with literary and iconographic sources in all aspects of archaeozoology, including assemblage species composition, cut marks and burning, flock composition and the use of animal raw materials, is increasingly gaining ground. A distinctly Greek character is gradually being developed in these studies. In a country with such a rich cultural tradition, the information to be gained from such sources cannot be ignored, nor should ethnographic parallels be invoked indiscriminately, without regard to the archaeozoologial evidence. Today, archaeologists involved with environmental studies are virtually obliged to incorporate zooarchaeological data in their historical reconstructions. Alternatively, without continued growth and recognition, this discipline will amount to no more than a long list of repeated or minimally differentiated data, without a presence in its own right.

ACKNOWLEDGMENTS

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FIGURE 7
Some recent publications of the Goulandris Natural History Museum.

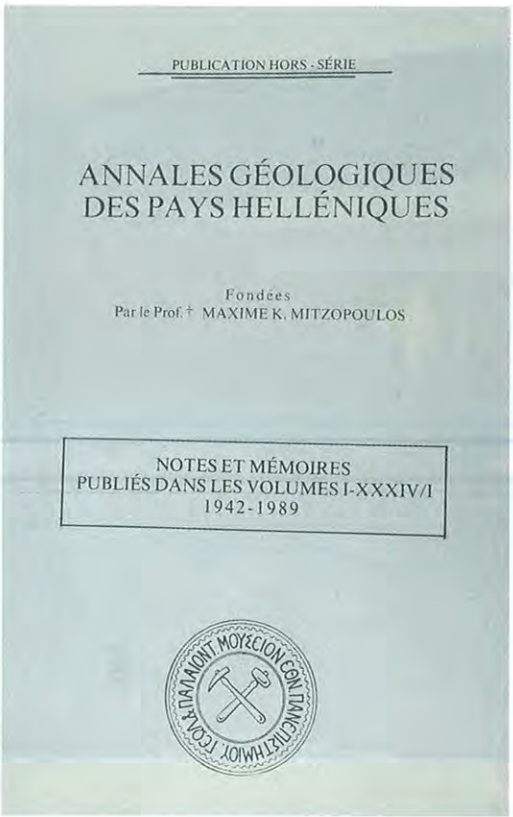


FIGURE 8

The Journal of the Geological/Paleontological Museum at Athens: *Annales Geologiques des pays Helleniques*.

logy), Prof. P.B. Chondropoulos (University of Patras, Department of Biology, Section of Animal Biology), Dr. Theodore Koukouras (Aristoleion University, School of Biology, Department of Zoology) and Dr. David Reese (Peabody Museum of Natural History, Yale University) for the information which they shared with me, and Prof. A. von den Driesch and Dr. L. Bartosiewicz for the photographs of I. Boessneck and S. Bokonyi. Thank you to A. Doumas and Lynn Snyder, respectively, for help in the translating and editing of the text of this paper. A portion of this paper was prepared while I was a Senior Research Fellow at the Malcolm H. Wiener Laboratory, American School of Classical Studies at Athens, and I thank the director, Sherry Fox, and the American School for their support. I would also like to thank all the professors and collegues, Greek and non-Greek for their work. Space limitations do not permit the listing of their hundreds of publications concerning the Greek environment and archaozoology, but I express here my deep appreciation for their work, and their contributions to our knowledge of Greek history.

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FIGURE 9
Museum of Natural History in Paranesti. View of the interior.

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The Practice of Zooarchaeology: An Assessment from the International Literature, 1969-1998

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ABSTRACT: A review of papers published in five international journals since 1965 indicates that publications with a zooarchaeological focus make up approximately 20% of the total. The majority of the papers presented methodological or thematic information of interest to a general audience; BAR was the only publication that routinely handled site reports or extensive analyses of regional faunas. Important methodological themes included quantification, taxonomy, taphonomy, and age assessment. The majority of authors was either European (including Israel), American, Australian, or New Zealander. This, no doubt, reflects the degree of national social support for archaeological research and the fact that English is the publication language for three out of the five journals. Asia and South America were noticeably under-represented in the sample. Authorship was male-dominated at the beginning of the study; the sex-ratio was equal at the end of the time period. The publications in this study are the products of an established discipline with well-defined areas of study and goals, that encourage development of new methodologies. The results of the study also suggest that the international journal publications are not sensitive to regional zooarchaeological developments.

KEY WORDS: ZOOARCHAEOLOGY, PUBLICATIONS, TRENDS, GENDER

RESUMEN: Un listado de artículos publicados en cinco revistas internacionales desde 1965 evidencia que las publicaciones de índole zooarqueológica constituyen aproximadamente el 20% sobre el total. La gran mayoría de estos artículos presentaron información metodológica o temática de interés para una audiencia general; sólo las monografías del BAR presentaron de forma sistemática análisis puntuales sobre yacimientos o análisis amplios sobre faunas regionales. Temas metodológicos importantes incluían la cuantificación, taxonomía, tafonomía y evaluación de las edades. La mayoría de los autores eran europeos (incluyendo israelíes), norteamericanos, australianos o neozelandeses. Esto, sin duda, refleja el nivel de apoyo social nacional para la investigación arqueológica y el hecho de que el inglés sea la lengua de publicación en tres de las cinco revistas. Asia y Sudamérica aparecían llamativamente infrarrepresentadas en la muestra. La autoría de los artículos estaba dominada por varones al comienzo del estudio pero esta relación de sexos era prácticamente idéntica al final del lapso temporal. Las publicaciones en este estudio son el resultado de una disciplina bien establecida con áreas de análisis y objetivos bien definidos que potencian el desarrollo de nuevas metodologías. Los resultados del estudio también sugieren que las publicaciones de las revistas internacionales no parecen ser sensibles a los acontecimientos zooarqueológicos de índole regional.

PALABRAS CLAVE: ZOOARQUEOLOGÍA, PUBLICACIONES, TENDENCIAS, GÉNEROS

INTRODUCTION

Like many other disciplines, zooarchaeology has developed through exchange of developments in research methodologies, quantitative framework, and increasingly sophisticated research agendas. Much of this information, as well as discussion and debate, is communicated through publications and conference presentations. Unlike conference presentations, however, publications codify information for later reference and transcend space and time. They provide access to debate and research when conference attendance is not possible.

Publications also provide a way to monitor intellectual growth within a developing field in terms of research methodologies, terminology, and the framing of research questions. The purpose of this study is to examine trends in zooarchaeological research world-wide, through the assessment of publications in journals with, potentially, an international readership. While books and conference proceedings are important sources of zooarchaeological information, the regular publication schedule of journals provided a more consistent means of monitoring research in zooarchaeology in the last 30 years. This study endeavors to identify trends in zooarchaeological research in terms of the development of methods, significance assigned to research topics, the geographical areas of research, and the demographic composition of zooarchaeologists through a diachronic assessment of zooarchaeological publications.

METHODS

The data that form the basis for this study were collected from five publications with an international distribution. Zooarchaeological articles were identified through review of journal issues. The zooarchaeological publications that were included in the study consisted of three categories: 1) articles and monographs whose main topic focused on some aspect of zooarchaeology that could be identified from the title or the abstract; 2) articles and monographs that were about other topics, such as site reports but that included a section, chapter, or appendix on zooarchaeology and 3) publications that included discussion of animal representation of utilization, such as ethnohistories or rock art analyses. The study did not include book reviews, editorials, obituaries, or letters to the editor.

All of the journals chosen for comparison were established in the last forty years, publish primarily in English, and have a history of publication of zooarchaeological research. These are *World Archaeology* (WA), *British Archaeological Reports (International Series)* (BAR), *Journal of Archaeological Science* (JAS), *International Journal of Osteoarchaeology* (IJO), and *Archaeozoologia* (AZ). WA and BAR include publications on a wide variety of anthropological topics. JAS appears to publish primarily on methodological topics pertaining to archaeological research. IJO and AZ focus more narrowly on bioarchaeological topics. IJO included human osteological studies; AZ is devoted almost completely to zooarchaeology.

The zooarchaeological papers in this sample were assigned to one of four categories: syntheses, methods, site reports, and topical reports. Syntheses included topical overviews as well as reviews of regional historical development. Methodological papers focused on analytical and interpretive techniques. There was some overlap between methodological papers and topical papers. Topical papers focused on a particular research problem or presented an analytical model for testing. It usually encompassed data from more than one site, and did not include the entire faunal assemblage. Discussions of faunal assemblages were tabulated as site reports. Each article was only tabulated once in this study, although it might fit under more than one category. This sample is not exhaustive, and was limited by access, in some instances, to abstracts of publications in lieu of the full text, and the inaccuracies inherent in this method of assessment.

World Archaeology (WA)

The oldest publication in this study, *World Archaeology* (WA), has been published in Great Britain since 1969 (see Table 1). It usually consists of three volumes per year. All articles are published in English. The articles in each issue are usually organized around a topical theme; papers for each issue can be solicited or independently submitted. Early issues had broad themes such as "Chronology" or "Analysis"; the themes of more recent issues tend to be more narrowly focused, such as "Buddhist Archaeology". Only one issue

Year	Total Assessed	*World Archaeology*		*Journal of Archaeological Science*		*British Archaeological Reports* Total Published	*British Archaeological Reports* Sample Size (%)		*Archaeo-zoologia* N (100%)	*International Journal of Osteo-archaeology*		Sample size	
		Total	N (%)	Total	N(%)			N (%)		Total	N (%)	N	(%)
1969-72	96	96	8 (8)									8	(8)
1973-76	192	101	8 (8)	91	16 (18)							24	(12)
1977-80	247	100	7 (7)	118	32 (27)	55 (39)a	29 (52) 13 (40)	16 (55) 1 (8)				55	(22)
1981-84	357	103	7 (7)	138	48 (35)	187 (137)b	116 (62) (66) (48)	58 (50) 6 (9)				113	(32)
1985-88	565	112	5 (4)	165	51 (31)	240	236 (98)	16 (7)	52			124	(22)
1989-92	490	109	3 (3)	181	54 (30)	98	98	7 (7)	31	71	.12 (17)	107	(22)
1993-96	607	109	0	277	64 (23)	60	45 (75)	0	32	144	21 (15)	117	(19)
1997-98	288	55	12 (22)	93	19 (20)	51	48 (94)	7 (15)	10	82	32 (36)	80	(28)
Total	2842	785	50	1063	287	625	523	101	125	297	65	632	

TABLE 1

Zooarchaeological papers published between 1969-1998 in five international journals.

a BAR Volume 62 tabulated as a single volume, rather than as individual articles in monograph.

b BAR Volumes 202 and 227 tabulated as single volumes, rather than as individual articles.

with a zooarchaeological theme was published in the time period assessed, in 1996.

All issues published between 1969 and 1996, a total of 730 articles, were included in this study. Of these 50, or 6%, addressed zooarchaeological issues.

Journal of Archaeological Science (JAS)

Journal of Archaeological Science, also published in Great Britain, issued their first volume in 1975. Initially, this journal was issued quarterly; in 1983 publication was increased to every two months. The number of articles per volume increased dramatically in 1994, going from 39 to 74.

All volumes published between 1975 and 1997 were assessed, a total of 1063 articles. Of these 287, or 27%, addressed zooarchaeological issues.

British Archaeological Reports, International Series (BAR)

British Archaeological Reports, International Series (BAR) began publication in 1972. It has had an irregular publication history, as there were few volumes published between 1991-1994. The first volume available to this study was published in 1979. In 1998, the BAR had published 625 issues; 523, or 85%, were available for assessment. The missing volumes may not have been published in English, but may have included zooarchaeological topics. This study assumes that an 85% sample of volumes is representative of the total population.

BAR consists of book-length monographs and symposia proceedings. A total of 37 volumes were included in this study, consisting of 34 monographs and 3 symposia (two additional symposia devoted to zooarchaeology were not available to this study). The individual articles in the conference proceedings were tabulated as independent publications.

The International Journal of Osteoarchaeology (IJO)

This journal is published in the U.S.; the first year of publication was 1991. All volumes published between 1991 and 1998 were included in this study, a sample of 297 articles. Of these 65, or 22 %, focus on zooarchaeology.

This journal specializes on both human osteology and zooarchaeology.

Archaeozoologia (AZ)

Archaezoologia (AZ), as its name implies, is devoted to zooarchaeological topics. Although the majority of papers are published in English, it is published in France and will accept papers submitted in English, Spanish, French, and German.

The first year of publication of AZ was 1986. A total of 125 articles were published between 1986 and 1998; all were devoted to zooarchaeology.

The publications in this study were chosen because they were international in readership and had a history of publishing papers with a zooarchaeological content. Each journal, however, had different degrees of commitment to zooarchaeology, ranging from WA, which included faunal papers only as they related to other themes, to AZ, which was devoted completely to publication of

JOURNAL	SYNTHESES	METHODOLOGICAL	SITE REPORTS	TOPICAL ANALYSES
World Archaeology	20	10	16	9
British Archaeological Reports	10	10	22	75
Journal of Archaeological Science	8	123	33	118
Archaeozoologia	18	32	35	31
International Journal of Osteoarchaeology	3	34	19	9

TABLE 2

Tabulations of types of articles published between 1969-1998 in five international journals.

zooarchaeological papers (see Table 2). Each of the journals examined here had a specific profile, a characteristic mix, of different types of zooarchaeological studies. These profiles remained relatively unchanged throughout the history of the journal. The oldest journal, WA, also had the highest proportion of overview or synthesis articles. BAR was suited for publication of longer studies, and able to accommodate publication of extensive data tables. This no doubt accounts for the high proportion of papers in BAR that contains primary data. BAR also published the highest frequency of symposia proceedings.

JAS focuses on topical studies and methodological studies. Few site reports were published, and almost no papers that were characterized as syntheses or overviews.

Two of the journals, IJO and AZ are devoted to the publication of osteological studies. IJO includes human osteology, but AZ publishes only zooarchaeological papers. The largest category of zooarchaeological papers in IJO is methodological; AZ papers are almost equally distributed among the four categories.

PUBLICATION CHARACTERISTICS

The number of articles published per year did not stay static over time, but increased as new publication series were established. The only journal in this study that was published in the period 1969-1972 was WA; about 8 percent of WA articles were focused on zooarchaeology. During the period 1973-1976, JAS was established, doubling the percentage of published papers in the sample devoted to zooarchaeology. BAR entered the study during the 1977-1980 time period, and the proportion rose to 21 percent. The following period saw the proportion of zooarchaeological papers in the sample rise to 29 percent, without the establishment of new journals. This is probably due to the publication of several BAR volumes devoted to zooarchaeological conference proceedings (Volume 202 and 227), that were tabulated by individual article. Although two of the journals in the study were established after 1984, the percentage of faunal papers in the sample dropped to 22%, and stayed stable throughout the duration of the remainder of the time period of the study.

The different types of articles were not distributed evenly throughout all of the journals.

Syntheses

The largest percentage of syntheses was found in WA; 38% of the articles in this journal consisted of overviews of geographical areas or of zooarchaeological topics. It is possible that the way that this journal assembles papers for publication lends itself to overviews. Historical factors may also be involved, as WA was the oldest publication in this sample of journals.

Topical and Methodological Papers

Topical and methodological studies were equally represented in JAS, AZ, and ISO. Topical papers were well represented in the BAR volumes. These studies were often book (or dissertation) length, and were more compatible with the BAR venue than journals that focused on shorter manuscripts. Topical studies constituted 58% of the BAR zooarchaeological studies by volume count. Two aspects of these publications were of interest to the study, research focus, and country of research.

In order to identify research topics that were significant to zooarchaeologists during the time period of the study, a sub-sample of publications was examined in more detail. Articles from JAS were used, as JAS has the longest publication history of the journals that routinely carried methodological and topical papers. A tabulation of these papers (see Table 3) suggests that several topics are of enduring significance; taxonomy, derived measures of assemblage composition, and taphonomy.

A concern for the development of criteria for identification of species reflects the influence of one of the origins of zooarchaeology in paleontology. A closely related topic, domestication, has also been of continuing interest, as evidenced by the steady number of publications. The first paper in JAS that used DNA to assess taxonomy was published in 1997. The development of this identification method may spark a flurry of papers in the future as DNA libraries are established and DNA analyses become more economical.

Interest in techniques for ageing individuals peaked in the late 1980s, within the time period of

	1973-76	1977-80	1981-84	1985-88	1989-92	1993-96	1997-98
Dietary reconstruction	3	6	6	7	7	6	2
Taxonomy	3	3	7	6	3	4	2
Domestication	5	2	1	2	2	5	2
Morphological assessment	6	5	2	2	0	1	1
Derived measurements	0	1	4	6	4	10	2
Ageing animals	1	0	2	6	4	3	1
Extraction techniques (hunting, ...)	1	2	2	4	4	7	4
Phytoliths	1	0	0	0	0	1	1
Climate reconstruction	1	0	1	2	1	0	0
Bone-chewing	1	0	0	0	0	0	0
Ethno-archaeology	1	0	0	0	1	3	0
Environmental reconstruction	0	4	6	2	14	5	3
Taphonomy	0	2	0	12	11	19	2
Bone tool-making	0	0	3	0	0	3	0
Wool/hair analysis	0	2	3	0	0	0	0
Seasonality	0	2	4	2	2	2	1
Dating	0	1	0	0	0	0	0

TABLE 3

Tabulation of zooarchaeological topics published 1969-1998 in *Journal of Archaeological Science.*

this study, as researchers explored the applications of thin-sectioning to tooth morphology.

The appropriate quantification of faunal samples has been of concern to zooarchaeologists since before the period of this study, and continues to be important, as the number of papers on the topic published between 1993 and 1996 demonstrates. This concern is, no doubt, partially fueled by the detailed information storage and processing made possible by access to computers, and the numerical structure to data tables that applications employ.

The large number of papers on environmental reconstruction in the late 1980s and early 1990s are partially to the extensive debate on anthropogenic sources of faunal extinction, megafaunal and otherwise, that made its way into the literature. This debate seems to have subsided at the present time.

Taphonomic studies in zooarchaeology have flourished throughout the past 30 years. This topic has probably benefitted from cross-over research in early hominid studies, which seem to exhibit increased impetus as well, possibly as a result of changing political landscapes in Africa and the Near East. The increase in fossil hominid studies funded by American institutions may also be a function of changing political landscapes in the U.S., as the passage of repatriation laws has blocked access to collections of Native American remains.

Although zooarchaeology has moved beyond the basic goals of dietary reconstruction, it continues to be important. Stable isotope analysis has also fostered new interest in the topic; the first article that included stable isotope analysis was published in JAS in 1986.

Another significant trend in topical studies is a renewed interest in reconstructing foraging economies and extractive techniques. Eleven papers

were published on this subject in JAS since 1993. In a similar vein, there has been a renewed interest in seasonality. New analytical techniques for extracting information from malacological samples may be responsible for this resurgence of interest.

An effort was also made to identify the country in which the published research took place (see Table 4). The most common countries listed were the United Kingdom, the United States, South Africa, and Israel. Southeast Asia and the Asian mainland were noticeably under-represented in the journals utilized for this study. The causes for this are unknown, as there is a dearth of both Asian nationals and foreign researchers publishing on zooarchaeological topics. This suggests national research agendas, international politics, and language barriers may all play a role, depending on the specific country.

AUTHOR CHARACTERISTICS

Country of origin

The country of origin for each author was identified from contributors' profiles (WA), or from professional affiliations (IJO, AZ) (see Table 5). Contributors who changed countries of residence during the years covered by this study were tabulated as being affiliated in more than one place. This was, however, the only reasonably easy way to identify the scientific communities that were contributing the most to these journals. BAR and JAS are excluded from this discussion, as it was not possible to identify the nationality of the majority of the authors.

Despite a relatively long history of publication, WA authors were primarily from the United Kingdom and former colonies, including the United States. IJO had a much wider distribution of nationalities of its authors, and contained the highest proportion of Asian authors of any of the journals in this study.

Gender

To assess gender characteristics of the population of researchers involved in zooarchaeological researchers over time, the gender of authors was monitored (see Table 6). It is assumed here that both genders were equally motivated to publish research results and had similar opportunities to do so, once the analysis was completed. Publication, therefore, would be a more appropriate means to monitor research activities than conference participation or even professional society membership. These professional opportunities may be linked to employment, and employment parity cannot be assumed, especially among the older cohorts of zooarchaeologists, if the development of archaeology in the United States serves as a model for other countries.

It was not always possible to determine the gender of the author, as several of the journals (IJO and JAS) encouraged the use of initials rather than first names in listing authors. They were also the most frequent publishers of papers by Asian researchers, whose authors' first names were unfamiliar to this Western author.

Overall, the proportions of author's genders appear to shift over time, from being male dominated to fluctuations around equilibrium. The causes for this gradual change through time are not clear from the data. As noted, the oldest journal, WA, tended to publish more syntheses addressing a specific topic. Often a guest editor who often solicited papers edited these volumes. A low recruitment of females to the field of archeology in general, and zooarchaeology in particular, might account for a lack of senior women in the field from which to solicit synthetic contributions to edited volumes.

The shift in proportion of female to male authors appears to begin in the early 1980s. It is unclear whether this is due to increased female recruitment to the field, or to the establishment of journals that publish a wider range of articles than WA. It is unfortunate that gender information is not available for authors in JAS. Tracking the gender of authors for a journal with open solicitations that encouraged methodological submissions that was established in the mid-1970s would add additional insight.

CONCLUSION

This review of zooarchaeological articles from five journals spanning the last 30 years has explored the range of variability in article content, choice

EUROPE

COUNTRY	1969-72	1973-76	1977-80	1981-84	1985-88	1989-92	1993-96	1997-98
Austria								1
France	1		1	2	7	2	3	3
Germany				1	1		4	1
Italy				1	3	2	2	4
Lithuania							1	
Netherlands				1	3		1	1
Poland								1
Portugal								1
Spain			1	3	2	1	6	3
Switzerland					1			
Ukraine						1		
United Kingdom	1	4	6	6	4	7	6	7
Balkans								
Bulgaria					1			2
Cyprus		1						
Greece					1		1	2
Hungary				1	1		1	
Serbia					1			
Scandinavia								
Denmark		1		1	1		1	
Iceland					1			
Norway					1			

AFRICA

COUNTRY	1969-72	1973-76	1977-80	1981-84	1985-88	1989-92	1993-96	1997-98
East Africa								
Kenya				1		1	2	
Madagascar						1		
Malawi	1							
Sudan		1			3	1		
Tanzania					1	1	1	1
Zaire								1
North Africa								
Algeria				1				
Egypt				2	1	4	4	1
Libya						1		
South Africa								
Botswana								2
Namibia						1		
South Africa	1	1	1	2	6	6	3	1
West Africa								
Mali			1		1			
Senegal						1		

TABLE 4

Countries hosting zooarchaeological research, 1969-1998.

THE PACIFIC

COUNTRY	1969-72	1973-76	1977-80	1981-84	1985-88	1989-92	1993-96	1997-98
Australia	1	1	1		1	2	2	1
Cook Islands				1			1	
Easter Island						1	1	
New Guinea					1			
New Zealand		3	3		1	2	1	3

ASIA

COUNTRY	1969-72	1973-76	1977-80	1981-84	1985-88	1989-92	1993-96	1997-98
China								1
India								1
Japan			1		1	1	8	1
Philippines					1			
"Siberia"					1	1	3	1
Thailand	1	1	2					

THE AMERICAS

COUNTRY	1969-72	1973-76	1977-80	1981-84	1985-88	1989-92	1993-96	1997-98
Argentina							2	
Mesoamerica		1						
Peru			3		2		1	
Mexico			1					2
United States				1	3	10	10	7
Canada						2		2
Bolivia						1		
Greenland								1
Patagonia								1

THE MIDDLE AND NEAR EAST

COUNTRY	1969-72	1973-76	1977-80	1981-84	1985-88	1989-92	1993-96	1997-98
"Arabia"						1		
Iraq					1			
Israel		3		3	1	3	2	1
Jordan			1			1		
Lebanon		1						
Syria		1	1				2	

TABLE 4 (CONT.)

of journal, and gender and nationality of author. This variability can be linked to a variety of factors, including changes in the demography of the profession, changes in opportunities for employment and publication in specific countries, and opportunities for study and travel, as the borders of countries open and close in response to local politics. However, many of the themes of the publication have remained relatively constant across journals and through time.

Site reports and the publication of raw data continue to be important, although there is more emphasis on interpretation. Faunal data is used increasingly to answer a wider range of questions than simply economy and climate. These data have been used as a reference point when interpreting rock drawings, reconstructing ethnicity, and interpreting religious symbolism.

Zooarchaeological studies have provided the impetus for tooth sectioning studies, models for

EUROPE

COUNTRY	1969-72	1973-76	1977-80	1981-84	1985-88	1989-92	1993-96	1997-98
Belgium					2	2	7	
Bulgaria								1
Denmark					2		1	1
France					11	6	3	1
Germany	1			1	6	6	7	
Greece					1			
Hungary				1	5		2	
Italy					3	2	2	3
Lithuania							2	
Netherlands					10	2	1	2
Norway							1	
Poland							2	4
Russia				1	4	2	6	4
Spain					1			
Sweden					3			
Switzerland					4	2		
United Kingdom	1	1	2	5	12	19	18	10

AFRICA

COUNTRY	1969-72	1973-76	1977-80	1981-84	1985-88	1989-92	1993-96	1997-98
Senegal						1		
South Africa				2	6			

THE PACIFIC

COUNTRY	1969-72	1973-76	1977-80	1981-84	1985-88	1989-92	1993-96	1997-98
Australia	1					2	1	
New Zealand		2	1		1			3

ASIA

COUNTRY	1969-72	1973-76	1977-80	1981-84	1985-88	1989-92	1993-96	1997-98
China								2
Japan							12	2
Philippines					1			

THE AMERICAS

COUNTRY	1969-72	1973-76	1977-80	1981-84	1985-88	1989-92	1993-96	1997-98
Argentina					1	1	1	
Mexico								
United States	7	1	5	7	16	14	5	4
Canada		1	1		2	3	8	3
Panama						1		

THE MIDDLE AND NEAR EAST

COUNTRY	1969-72	1973-76	1977-80	1981-84	1985-88	1989-92	1993-96	1997-98
Israel				1		3	10	4

TABLE 5

Country of Affiliation of Authors of Zooarchaeological Publications, 1969-1998. (Data from WA, BAR, IJO, and AZ).

Year	*World Archaeology*			*British Archaeological Reports*			*Archaeozoologia*			*International Journal of Osteoarchaeology*		
	Female	Male	(?)	Female	Male	(?)	Female	Male	(?)	Female	Male	(?)
1969-72	1	8	(1)									
1973-76	0	8										
1977-80	3	5		6	9	(9)						
1981-84	1	8	(1)	18	28	(14)						
1985-88	1	1	(3)	8	7	(1)	30	31	(3)			
1989-92	1	1	(1)	3	2	(1)	13	27	(4)	2	7	(7)
1993-96				0	0		14	17	(16)	10	21	(13)
1997-98				3	7	(2)				15	22	(14)

TABLE 6
Gender of Authors of Zooarchaeological Papers from four selected journals, 1969-1998.

domestication, ageing and sexing of animals, and stable isotope analysis. The first mDNA zooarchaeology paper in the study was published in 1997; it is likely that this analytical tool will become more common in the future. There also appears to be a relatively constant concern with site formation processes and quantification issues pertaining to derived measures of assemblage characteristics.

Although this study was intended to document the development of international trends in zooarchaeology, the corpus of papers examined here suggest that by the early 1970s the basic goals of zooarchaeology were established in terms of development of appropriate methodology, faunal interpretations, and research agenda. The most significant changes appear to be demographic, in terms of gender composition, nationality, and research landscape. This suggests that we would have to look at the previous 30 years, or more to see a significant change in the ways that faunal data were used in archaeological research.

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I am grateful to Dr. Elizabeth Moore and Dr. Lynn Snyder for their invitation to participate in their symposium at the 1998 ICAZ meetings. I am also grateful to Mr. David Reser, Library of Congress for obtaining titles and abstracts of all of the LOC holdings of BAR reports, and for the table of contents for all published issues of AZ. As always, I am grateful to my husband, Chris, for his assistance in editing and graphics.

Book Reviews

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THE COMPARATIVE OSTEOLOGY OF EUROPEAN CORVIDS (AVES: CORVIDAE), WITH A KEY TO THE IDENTIFICATION OF THEIR SKELETAL ELEMENTS. Polish Academy of Sciences, Institute of Systematics and Evolution of Animals, Krakow, 102 pp., 148 fig., XX tabl. ISBN 83-907187-8-2. *T. Tomek & Z.M. Bochenski* 2000.

Cet ouvrage étudie les caractères ostéologiques distinctifs des Corvidés d'Europe, c'est à dire des espèces suivantes: *Corvus corax, C. corone, C. frugilegus, C. monedula, Pyrrhocorax pyrrhocorax, P. graculus, Garrulus glandarius, Pica pica, Nucifraga caryocatactes*, *Cyanopica cyanus* et *Perisoreus infaustus*. Et il donne également les mesures de tous les principaux éléments du squelette, crânien et post-crânien. Le plus grand nombre possible de squelettes de ces espèces a été examiné et mesuré, provenant des plus importantes collections ostéologiques d'Europe. Ceci est important pour les espèces qui sont relativement peu représentées dans les collections de référence, comme *Cyanopica cyanus, Perisoreus infaustus, Pyrrhocorax pyrrhocorax.*

Ce travail sera particulièrement utile pour tous les archéozoologues et les paléontologues spécialistres d'oiseaux, car les Corvidés sont toujours bien représentés dans les gisements. Certaines espèces de taille voisine comme les deux Corneilles, noire et mantelée, *Corvus corone corone* et *C. corone cornix*, d'une part, et le Corbeau freux, *Corvus frugilegus*, d'autre part, sont très difficiles à distinguer et pourtant leur identification est importante car les corneilles correspondent à un environnement plus forestier que celui du Corbeau freux. Pour les petits Corvidés, l'identification précise de *Perisoreus infaustus*, le Mésangeai imitateur, et de *Nucifraga caryocatactes*, le Cassenoix moucheté, apporte des éléments indiquant la présence de grandes forêts, surtout de conifères, sous un climat froid, tandis que celle de *Cyanopica cyanus*, la Pie bleue, récemment trouvée à l'état fossile à Gibraltar (Cooper & Voous, 1999), a permis de résoudre un problème biogéographique qui était longtemps resté sans réponse.

Tous les éléments du squelette ont été passés en revue, y compris ceux qui sont rarement étudiés, tels que le carré, la furcula, la scapula ou la première phalange du doigt majeur de l'aile, et tous les caractères distinctifs sont illustrés par des schémas.

Mais le plus grand mérite de cet ouvrage, à mon avis, est d'avoir montré que les caractères ostéologiques distinctifs ne sont pas toujours obligatoirement présents chez tous les individus d'une même espèce, et d'avoir quantifié leur variabilité. Cependant, lorsque un caractère n'est pas parfaitement exprimé, mais s'il y a d'autres caractères présents et concordants, on peut considérer qu'il y a une bonne probabilité pour que l'os examiné appartienne à une espèce donnée. Les auteurs insistent sur la nécessité de ne pas se contenter des dessins pour déterminer une pièce, mais de la comparer avec une collection de référence d'espèces actuelles, afin de bien repérer le caractère indiqué sur le schéma. Les caractères n'étant pas toujours présents sur tous les individus d'une même espèce, il est également nécessaire d'avoir des collections de référence comportant plusieurs individus. Cette reflexion sur le nombre minimum d'individus nécessaire pour déterminer des restes d'oiseaux avait déjà fait l'objet d'un article des mêmes auteurs (Bochenski & Tomek, 1995).

L'étude biométrique a permis de montrer que les sept espèces pour lesquelles il y avait un matériel de comparaison important présentaient un dimorphisme sexuel. L'analyse des caractères ostéologiques a permis en outre de tirer des conclusions sur les relations de parenté entre les différents genres étudiés. *Perisoreus*, par exemple, présente un plus grand nombre de caractères communs avec *Garrulus* et *Cyanopica* qu'avec les autres genres, et *Pyrrhocorax* présente plus de caractères communs avec *Corvus*.

En conclusion cet ouvrage constitue un outil vraiment précieux pour la détermination des avifaunes pléistocènes d'Europe et je remercie très sincèrement T. Tomek et Z. M. Bochenski d'avoir réalisé ce travail extrêmement minutieux et détaillé.

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THE ARCHAEOLOGY OF ANIMAL BONES. Stroud, Gloucestershire (U.K.): Sutton Publishing Limited. 206 pp. (Price £30.00). *Terry O'Connor* 200

Among the zooarchaeological (or archaeozoological, if you so prefer!) fraternity, Professor Terry O'Connor is widely recognized and respected as one of the established experts in the field, with over twenty years of research and teaching experience behind him. Having such a sound professional background it comes as no great surprise that O'Connor has written a splendidly lucid book and one which provides a good overview of current theories and methodological procedures in faunal studies. It is however not written for the benefit of fellow professionals but is instead clearly intended as an introductory guide for undergraduate students, providing them with a series of up-to-date critical reviews of many of the core themes familiar to more advanced faunal analysts. As a beginner's handbook, it fulfils this role admirably while avoiding any tendency towards becoming a tiresome, didactic instructional workbook directing *how* animal bones from archaeological sites *ought* to be examined, analysed and interpreted. This point is specifically highlighted by O'Connor in the preface and reinforced by his declared objective to "give sufficient detail about the development of methods and ideas to allow readers to draw informed conclusions about the best way to proceed" in their own studies.

All the methods and theories covered in this book are arranged in a straightforward format under well-defined broad-headings, and supported by a comprehensive index; enabling readers to directly access particular information they are seeking – allowing them to delve into the text as required, skipping past sections not of immediate concern. For readers requiring an overview of zooarchaeology, however, and who are prepared to read through the book as a whole, the topics taken collectively will indeed seem to have "coherence as a single work", as O'Connor claims. Although the case studies chosen to illustrate the topics covered do include those from a wide geographical and temporal distribution (ranging from Pleistocene Africa to Post-Medieval England) there is an apparent and inevitable bias towards those from British and north-western European Roman and Medieval contexts (as admitted by O'Connor himself in the preface), which is entirely understandable given the author's professional background. This in no way detracts from the value of the book as a more general introductory guide to the subject as irrespective of their origins, the methodologies and theories expounded will have wide applicability whether the student eventually finds him/herself working as a faunal analyst on material from Europe, North America, Near East or further afield.

The book begins (Chapter 1) with a brief personal account of how Professor O'Connor came to be involved in zooarchaeology. It is fascinating to learn that an eminent pioneer figure in this field, Ian Cornwall, played a role in influencing the author's early studies. Although O'Connor makes no mention of the fact, it is perhaps worth noting in this review that Cornwall's book *Bones for the Archaeologist,* first published as long ago as 1956, represented the nascent prototype for many successive (more comprehensive) handbooks (published in Britain) dedicated to the specialist field of zooarchaeology. O'Connor's book follows in this tradition set by Cornwall - and comparison of the two works reveals just how far the field has developed as a scientific discipline in its own right since those early days forty five years ago. For those of us who first entered this field in the early 1970s, there was still a relative dearth of available reference books to guide our researches, a situation partially remedied by the publication in 1971 of Raymond Chaplin's *The Study of Animal Bones from Archaeological Sites*, a somewhat slender volume of 170 pages but nevertheless useful especially when used in conjunction with relevant chapters in the massive tome *Science in Archaeology* edited by Brothwell and Higgs (first published in 1963 and subsequently revised and updated in 1968) which in that same year (1971) had been re-released in a reprint edition. Interestingly, O'Connor fails to include Cornwall's book in his bibliography but does include Chaplin's. This is perhaps not all that unexpected given that even at the time of its publication in 1956 Cornwall's book was regarded by many as too elementary and noticeably lacking in any consideration of osteometric analytical methods (see Juliet Clutton-Brock's comments made in *Circaea*, in 1993).

Chapter 2 considers the composition, form and growth of bone and examines skeletal structures in mammals, birds and fishes. Taphonomic processes are then reviewed in some detail in Chapter 3, with

an explanation of how these may have impacted and modified the formation and ultimate composition of animal bone-assemblages found at archaeological sites. Aspects of sampling strategies and recovery procedures during the excavation phase are explored in Chapter 4, with medieval Fishergate, York quoted as a case study, showing how mesh size of sieved samples greatly influences the recovery of for example the bones of the smaller bird taxa. O'Connor makes the important observation that although the finer mesh sieve (2 mm) resulted in the recovery of a greater range of species, the additional species so collected over those from the coarser (12 mm) sieve, were "mostly small commensal birds of little archaeological significance" (at least in the context of this particular project), leading him to acknowledge that the selection of a "recovery method [has to be] a compromise between the desire to recover as much as possible of what is in the deposit, and the need not to build up a logistically impossible backlog of material to sort, identify and record". This fundamental and sensible dictum is sometimes unheeded even by the more advanced practitioner in zooarchaeology in the enthusiasm following discovery of a particularly bone-rich deposit – and its emphasis in O'Connor's book is therefore fully justified.

Chapters 5 to 10 form the bulk of the book and cover the principal methodological themes which characterize zooarchaeological research: identification, recording and measuring bone specimens; quantification (including establishing the minimum number of individuals/ body-part representation in a particular species); ways of estimating age at death and sexing bones; recognising and describing evidence of pathologies; investigating and understanding non-metrical traits. In Chapter 5 O'Connor rightly emphases the importance to future colleagues of properly curating and storing animal-bone assemblages once a study is completed; pointing out that the bones will be far more valuable to them than any paper or electronic database of the material produced. Based upon his own experience, O'Connor believes that reinterpreting someone else's records is a poor substitute for going back to the actual bones themselves (the primary record) in order to investigate in greater depth aspects perhaps not fully considered or which may even have been overlooked entirely by the original researcher.

In Chapters 11 – 14, O'Connor demonstrates using case studies how application of zooarchaeological theories and methodologies is not merely confined to providing information about the animals themselves but often extends to addressing archaeological questions about the relationships between those animals and their human contemporaries. Among the topics chosen to illustrate this aspect is the role of humans as predators/big-game hunters. This is examined with reference to Paleoindian bison kills on the North American Plains and the hunting of large ungulates (red deer and reindeer) in late Pleistocene and early Holocene northern Europe. Also reviewed is how animal bone studies contribute to our understanding of the development of animal husbandry and the origins of the major domestic animals. While these domesticated animals played a positive role in the lives of humans, other animals who became associated with the inhabitants of the early agricultural settlements were to prove not so beneficial – and even harmful. Among this latter group were the commensal rodent species, particularly rats which were destined to become "mankind's worst enemy", and as O'Connor outlines in his book, these unwelcome pests later spread globally, a process unwittingly facilitated by humans themselves as a consequence of their expansion in trading contacts. It was from bones excavated from urban refuse deposits in York and London that faunal analysts first discovered that the black rat had spread to Britain as early as the Roman period (contrary to earlier held notions that this species had been brought back in the ships of returning crusaders in the medieval period). Urban refuse deposits have also provided insight into the economic relationship between the towns/cities and their respective rural hinterlands, a topic examined in depth by O'Connor in Chapter 14 with particular reference to case studies from Britain.

The final chapter in the book (Chapter 15) briefly considers the future direction of zooarchaeological studies and the contribution new scientific advances (e.g. analyzing ancient DNA) may make to these.

In summary, this book is highly recommended to all archaeological students who have aspirations of later specializing in studying animal bones – for whom this book should be considered as essential (required) reading. It is then recommended that the novice zooarchaeologist then reads Reitz and Wing's *Zooarchaeology* (1999) which will provide insight into more advanced methodological procedures and theories not covered in O'Connor's

book. It is perhaps unfortunate that O'Connor's book does not have the same quality of line drawings, schematic diagrams and tables as those in Rietz and Wing's work.

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PREHISTORIC AGRICULTURE IN SOUTHERN SPAIN DURING THE NEOLITHIC AND THE BRONZE AGE. THE APPLICATION OF ETHNOGRAPHIC MODELS. B.A.R (International Series) 818. Archaeopress. Oxford, 167 pp., ISBN 1 84171 031 8. *Leonor Peña-Chocarro* 1999.

A novel approach to the study of prehistoric agriculture in a small region of the inner Andalucia is presented. The subjects of this study are two different sites in this area, one from Neolithic and Calcolithic levels at Cueva de los Murciélagos, and the other is a Bronze one at Peñalosa. The understanding of the daily farming works of the inhabitants at these sites was approached in a well differentiated two steps project. First, comprises the careful collection and analysis of the botanical macroremains (fruits, seed and parenchymous tissues of rots and tubers) using a rigorous methodology. The second, and more innovative, means to apply the existing ethnographic documentation about crop processing, especially wheat, in some restricted areas of the Mediterranean basin, where nowadays still carry on this process in a non-mechanical way.

Most of the archaeobotanic researches working in Spain, independently on their specialisation subject (pollen, seeds, fruits, textile plants, phytoliths or charcoal), have been trained outside Spain. The author is not an exception. She followed her PhD training at the *Institute of Archaeology of London*.

During the first half of present century, the references to macrobotanical remains are very scarce, however fruits and seeds are not so infrequent when a methodical search is done. Tellez & Ciferri (1954) could be considerated the pioneers, after publishing the *corpus* of Spanish archaeological wheats. In the following three decades, most of the fruits and seeds recovered from peninsular sites were studied by Hopf (1987), unfortunately the vast majority of these materials were sampled with no-systematic criteria. The goals of this early works was mainly to identify the different species, establish presence/absence patterns, as well as origin and the diffusion paths. On the other hand, almost nothing is said about the agrarian practices that could be suggested by these finding.

In this book Peña-Chocarro follows the steps of G. Hillman, who during the early 80´s starts a new research line, that propose the use of ethnographic models to understand the meaning of archaeobotanical remains.

Ethnographic models had focused on Easter Mediterranean (Turkey, Greece, Syria), in some geographic, cultural and politic isolated areas, where traditional agrarian practices survive throughout centuries. The main interest of this book, as the author point out, is to be the first for the Western Mediterranean. In fact, the first and the latest until today, in spite of the five years from the submission as doctoral thesis, until now that come to us in a book format.

Following a conventional thesis style, the work is structured in 9 chapters. The terseness is greatly appreciated unless some part could be considered brief in excess, like chapter 1, where objectives are exposed in terms of to interpret archaeobotanical remains according with the presumed human activities, or the final conclusion.

After briefly, but correct exposition about the present state of research on prehistoric agriculture in Spain (Chapter 2), come the presentation of the chosen sites: Cueva de los Murciélagos and Peñalosa (3). In the fourth is outlined the methodology procedure in the recording the etnographic information as well as arhaeobotanic material. The needed of the application of a rigorous sampling of the site, and the utilisation of flotation systems, to maximise the recovery of macrobotanical remains, is strongly emphasized.

In the most innovative chapter (5), the results of ethnographic fields studies are displayed after several months of consultations, coexistence with the farmers and even participation in the agrarian work, which was carried out, following the traditional way, in rural areas of South Asturias, and provinces of Cádiz, Córdoba and Jaén. Furthermore, the author brings forward an excellent photographic collection about the different phases involved in the glume-wheats processing, although, the quality of impression is no as good as desired.

The main body of the book are chapter 6 and 7, which are divided into several sections. In the first one, and with the support of a large number of tables, the results of the archaeobotanical analysis from Cueva de los Murciélagos and Peñalosa are presented. In the second one, the author examines the results of ethnographic observations recovered in Spain, based exclusively in the processing of

hulled wheats, like einkorn, emmer and spelt. In the followings sections an approach between archaeobotanical and etnographical data is attempted. The problem comes later on, as the identified cereal species from both sites, are chiefly barley and free-threshing wheats. As the own author says (p: 110), the application of Spanish ethnographic model is not useful to illustrate the main cereal findings from Cueva de los Murciélagos and Peñalosa. To sort this handicap, the author resorts to apply the model proposed by Jones (1984) for free-threshing wheats in Greece. The identification of different agrarian process is possible by the statistical comparison between archaeobotanical samples, and the ethnographic data (Chapter 7).

Finally, the author reviews individually the species that has been identified, as well as the roll played by these species in the ancient human communities. The possibility to trace the different agrarian works at the sites is also reviewed, according with the finded remains.

In Cueva de los Murciélagos the low number of items do not allow the needed statistical treatment, but shows the main trend, that seems a rule in the Western Mediterranean during Neolithic Age, were free-treshing wheats are predominant (Buxo 1997). A key contribution is the first evidence of poppy's use. The documented seeds of *Papaver somniferum* from Los Murciélagos gives the oldest European chronology for de human use of poppy.

The range and number of plants identified at Peñalosa is significant, but not enough to get a final conclusion about the agricultural practices followed at the site (p: 136). This is much due to the needed of fire, spontaneous or provoked by man, to preserve the plants remains by charring, but also is affected by depositional factors. Anyhow, the author evaluates a number of evidences that shows Peñalosa as an agrarian processing centre, always after Hillman's premises.

The use of etnographic models in archaeology renders interesting results (Hillman, 1984; Jones, 1984) in order to state if a site is a production centre or not, it also allows to differentiate between the diverse practices, crop systems, etc. On the other hand the use of theese models has a number of limitations, pointed out in this book. First of all, in order to use an etnographic model, is needed to have it available, but also is needed that the quantity and quality of the remains allow a statistical treatment. There are a number of reasons that make it difficult to put both requirements together.

In brief, the book offers a novel treatment of achaeobotanical remains from two Spanish sites, but at the same time shows the difficulties in the use of etnographic models in order to give a full meaning to these remains. Perhaps the mayor contribution of this work is the detailed documentation about glume-wheats processing, from the seeding planning to final consumption, according with traditional procedures, in a country like Spain, where is rare to find areas where this process is still carry on in a non-mechanical way. Unfortunately, the chances to collect these informations are day by day reduced. This is why this work is so valuable.

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FISCHEREI UND FISCHHANDEL IM MITTELALTER. Wirtschafts- und sozialgeschichtliche Untersuchungen nach urkundlichen und archäologischen Quellen des 6. bis 14. Jahrhunderts im Gebiet des Deutschen Reiches. Matthiesen Verlag, Husum. *Angelika lampen*, 2000.

Die Fischereigeschichte und Teichwirtschaft im Mittelalter ist in Deutschland bis jetzt kaum eingehend erforscht worden. Einzeluntersuchungen sind zwar vorhanden- insbesondere der hansische Herings-und Stockfischhandel-, aber keine Arbeit, in der urkundliche und archäologische Quellen des 6. bis 14. Jahrhundert dargestellt werden. Diese Arbeit, zusammen mit der Ichtyiologischen Auswertung über die Fischerei in der Nordsee von Bødker Enghoff (2000) erlauben es, über umfassende überregionale Studien zu verfügen und Forschungslücken zu schliessen.

Ziel der Arbeit von A. Lampen war nach Ursachen für die Entstehung des überregionalen und internationalen Fischhandels zu forschen und zu prüfen, ob traditionelle Forschungstopoi, wie z.B. christliche Fastengebote, als der eigentliche Grund für den Aufschwung der Fischerei weiter anzusehen ist.

Unter anderem werden 2200 Urkunden des ostfränkischen-deutschen Reichs, sowohl herrscherliche, städtische wie auch adelige Diplome mit einer Datenbank erfasst, um Aussagen über den Bedarf des Fischkonsums, der Fangtechniken und der Entstehung des Marktes zu erhalten. Die Herrscherukunden zur Fischerei erfassen die rechtlichen Verhältnisse und die herrschende Rechtpraxis und bestätigen heufig ältere Rechte der Empfänger, hauptsächlich italienische und alpine Klöster und Kirchen. Bei den städtischen Ukunden wurden norddeutsche und süddeutsche Städte betrachtet, um Vergleiche zwischen Küstenregionen und Binnenland herzustellen. Es wird auch in klösterliche und adelige Haushaltsverzeichnisse eingesehen die Auskunft über die Fischerei geben.

In der Völkerungswanderzeit und im Mittelalter waren Fische eine geschätzte Nahrung. Neben dem Hauptnahrungsmittel Getreide waren sie, zusammen mit Fleisch und Laktizinien ein wichtiger Eiweissspender. Ihr reichhaltiges Vorkommen an Küsten, in Flüssen und Seen bot eine sichere Zusatzversorgung, die nicht, wie andere Tier- oder Pflanzenarten, abhängig von klimatischen Schwankungen, Kriegs- oder Seuchenzüge waren. Um den Wert der Fische innerhalb der Nahrungsmittel zu erkennen, greift die Autorin zu den verfügbaren Preislisten, die für Deutschland erst seit Mitte des 14. Jahrhunderts vorliegen. Zusammen mit Angaben aus anderen Ländern ergab sich, dass konservierte Fische wie Hering und Stockfisch auch im Binnenland noch erschwinglich waren, während andere Fischarten, wie Hecht, Lachs oder Stör sogar als *Herrenspeise* galten.

Im Mittelalter gab es ca. 150 Fasten- bzw. Abstinenztage im Jahr. Ein grosser Teil der Bevölkerung nahm an normalen Fastentagen Nahrungsmittel wie Getreide, Hülsenfrüchte, Hering oder Stockfisch zu sich. Klöster galten tradizionell als Hauptabnehmer für Fische im Mittelalter, da die Benediktsregel verbat, vierbeinige Tiere zu konsumieren, Einfluss der sich noch auf spätere Orden wie die Zisterzienser oder die Cluniazenser bemerkbar machte. Fische galten als *Flussgemüse* und waren daher als Fastenspeise erlaubt. Viele Klöster bestrebten sich ausreichende Fischmengen anzuschaffen und ausserdem Ihre Fischereirechte schriftlich zu fixieren, da die Anzahl der Mitglieder ständig stieg, insbesondere in der Karolingerzeit, wo die Grossklöster bis zu 600 Mönche und die *familia* dieser Abteien mehrere tausende Personen umfassen konnten. Nutzniesser dieser Verleihungen waren hauptsächlich die Klöster, wie auch Bistümer, Domkapiteln und Kirchen, während Laien selten genannt wurden.

Um die Nahrungswohnheiten nicht nur anhand der schriftlichen Quellen zu analysieren, können Heutzutage einige archäologische Funde aufschlussreiche Information liefern. Speiseabfälle aus den Abfallgruben, Latrinen und Küchen der Klöster erlauben es zu überprüfen, in wie weit das Fleischverbot eingehalten wurde, ob es interne Standesunterschiede gab oder ob es sich dabei um Süsswasserfische aus der Umgebung, oder um importierte Arten handelt.

Leider sind bis jetzt vorbildliche Grabungsmethoden mit Schlämmverfahren in zahlreichen Klosteranlagen nur in einigen Ländern durchgeführt worden. Ichtyoarchäologische Analysen sind von England, Niederlanden und Belgien bekannt. Im deutschen Bereich haben solche Auswertungen kaum stattgefunden, deshalb sind Vergleichsbeispiele aus den benachbarten Ländern vorgestellt worden. Auch wenn in den Funden aus dem Westminster Abbey Salzwasserfische, wie Stockfisch und Hering überwiegen, nutzte die lokale Fischerei kaum. Das Konvent von Utrecht in Niederlan-

den und das Benediktinerkloster Ename in Ostflanden benutzten, trotz importierer Ware auch ihre einheimische Ressourcen, während im französichen Kloster Charité-Sur-Loire nur Süsswasserfische identifiziert wurden.

Die Fische in nichtchristlichen Siedlungen waren auch aufgrund ihrer Nahrhaftigkeit und reichen Vorkommens ein wichtiger Bestanteil der Grundernährung. Die Siedlungen ergaben verschiedene Resultate in ihren Auswertungen: in Ralswiek in Rügen war die bevorzugte Fischart der Hering, der in Menzlin auch verarbeitet wurde, während in Mecklenburg eher Süsswasserfische konsumiert wurden. Angelika Lampen besteht in ihrer Arbeit darauf, das nicht nur die Fastengebote für den Aufschwung der Fischereiwirtschaft verantwortlich waren sondern auch der ständige Bevölkerungszuwachs und die steigende Stadtentwicklung, die seit dem 12. Jarhundert neue Bevölkerungsstrukturen aufweist. In diesen neuen Zentren, wie auch in kleineren Siedlungen, belegen die Urkunden, dass Fisch ein Hauptbestantteil der Nahrung war.

Die rechtlichen Voraussetzungen des Fischereihandwerks ist ein anderer interessanter Aspekt, der untersucht wird. Es hat sich herausgestellt, dass das Recht zum Fischfang meistens als ein unabhängiger Rechtstitel galt, insbesondere auf königlichen Gütern. Es konnte aber auch als Bestantteil des Grundeigentums vergeben werden. Andernfalls, die Nutzungsrechte in grossen Wasserläufen durch den Bau von Fischwehren verursachten Komplikationen mit der Schiffahrt und wurden anders geregelt. Für den behandelten Zeitraum muss für das deutsche Reich hervorgehoben werden, dass es kein einheitliches Fischereirecht für die Binnenfischerei gab. Die Fischereirechte konnten sowohl räumlich- in Form von einzelnen Netzügen-, wie auch zeitliche Einschränkungen (einzelne Wochentage, auf Lebenszeit) oder mengenmässig, d. h. für den Eigenverbrauch beschränkt werden.

In Bezug auf die Geräte der Binnenfischerei stehen diese im Zusammenhang mit dem rechtlichen Status des Betreibers. Es gibt für diese Zeit kaum schrifltiche Quellen, sondern die Hauptinformation stammt von der die Archäologie. Da in den verschiedensten Kulturkreisen sich selbständig ähnliche Fangmethoden entwickelt haben, ist es möglich, Analogieschlüsse herzustellen, Hinzu kommt die geringe Entwicklung der Geräteformen seit der Steinzeit. Erst die Technik im 20. Jahrhundert hat die Fischerei grundlegend verändert. Die Fangtechnik ist abhängig von der Fischart und seinen Lebensweisen. Schwarmfische werden vor allem mit grossen Netzen gefangen. In Bodennähe schwimmende oder einzelne Fische werden geangelt und Wanderfische wie Aale, Lachse, Forellen und Störe mit Fischwehren und Reusen gefangen. Bei den Methoden werden Speerfischerei,- die für das Mittelalter keine grosse Rolle mehr spielte-, die Angelfischerei mit Haken, Knebeln oder Legangel, die Netzfischerei (Stocknetz, Wurfnetz, Schleppnetz), Fanggeräte wie Fischfallen und Wehren beschrieben. Über die Organisation der Fischerei mit Wehren sind besonders die Aussagen der Herrscherdiplome und die städtischen Urkunden wichtig. Bei den ersten scheint es meistens um Schenkungen an die Klöster zu handeln, aber später ab dem 12. und 13. Jahrhundert wurden Fischwehre auch an Bürger verkauft oder verpachtet.

Fischer als Berufsbezeichnung taucht in den Urkunden seit dem Frühmittelalter auf. Es handelt es sich sowohl von den Klöstern, Adelshöfen oder auch von Städten abbhängige Fischer. Die abhängigen Fischer von Klöstern gehörten als Laien zur *familia* der klösterlichen Haushalte und wurden von diesen versorgt und untergebracht. Obwohl die klösterliche und adelig abhängige Fischer z. T. wie ihre Anlagen selbst bei Güterschenkungen übertragen werden konnten, scheint doch dieser Berufstand über gewisse Rechte verfügt zu haben. Fischer, die zu städtischen Berufsgruppen gehörten, lebten in Wohngebieten die über ihren Beruf Auskunft gaben. Reminizsensen dieser Aktivität werden z.B heutzutage durch Strassennamen wie *Fischerstrasse* in Lübeck, Schleswig, Ulm oder Minden belegt. Es gab aber auch freie Bürger, die auf eigene Kosten Fischwehre von Städten pachteten und sogar eigene Fischereiunternehmen aufbauten.

Über 10% der ausgewerteten Urkunden beschäftigen sich mit der Teichwirtschaft. In bisherigen Forschungen galt, dass die Karpfendomestikation und Zucht in aufwendigen Teichanlagen ein Höhepunkt klösterliches Wissen- und Witschaftslebens darstellte. Diese These stimmt nur zum Teil. Die Analyse der Urkunden zeigen zwar, dass die kirchlichen Institutionen die Wegbereiter der Teichwirtschaft in engem Zusammenhang mit der Einführung im 9. Jh. von Wassermühlen stehen, aber bereits ab dem 13. Jahrhundert wird die Karpfenzucht vom Adel als lukrative Einnahmequelle erkannt und weiter ausgebildet. Auf diese Weise wurde der Karpfen der

wichtigste Teichfisch Europas. Die domestizierte Form konnte die ursprüngliche Länge (50 cm) verdoppeln und das Gewicht von ca. 1 kg auf 30 kg erreichen. Dokumentation und Befunde von Karpfen gibt es in Europa erst ab dem 13 Jahrhundert. Ein Jarhundert später tauchen Karpfenknochen sowohl in Siedlungen, in Klöstern, als auch in Adelsitzen auf, wo die Teichzucht den Kauf von Seefischen weitgehend ersetzt, während die Städte die Nutzunzrechte gegen die Hälfte des gefangenen Fisches verpachteten aber durch die grosse Nachfrage auf den Handel von konserviertem Seefisch angewiesen war.

In Bezug auf die Seefischerei werden vom historischen und archäologischen Standpunkt die Fangmethoden und Konservierunstechniken einigerer Handelsplätze besprochen: die dänische Halbinsel Schonen und Bergen an der Westküste Norwegens und die Insel Rügen. Der enorme Fischreichtum an den Küsten dieser Handelsplätze, -Schonen wegen den grossen Herinfsfängen,- Bergen wegen des Kabeljaus, ergaben eine Produktion, die weit über den Eigenverbrauch stieg und erlaubte, wichtige Nahrungsmittel wie Getreide und Salz einzutauschen. Es entwickelte sich ausser dem zum Mittelmeer bezogener Handel ein neuer Markt, der die skandinavische Handelskreise die Nord- und Ostsee umschloss und dessen Zentrum Lübeck und die Vereinigung der Hansen wurden. Diese Stadt verfügte über weitverzweigte Handelssyteme mit zahlreichen Absatzmärkten, die ihr eine Monopolstellung garantierten. Zudem war sie der Haupthändler der bedeutenden Salzvorkommen der Stadt Lüneburg, die in Skandinavien fehlten. Eingetonntes Salz wurde zu den grossen Heringsmessen gebracht und als Rückfracht die gleichen Tonnen mit einsalzenem Hering gefüllt. Das Leben der fremden Kaufleute spielte sich innerhalb zugewiesenen Vitten ab, die von den dänischen Königen vergeben wurden und ein Ausmass von sechs bis zehn Hektar hatten. In diesen Arealen konnten Buden, Lagerhäuser, Schuppen in denen die Heringe zugerichtet, verpackt und gekennzeichnet wurden. Die Ausgrabungen belegen diese Einrichtungen bis ca. 1300 als sehr provisorische und spärlich eingerichtete Installationen.

Über den Fang und die Verarbeitung des Herings geben die schriftlichen Quellen kaum Hinweise. In diesen wird aber in Schonen ausdrücklich zwischen Fischfang, der von dänischen Fischern ausgeübt wird und Fischverarbeitung, die von deutscher Hand erledigt wurde.

Die Archäologischen Quellen haben jedoch interessante Resultate erbracht: in Roskilde (Seeland) konnte eindeutig zwischen konsumierten Fischen für Eigenverbrauch in der Wikingerzeit und Shlachtabfälle durch das Auskehlen der Heringe differenziert werden, was für eine industrielle Verarbeitung spricht, zwei Jahrhunderte bevor diese rationelle Schlachttechnik von dem offiziellen Erfinder *Willhelm Beukels* dokumentiert wurde. Auch in anderen Städten wie Kolberg haben die Funde gezeigt, dass schon seit dem 9. Jahrhundert Heringsknochen überwiegen, wie auch Stettin oder Danzig. Die Heringe wurden nicht nur gesalzen oder getrocknet, sondern auch geräuchert, wie es die Räuchergruben aus Wollin belegen. In dieser Hinsicht sind wir der Meinung, dass es mit zukünftigen Funden auch interessant wäre, festzustellen, ob nicht einige von der Antike bekannten Fischkonservierungs-und Verarbeitungstechniken in römischen Siedlungen in Niederlanden und Belgien bis ins Mittelalter überlebt haben könnten, oder ob diese Techniken im Norden nur einem vollkommen lokalen Ursprung haben.

Es wird anderseits auch der Handel des Herings und Stockfisches entlang der Nord- und Ostsee ins Binnenland untersucht. Dabei fungiert Lübeck als Hauptumschlagplatz und kontrolliert einen Dreieckshandel zwischen Skandinavien, England und Flandern der wiederum den internationalen Fischhandel dominiert. Gegen Salz für Schonen bzw. Hopfen und Getreide nach Bergen, transportierten lübecker Kaufleute Hering und Stockfisch, um sie gegen Tuche einzutauschen. In Deutschland entwickelten sich verchiedene Zentren des Binnenhandels, durch den auch von der Küste entfernte Städte, Klöster oder Adelsitze mit konservierten Fischen versorgt wurden, wie z.B. Köln, Frankfurt, Mainz oder Nürnberg. In den Städten sorgte ein spezialisiertes Gewerbe wie die Heringsträger- makler- wäscher und Stockfischaufweicher für die Aufbewahrung und Weiterverarbeitung. Die Heringshäuser, wo die Fische gewaschen und ensaltzt wurden, lagen meistens am Hafen, obwohl bald, wegen der Geruchsbelästigung, diese Installationen aus den Städten verbannt wurden. Von dort aus gelangte der Fisch durch die Heringswäscher - oder träger auf die städtischen Märkte, wobei es in vielen Städten neben Getreide- und Viehmärkte auch Fischmärkte gab, wie z. B. in Hamburg oder Köln. In einigen Städten wie Lübeck, versuchte der Rat Kontrollmassnahmen durchzuführen. Es gab für die Fis-

cher einen Marktzwang, d.h. der Verkauf ihrer Waren war ausserhalb des beaufsichtigten Marktgeschehens verboten. Damit wurde der Fisch für alle zugänglich und zu festgesetzten Preisen verkauft.

Zahlreiche Zollurkunden, die die Abgaben für Hering und Stockfisch auflisten, sind für flandrische und holländische Städte bekannt. Aber auch andere deutsche Städte wie Hamburg, Braunschweig, Halle oder Magdeburg importierten konservierten Fisch. Die Summe der Abgaben und die Form der Verzollung hing von jeder Stadt selber ab und lassen, sowohl für den geläufigen Stockfisch und Hering, wie auch für die restlichen Fischarten keine Verallgemeinerungen zu.

Da bei steigender Nachfrage sich die Fischbestände reduzierten, bedingt durch eine Überfischung, Veränderungen der Flussläufe, wie auch Wasserverschmutzung durch verschiedene Gewerbe, wurden im 14. Jahrhundert Hegemassnahmen durchgeführt, die sowohl die Fangzeiten, wie auch die Fangutensilien einschränkten. Unter anderem, wurden auch Mindestgrössen für die einzelnen Arten festgelegt, die auf den Märkten durch Fischmeister und Marktaufseher kontrolliert wurden. Ein Jahrhundert später übernahmen die Fischerzünfte diese Aufgaben.

Ohne Zweifel handelt es sich um eine sehr ausführliche Arbeit in der, von einem interdisziplinären Standpunkt aus, die schriftlichen Quellen mit all den von der Autorin besprochenen Limitationen, doch sehr ausgiebige und ins Detail gehende Information geliefert haben. Die ausgehenden Fragestellungen über die grosse Nachfrage des Fischkonsums, Fang und Verarbeitungstechniken und des intensiven Handels konnten auch Dank der archäologischen Quellen in vielen Hinsichten alte Thesen wiederlegen, womit dieses Werk ein für den heutigen Forschungstand der mittelalterlichen Fischerei in Deutschland eine obligatorische Lektüre und Nachschlagewerk darstellt.

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DOGS THROUGH TIME: AN ARCHAEOLOGICAL PERSPECTIVE. Proceedings of the 1st ICAZ Symposium on the History of the Domestic Dog; Eighth Congress of the International Council for Archaeozoology (ICAZ 98), August 23-29, 1998 Victoria, B.C., Canada edited by *Susan Janet Crockford.* ISBN 1 84171 089 X 47.00. BAR (International Series) 889, 2000.

Dogs being the first species domesticated by man and also one that has followed him throughout the world constitute *"... the **only** animal that prehistorians around the world have in common"* (vii). Very many good books about dogs have been written in the recent past a good example being the multi-authored volume edited by Serpell (1995) but the one here is a completely different publication. *Dogs through Time* brings together twenty nine contributions of original research presented to the first monographic session ever devoted by an ICAZ Conference to a domestic species. The aim there, as in this book, was twofold: (a) an exchange of information about the history of the dog at a truly global scale and (b) a plea for a more consistent collection and reporting of dog archaeological remains than has been the rule until present. For such reasons this is neither a textbook nor a comprehensive review but instead a seminal contribution intended to enlighten *"... what is presently known (and **not** known) about the history of dogs ..."* (vii) and to focus future research on particulary "hot" issues.

Partly due to the reasons just mentioned, and except for a few cases such as those of Armenia (Manaserian & Antonian) or prehispanic México (Valadez), regional surveys have been only ocassionally conducted and then only on a restricted temporal scale such as the Neolithic for Japan (Shigehara & Hongo), roman Britain (Cram) and Hungary (Bartosiewicz) or slightly larger periods in the case of prehistoric Britain (Clark), Italy (Mazzorin & Tagliacozzo) or the northeastern United States (Handley).This is also the reason for some apparent geographical biases with nine contributions from european sites and none from such emblematic places as China, India, Australia or Africa.

The book has been organized into seven parts that reflect areas of special interest, namely: (1) Evolution & early dogs (seven contributions), (2) Interpreting roles: early practical and ritual uses of dogs (six contributions), (3) Interpreting skeletal variation: the roman influence on breed development (four contributions), (4) Interpreting skeletal variation: non-roman contexts (four contributions), (5) Modern primitive dogs represented by a single contribution reporting on the status of the New Guinea singing dog, (6) Archaeozoological analysis: methods and results (five contributions) and (7) Discussion and additional references which, in addition to a review paper by the editor, includes an extremely useful listing of references on dogs and wolves *"... stressing archaeological occurrences, hybridisation and the process of domestication"*(ix). Since this arrangement is, of necessity, arbitrary, many papers cutting accross boundaries, we will mention them not in the order they appear but when addressing specific issues that, in a somewhat simpler way, we have re-organized under the three headings of (a) origins, (b) intraspecific variability (breed would be a misleading term in our context!) and (c) roles.

The introductory chapter by Juliet Clutton-Brock is far more than what one would derive from its title, a *"... fascinating and quite personal overview of the history of research on dog evolution ..."* to paraphrase the editor once again (vii). Indeed. Through its mere five pages, though backed by a personal experience of more than forty years in the field, Clutton-Brock uses the dog as an "excuse" to reflect on past errors and achievements as well as on the nature of the domestication process as recapitulated through the domestication of the dog. In so doing, she warns us on the dangers of a die-hard behaviorism, the politics of scientific research and the false dichotomies divorcing man from nature setting the stage for what will surely become a radical new vision of archaeozoology in a not too distant future. Clearly, this work transcends the discourses of the papers that are to follow.

The issue of dog origins touches upon a wealth of questions, ideological, methodological and analytical which range from the nature of the agriotype (now resolved at the species level despite authors like Manaserian & Antonian still unsure on whether jackals should still be granted genealogical credit) the problems of hybridisation and introgression and the sequence of earliest claims throughout the world. The most encompassing paper here is the first one contributed by the editor where she argues on the central role played by thyroid hormone in selecting subsets of wolves less

prone to stress caused by the presence of man and in mediating in the appearance of a large series of traits, both somatic (eg., skeletal proportions, colour disruption) and physio-ethological (eg., alterations of reproductive cycles, tameness) without purposeful selection on the part of man. This hypothesis is attractive in that it elaborates on the idea of *"... understanding the initial stage of domestication as an evolutionary, rather than a cultural, process"* (p.11) . It is also scientific in the sense that it gives rise to testable predictions (postdictions!) such as the need of humans to be settled in order for a new kind of (anthropic) environment to arise selecting wolves *"...which possesed a similar genetic phenotype for thyroid hormone physiology..."* (p.11). Thus, independent of how well it will fare in the long run, the value of the hypothesis lies in the way it promises to frame research from here onwards.

One major corcern in this conflictive issue of dog origins has to do with the difficulty of finding unequivocal signatures of status (ie., domestic vs. wild). Osteological traits, for example, are most subtle and for such reason the short paper by Yates is a most welcomed addition to this kind of literature. Through diagnostic features in the mastoid region, this author is able to separate wolf from dog with an accuracy rate of <95% and wolf from wolf-dog hybrids with an accuracy rate of 88%. In view of this, one is left wondering why traits have not been illustrated more adequately (the only photo provided is very difficult to interpret) and also how good the method is for setting apart dog from wolf-dog hybrids though with respect to the latter comment one should keep in mind that this is just a preliminary study.

At the genetic/molecular level diagnostic traits are equally elusive. Since dogs and wolves presumably belong to the same species (a hotly debated issue that has more to do on how does one define "species" than with controversy about the agriotypic species itself!) one can not properly speak of hybridisation in the conventional sense, a problem compounded by the reproductive compatibility all *Canis* species exhibit (Wayne, 1993). Notwithstanding these and other constraints, the paper by Koop *et al.* shows that the coyote, once invoked as a putative agriotype for North American dogs, stays clearly outside the wolf-dog clade (Figure 5: 278). In addition, one out of the five groups with dog mtDNA sequences is uniquely constituted by Indian dogs and some of the North American wolves, lending preliminary support for an independent origin of dogs in the Americas. The sharing of haplotypes by so many of the sampled individuals, on the other hand, suggests a recent ancestry of dogs from wolves whereas three unique wolf sequences indicate the existence of additional, and rare, ancestral lineages within the agriotype. The presence of both dogs and wolves together in four of the groups means that using a "molecular clock" method for estimating the timing of dog domestication from wolf ancestors with this kind of data, as Vilà *et al.* (1997) did, would be not only inappropriate but also unscientific. As a corollary of this, the date of 135,000 years ago for the initial domestication event, suggested by Vilà *et al.* for dogs, is not supported, because it should never have been done in the first place (the dataset of Koop *et al.* included **all** of Vilà *et al.*'s sequences, plus several others). The data presented by Koop *et al.*, on the other hand, can be taken to support either a monophyletic origin of dogs (the presence of a large and exclusive dog group with introgression between distinct genetic lineages explaining the presence of multiple haplotypes) or a polyphyletic one. The problem here might still be strictly methodological in that ancient mtDNA segments short enough to be easily extracted and amplified (ie., 300bp or less) may not provide enough variability for conducting reliable phylogenetic analyses. Such limitation can be hinted at when one realices that in all the studies carried out thus far, low bootstrap values (ie., less than 50%) indicate that groupings had very low levels of confidence (Okumura *et al.* 1996; Tsuda *et al.*, 1997; Vilá *et al.*, 1997). A more serious problem has to do with introgression. Crockford (p.309) contends that rare but recurring hybridisation episodes during prehistory involving bitches could have moved distinctive dog mtDNA haplotypes into local wolf populations throughout the Northern Hemisphere. If this has been so recent wolves might not be adequate for phylogentic analyses at the molecular level and one should know first the genotypic peculiarities of wolves before dogs came into existence if one hopes *"... to untangle the mess of dog genetic history: multiple origins and widespread dispersal, accidental and deliberate lineage crosses and* ***interspecific*** (our bold) *hybridisation with wolves"(Ibid.).* The paper by Clutton-Brock & Kitchener insists on some of these issues while stressing how simplistic interpretations of osteological data (shortening of the muzzle in their case) and lack of reliable reference collections can lead into greater confusion.

In the archaeozoological record problems relating to dog origins are most vividly expressed when deciding on what side of the line a particular specimen falls. The Pre-Pottery Neolithic canids of Atlit-Yam reported by Dayan & Galili conform to dogs when considering their shortened jaws and reduced bulla yet exhibit only slight metric differences in comparison with recent Israeli wolves thus pointing to a rather slow rate of change for thousands of years since first domesticated.

Matters are more contentious when ambiguous data are interpreted in straightforward ways. Thus, Musil's Magdalenian "domestic wolves" from central european sites often stand *"... at the lower limit of the range of variation for "typical" wolves ..."*(p.23) so that resolving their status on metrical grounds requires no small amount of subjective reasoning. It is rare when one finds, as Chaix has done with a Preboreal dog from the French Alps, a complete specimen exhibiting a whole set of unequivocal traits but it is precisely this kind of data, properly dated, that we should seek for establishing a reliable chronology of domestication events.

The issue of dog breed development is another hotly debated phenomenon of a rather futile nature. From an osteological standpoint, unless one is able to link discrete traits with specific breeds as Valadez manages to do in the case of the hairless Mexican Xoloitzcuintle thanks to a mutation linking this trait with a loss of cheek teeth, one is often forced to leave matters at the rather uninformative level of metrics where terms such as "large", "medium" and "small" remind us on the pressing need for a more operative, hopefully standardized, nomenclature in the future. Standarization based on a more sensible choice of criteria, including measurements that correlate well with particular features of the animals as well as standard metric dimensions, is also the plea of Clark in her reassesment of the variability of prehistoric british dogs.

Several papers evidence the coexistence of dogs of different sizes from early times onwards. Traditionally, in Europe the burst in variability (again, mostly size differences) is attributed to the Romans and, indeed, different papers in the book evidence the homogeneity of Iron Age dogs (eg. Galik) whereas papers reporting trends, like those of Mazzorin and Tagliacozzo (Italy) and Cram (Britain) do point to larger ranges of variation during Roman times. But matters might not be as simple. Bartosiewicz, in his comparative analysis of dogs from the Roman province of Pannonia and the non-Roman territories of the *Barbaricum* in Hungary, stresses that significant differences in dog skulls are only to be spotted through statistics (ie., mean values) and are not so readily apparent when ranges are inspected by the eye. This implies that dog variation, though undoubtedly more restricted in non-Roman settlements, was still evident. Such pre-Roman variation transpires also in the paper by Clark (prehistoric Britain) and is expressed in prehistoric Armenia (no less than two types of dogs; Manaserian & Antonian). That Romans have nothing to do with this phenomenon is also evident in the papers describing dog types in the Americas not only with most distinctive features such as wool, curly tails, hairlesness and the like (Koop *et al.*, Schwartz, Valadez) but also with two, or perhaps up to three, size groups being reported in the same area (Handley). In strong contrast, Jomon dogs appear to remain unmodified during a protracted time lapse of some 10,000 years that Shigehara & Hongo speculate was caused by *"... the japanese tendency to accept nature as it was"* (p.65) meaning that certain traditions may go back to the Pleistocene!

Unless traditional osteological data are combined with alternative methodologies, and from such standpoint the paper by Ryder on hair traits from selected dog breeds looks promising, we fear that developments in the field of dog breed studies is reaching an impasse which may last for quite a long time.

Which brings us to the topic of dog use, also subjected to no small amount of speculation unless exceptional contextual or complementary evidence is readily available. In this way, cut marks are taken to indicate butchery of the animals but proceeding beyond that loose process characterization is often difficult. For this reason, several papers, mostly from pre-Roman european sites, describe traces of this kind without reaching clear-cut conclussions on whether these mean consumption, skinning or less parsimonious alternatives (eg. Hriscu *et al*). Horard-Herbin, however, is able to make a more compelling case by combining such traces with a demographic analysis of dog remains based on a wear calendar she has compiled for the lower carnassial. Her analysis, despite a scarcity on data for certain cohorts, evidences a selective culling of dogs of very similar nature to that recorded for the domestic ungulates but, more importantly, uncovers a potentially fruitful field of

analysis in addition to the standarization of recording procedures it introduces. These papers assess the role of dogs as a marginal food item for humans, the ritual nature of which is only resolved, partially, through the use of written sources, art or ethnohistorical records (Schwartz).

Ritual uses have also been proposed in the case of dog burials and two papers, one by Olsen (Kazahkstan) and another one by Yohe II & Pavesic (northwestern United States), discuss these matters in detail. Once again, despite much speculative effort, it is context and complementary data what eventually allow one to put forward the most compelling hypotheses although in some cases one can have difficulties in devising ways for refuting them.

Paleopathology is another tool that can, in theory, provide clues for inferring uses and it has, for example, been invoked by Warren to postulate about the role played by certain Indian dogs as sledge haulers. The truth of the matter is that very seldomly (for dogs, that is) has a particular pathology been unequivocally attributed to a specific "activity" among other things because no comparative analysis has been ever attempted to systematically record what kinds of osteological signatures do specific "activities" leave on the bones (another area were standarization would be most welcomed). At times, the most one can say, as Cram does after finding that fully 22% of the skulls at Silchester exhibit healed fractures, is that ill-treatment of dogs on the part of man appears to be a routine in the past.

As stated at the beginning, future research on archaeological dogs will not only require more data but also more careful retrieval and recording. Crockford argues that treating dog remains with the same care and attention devoted to human remains should solve many of the problems we now face concerning the resolution of the data available. Perhaps this is unrealistic or perhaps not but changing the present day "frame" will require a lot of standarization for which several of the contributions here may pave the way (Meadow, Ryder, Horard-Herbin, Clark).

Another critical aspect to be taken into consideration is comparative analysis, in particular, transcending the local or regional sphere were patterns and trends are extremely difficult to spot. At the "show & tell" session held during this dog symposium, when specimens from all over the world were placed together, interesting patterns appeared. In her last contribution to the volume, Crockford comments how it was noticed that patterns of tooth wear run parallel to the gum line in european dogs but were clearly concave in all Pacific Rim dogs available. A coincidence? Evidence of independent origins? The specimens assembled were too few to decide but, in addition to its anecdotical nature, this example is indicative of the type of research that should start to develop from here onwards.

Perhaps, when our agenda is finally met, a future book on the archaeology of dogs will be a much more balanced and comprehensive treatment of issues that the one we now have. If this is so, it will mean that many of the loose ends mentioned here have been finally brought under control and that would be good news for eveybody. We rather fear that this will never be the case for science is designed in such a way that the more effort one puts into it more effort is demanded and as more problems get solved, an ever increasing range of problems appear. No need to worry, though .... this is actually the fun of the whole business!

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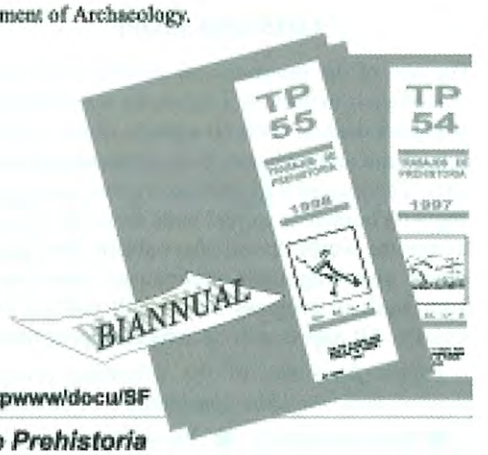
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