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# MAN OR CARNIVORES? STUDY PROTOCOL OF MIXED BONE ASSEMBLAGES: THE EXAMPLE OF THE LES PRADELLES MOUSTERIAN SITE (MARILLAC-LE-FRANC, CHARENTE, FRANCE)

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## Abstract

In many archaeological assemblages, the presence of traces made by humans and made by carnivores on faunal assemblages raises the question of the respective roles played by these two agents in the accumulation and modification of the bones. This article presents a critical review of the different criteria taken into consideration in distinguishing between hunting and scavenging by men and by carnivores. The Mousterian site of Les Pradelles is analysed on the basis of this synthesis. From this study, it emerges that the anthropic impact on bones decreases from the base to the summit of the stratigraphical sequence, lower levels corresponding to sites of habitat (in a very broad sense) and upper levels corresponding to carnivore dens. In the lower sequence, the capacity of Neandertals to hunt all sizes of ungulates is clearly demonstrated. This study also shows the necessity of diversifying actualistic approaches in order to document the complexity of archaeological deposits. Finally, it indicates that the refitting method recommended by C. W. Marean (Bartram & Marean, 1999; Marean, 1998; Marean & Kim, 1998) for the determination of shaft fragments is not always necessary for the distinction between hunting and scavenging in assemblages of bones extensively ravaged by carnivores, the determination of shaft fragments using morphological criteria being, in most cases, largely sufficient.

**Key-words :** taphonomy, Neandertals, carnivores, hunting, scavenging, study method, Mousterian

## Introduction

Carnivores, like humans, can be at the origin of significant bone accumulations (e.g. Binford, 1981; Brain, 1981; Fosse & al., 1998). The presence of both anthropic and carnivore traces within a single bone assemblage raises the question of the respective role played by these two agents in the accumulation and modification of the bones. Concerning the earliest periods, the question is all the more important as the problem arises of whether first hominids were capable of hunting medium to large prey (Binford, 1981, 1988b; Blumenschine, 1988a, 1988b, 1995; Blumenschine & Marean, 1993; Bunn & Kroll, 1986; Capaldo, 1997, 1998b; Lupo & O'Connell, 2002; Monahan, 1996; Potts, 1988; Selvaggio, 1994, 1998a). This debate is still current and not restricted to these remote periods, as the existence of traces left by carnivores on bones from Mousterian or Middle Stone Age (MSA) sites is one of the arguments used by many authors to assimilate Neandertals and MSA people to scavengers (Binford, 1984; Binford, 1988a; Patou Mathis, 1993; Stiner, 1994). However, the existence in a site of bones damaged by carnivores is not necessarily indicative of the role they may have played in the accumulation of the bones. Indeed, although the hypothesis of carcasses hunted by carnivores and then secondarily scavenged by men is acceptable, a second and not less acceptable hypothesis is perfectly conceivable, that is the scavenging by carnivores of carcasses abandoned by men after the extraction of sought-after nutrients.

A critical examination of several Mousterian and MSA<sup>1</sup> sites recently conducted by C.W. Marean (1998) seems to show that the predominant place of scavenging in the subsistence economy of Neandertals and the first modern men is far from proven, the bone assemblages on which arguments are based being very often biased by the excavation methods used (Bartram & Marean, 1999). Such observations are closely akin to those of many authors who, in many Middle Paleolithic sites - Artenac (Armand & Delagnes, 1998; Delagnes *et al.*,

1999), La Combette (Texier *et al.*, 1998), Espagnac (Brugal, 2001), Abric Romani (Caceres, 1998), Umm el Tlel (Boëda *et al.*, 1998) - reveal a near absence of action by carnivores, proving, in fact, that people of this period were capable of acquiring by their own means the meat that they needed. On the other hand, it is difficult to deny the not negligible part played by carnivores in some Middle Paleolithic bone assemblages - La Quina (Chase, 1999), Kebara (Meignen *et al.*, 1998), Die Kelders (Marean *et al.*, 2000), Kobeh (Marean, 1998) - for which it still remains necessary to identify which of the two, man or carnivore, is the primary predator. On such sites, the implementation of detailed taphonomic studies is essential to the identification of the formation processes of the bone assemblages, thereby allowing hypotheses on the subsistence behaviours of Neandertals.

On the Mousterian site of Les Pradelles, the existence of significant remains of carnivores, and above all of numerous traces of them, raises the question of their role in the bone accumulation. After a brief presentation of the site, we give a critical review of the different criteria generally considered as clues to human scavenging. This synthesis leads on to the study methods implemented on the bone material found in Marillac and the presentation of the results. Finally, the discussion will concern the interpretation of the different assemblages and the problems encountered. A study protocol allowing the reconstruction of the taphonomical history of bone assemblages showing both anthropic and carnivore activities will then be presented.

## Presentation of the site and study material

The Les Pradelles site, located in the village of Marillac-le-Franc in the Charentes, has been known since the end of the 19th century, but was then used as a stone quarry. In 1932, M. Richeboeuf, who then exploited the quarry, reported to P. David the discovery of paleontological material (David, 1935). In spite of

<sup>1</sup> - In what follows, only the terms Mousterian and Neanderthal Man are employed.



the intervention on-site of A. Ragout and B. Balout in 1939 and the discovery of a Neandertal mandible (Ragout & Balout, 1942), not until 1967 was the site subject to real scientific excavation. This fieldwork, conducted by B. Vandermeersch, continued until 1980. And today, a resumption of the excavation conducted by B. Maureille is programmed on the site (Beauval *et al.*, 2002).

The data gathered by B. Vandermeersch (unpublished) during his different field campaigns show that the site is located in a dismantled karstic gallery. The archaeological deposit extends over almost five metres and rests on sterile clay. Within this sequence, B. Vandermeersch identified 11 different levels, all of them delivering varying quantities of Mousterian industry and bone remains. The geological studies conducted by A. Debenath (1974) seem to indicate deposits contemporary with the old upper Würm glaciation (isotopic stage 4 and/or 3). However, these conclusions are to be taken with much caution as interpretation in climatochronological terms of sedimentary sequences based on textural and colorometrical criteria belong to outdated methodological principles. Studies on the basic lithic industries (layers 11, 10 and 9) underline the presence of a Quina-type Mousterian (Bourguignon, 1997; Meignen & Vandermeersch, 1986). The partial study of the fauna by one of us (B. Lange-Badré) presently remains unpublished. The bone material comes from excavations conducted by B. Vandermeersch between 1967 and 1980. Only the items previously analysed by B. Lange-Badré are included in this study; those remaining are currently being examined. As can be seen in table 1, close to 3000 remains have been analysed. Given the limited number of bones found in levels 1, 2 and 12, these levels were excluded from the study. Objects for which stratigraphic attribution was problematic (1/2; 3/4; etc), were systematically included in the upper level. Levels 8 and 8J were studied simultaneously, as were units 9, 9a, 9b and 9c.

### Clues to human scavenging in a bone assemblage

If the presence of traces of carnivores in a bone assemblage reveals an action of the carnivores on the bones, the identification of scavenging by man on

carcasses of animals hunted by carnivores requires that other arguments such as the shape of the skeletal profiles or of the mortality profiles be taken into account, or indeed the respective position of carnivore traces and butchery marks on the bones.

Niveaux	Nombre de restes
1	5
2	4
3	82
4	70
5	101
6	89
7	250
8	173
9	1219
10	703
11	214
12	29
Remanié	22
-	16
<b>Total</b>	<b>2977</b>

**tabl. 1** : Total number of studied remains by layer

### Skeletal profiles

Concerning Middle Paleolithic, the arguments put forward reside mainly in the shape of the skeletal profiles (Binford, 1981, 1984; Stiner, 1994). Indeed, the work of L.R. Binford (1978) has shown that the food value of the skeletal parts could play a not negligible, not to say major, role in the selection criteria for parts of carcasses to be transported from slaughtering sites to base camps. The MGUI (Binford, 1978), utility index, which takes into account the quantity of meat, marrow and fat for each skeletal portion and its position in relation to neighbouring skeletal elements, also allows to test whether transport strategies were dictated by nutritive contingencies. In this case, a residential camp will theoretically be characterized by an overrepresentation of nutritionally rich elements (namely, upper limb long bones) and an underrepresentation of nutritionally poor elements (cranium and leg extremities), the reverse configuration indicating a slaughtering site. Thus, in a bone assemblage, a negative ratio of the relative representation of skeletal elements (% MAU: Binford, 1984) to their nutritional utility is typical of a slaughtering site, the rich elements having been



transported elsewhere. However, many archeological sites, which obviously correspond to base camps have skeletal profiles with reverse utility curves (Grayson, 1989). In L.R. Binford's opinion (1984), their preponderance in *some* Mousterian bone assemblages would indicate the incapacity of Neandertals to hunt large prey. In effect, the presence on a residential site of nutritionally poor elements would show a secondary acquisition of carcasses initially hunted by carnivores, the latter having already consumed the nutritionally richest parts (Blumenschine, 1986).

While apparently methodologically strong, these arguments present numerous deficiencies. In fact, as has been demonstrated by many authors, the differential representation of skeletal elements may also result from a preservation problem (Brain, 1976; Grayson, 1989; Lyman, 1991). The density of bones being a major factor in their preservation (Brain, 1969, 1981), the observation in a bone assemblage of a positive and statistically significant correlation between the frequency of the skeletal elements and their density therefore implies the action on the assemblage of taphonomical agents of destruction (Lyman, 1985). Now, the nutritionally poorest elements are also the densest and the richest are also the least dense. More fragile, the latter will tend to disappear more quickly (Lyman, 1985). The differential preservation and transport of some skeletal elements may thus have identical consequences for archaeological assemblages. A bone assemblage characterized by an overrepresentation of elements with a low nutritional utility and an underrepresentation of elements with a high nutritional utility may therefore also be interpreted either in terms of differential transport: transport of the richest parts to another site, or in terms of differential preservation: destruction of the less dense parts, or else by a combination of those two factors (Lyman, 1992). Carnivores, in eating the rich-in-fat epiphyses, act as agents of destruction (Blumenschine, 1988a; Blumenschine & Marean, 1993; Brain, 1981; Capaldo, 1998b; Marean *et al.*, 1992; Marean & Spencer, 1991), therefore on a base camp type of site, the existence both of traces of carnivores and of skeletal profiles with an overabundance of elements with a low nutritional value

may indicate either a secondary acquisition by men of carcasses hunted by carnivores, or a scavenging by carnivores of carcasses accumulated by men.

As C.W. Marean and L. Spencer have demonstrated (1991), the shaft parts, denser than the extremities and therefore less sensitive to preservation problems, are those which will provide the best estimation of the respective abundance of long bones. Yet in all the above-mentioned studies the shaft portions are not taken into account, the relative frequency of long bones being based only on epiphysis portions. (Marean & Frey, 1997). For C.W. Marean and L.E. Bartram (1999), this methodological bias could explain the underrepresentation of long bones in the Mousterian bone assemblages secondarily scavenged by carnivores, and thus the abundance of reverse-utility skeletal profiles. Indeed, these two authors, who have respectively conducted « ethno-archaeozoological » studies on bone assemblages accumulated by the Kuas (Bartram, 1993) and archaeozoological studies on the Mousterian sites of Die Kelders (Marean, 1998; Marean *et al.*, 2000) and Kobeh (Marean, 1998; Marean & Kim, 1998), have shown that excluding diaphyses can drastically modify the shape of the skeletal profiles. For the Kuas, the case is particularly illuminating as, contrary to archaeological bone assemblages, the taphonomic history of the bone accumulation is known. Thus, for the carcasses of animals hunted by the Kuas and later scavenged by carnivores after the camp was abandoned, the skeletal profiles taking into account the shaft portions show a distinctive predominance of upper limb long bones. When these portions are excluded from the counts, profiles then dominated by cranial elements and limb extremities become closer to the skeletal curves considered by L.R. Binford as typical of scavenging by man. In Kobeh and Die Kelders, identical analytic procedures give similar results. Thus, for C.W. Marean (1998), the hypothesis of scavenging by Neandertals or MSA men based on the sites of Klasies River Mouth (Binford, 1984), Combe Grenal (Binford, 1981, 1985), Grotte Vaufray (Binford, 1988a), Grotta dei Moscerini (Stiner, 1991a, 1994) and Grotta Guattari (Stiner, 1994) cannot be retained, as



shaft fragments were rejected at excavation or excluded from studies.

In short, an inverse-utility skeletal curve can only be an argument in favour of scavenging if the shaft fragments are included in the analysis. Taking into account this criterion thus requires a perfect knowledge of biases resulting from excavation and study methods, as well as storage problems (Costamagno, 2002).

### *Mortality Profiles*

The age of the slaughtered animals whose remains constitute a bone assemblage may be used to identify the acquisition strategies implemented by prehistoric man. Ethological studies demonstrate that there exist two different hunting strategies among carnivores: tracking or hunting from a hide. Thus, “social” animals such as wolves, wild dogs (*Lycaon pictus*) or hyenas (Fuller & Keith, 1980; Kruuk, 1972), when chasing their prey, catch the individuals lacking in stamina and therefore the weakest ones, i.e. mainly the young and the old. On the other hand, lone carnivores, essentially felines (tigers, wild cats, leopards), which hunt from a hide, acquire random individuals (Schaller, 1967, 1972). If the hunted populations are demographically stable, the mortality profiles thus obtained will correspond to the age profile of a living population, which is to say an attritional curve (L-curve) characterised by a slow decrease in the number of individuals according to age (Stiner, 1991c).

However, these two types of profile are not inevitably characteristic of a mortality linked to the action of carnivores. Indeed, natural mortality which mainly affects young and old individuals will show a mortality profile similar to the one of preys tracked down by carnivores, i.e. a U-profile (Stiner, 1991c). In the same way, a catastrophic mortality affects, by definition, a population as a whole (Lyman, 1989); therefore the original agents of an L-profile may as much be carnivores, volcanic eruptions or floods as men conducting massive slaughterings. So, as M.C. Stiner notes (1990), the shape of skeletal profiles cannot of

itself alone be used to identify the original agent of bone accumulations. However, on deposits where scavenging by men of prey acquired by carnivores is suspected, the shape of the mortality profile may be an argument to support or refute this hypothesis. Indeed, according to this reasoning, the presence of a mortality curve dominated by adult individuals effectively contradicts the scavenging hypothesis, man being the only predator capable of preferentially hunting animals in the prime of life (Stiner, 1990, 1991b). Moreover, for R.G. Klein (1982), if it is true that an attritional mortality profile may reflect either hunting or scavenging, an abundance of very young individuals will show a primary acquisition of the carcasses by man. Indeed, in the case of scavenged carcasses, young individuals having been totally consumed by carnivores, will be completely absent from the profile, and therefore not exploitable by man.

The problem of the non-conservation of young individuals mentioned by R.G. Klein (1982) appears as a major drawback in the interpretation of mortality profiles. Indeed, carnivores, and especially hyenas, are agents of intense destruction (Brain, 1981; Sutcliffe, 1970) whose activity can result in the complete disappearance of small carcasses (Richardson, 1980). In a deposit where there are abundant traces of carnivores, therefore, the absence of young individuals may be linked to scavenging either by man or by carnivores. Moreover, mortality profiles rest mainly on dental remains which are the only skeletal elements which evolve during the whole life of the animal (for example Costamagno, 2001; Gifford-Gonzalez, 1991; Guadelli, 1998; Klein *et al.*, 1981; Levine, 1982; Stiner, 1998; Vigne *et al.*, 2000). In fact deciduous teeth, which are more fragile than permanent teeth, tend to disappear much more quickly. Thus, an underrepresentation of juvenile individuals may be linked to a differential conservation problem related to the processes of compaction or gelifraction. Indeed, laboratory work conducted by J.-L. Guadelli and J.-C. Ozouf (1994) shows that an alternation of freezing/thawing phases very quickly leads to the destruction of teeth from

<sup>2</sup> - Present-day hunter-gatherers occupying the central part of the Kalahari within Botswana.



immature animals. Consequently, it is essential, before concluding that there is an overrepresentation of older individuals (“*Old-Dominated Mortality Profile*”: scavenging) or adult individuals (“*Prime-Dominated Mortality Profile*”: elaborated hunting), to make sure that the absence or rarity of immature individuals is not the result of a conservation problem, in which case the two mortality profiles may respectively refer to a U-profile [*‘E-profile’ in the English translation*] and an L-profile that have no clear significance with regard to acquisition strategies (Costamagno, 1999b).

To sum up, the shape of mortality curves as a means for distinguishing between scavenging and hunting seems to us to call for very delicate interpretation and may even be completely unsuitable if a differential conservation problem is suspected. Given the ambiguity of this criterion, we recommend that it not be used to differentiate hunting and scavenging.

#### *Study of bone surfaces*

The study of the traces existing at the level of bone surfaces is an essential stage for recognising which taphonomic agents have acted on the bones (Binford, 1981; Costamagno, 1999b; Fisher, 1995; Lyman, 1994). However, if the existence of both anthropic and carnivore traces is essential to recognising the action of these two agents on bone assemblages, this simple observation does not tell us in what order they acted.

The superposition of traces of one or other of the agents may help in the reconstruction of the taphonomic history of an assemblage (Huguet, 1998) but the very random character of such a configuration notably reduces the interest of such an approach. According to certain sources, an abundance of butchery marks on fleshy long bones would indicate a primary access to the carcasses by man (Bunn & Kroll, 1986; Monahan, 1996) whereas, according to others, the existence of such traces simply reflects the removal of meat remaining on bones after a primary consumption by the carnivores (Binford, 1981; Blumenschine, 1995). The level of the damage caused by carnivores is equally problematic in the evaluation of the order of intervention of man and carnivore on bone assemblages (Capaldo, 1998b). For L.R.

Binford (1981, 1984), certain cut marks would be specific to the butchering of carcasses already dry, and therefore scavenged by men. However, a study conducted on present-day hunter-gatherers shows that identical marks may be produced when a delay exists between the slaughtering of the animal and its treatment (Lupo, 1994).

The many actualistic studies carried out in the last fifteen years show that the position of marks is probably the most pertinent criterion in determining whether man or carnivore has had first access to a carcass (Blumenschine, 1988a, 1995; Capaldo, 1997, 1998a, 1998b; Domínguez-Rodrigo, 1997; Lupo & O’Connell, 2002; Selvaggio, 1994, 1988a, 1998b). The discussion which follows only concerns long-bone fragments since other skeletal elements, notably the axial skeleton and the compact bones are thoroughly demolished by carnivores (Blumenschine & Marean, 1993; Capaldo, 1998b). Besides, among researchers working on this problem, S. Capaldo (1998b) is the only one to take into account all the skeletal segments. Experimental studies conducted on hyenas underline the fact that the position of the tooth marks varies according to the state of the carcass. If carnivores have access to complete carcasses, the tooth marks on long bones are more frequent - by around 82 % on average - than if they have access to bones of which the marrow has already been exploited (15%) (Blumenschine, 1988a). Moreover, in this case, the middle shaft fragments (MSH) with no fat (no spongy substance) and therefore of little interest for carnivores (Blumenschine, 1988a; Blumenschine & Marean, 1993; Marean & Bertino, 1994) will show very few tooth marks in comparison with the epiphyseal portions (EPH) and with the shaft portions close to the epiphyses (NEF) (Blumenschine, 1988a; Capaldo, 1997, 1998b). The experiment conducted by M.M. Selvaggio (1994) is slightly different from those of the previous authors. Instead of testing the scenario of a primary access to the carcasses by men and a secondary access by carnivores, it evaluates the reverse hypothesis by estimating the still-exploitable resources on carcasses initially consumed by carnivores. In General, his results show that in such a case, on long bones, teeth traces are

more frequent than percussion traces, the latter being more frequent than butchery marks. However, the percentages of, on the one hand, the number of remains showing cut marks and those showing tooth marks and, on the other hand, the bones showing butchery marks and those having traces of percussion, seem to be linked to the number of carnivores having initially consumed the carcasses. Thus, in the case of little competition between carnivores, it will be possible for men secondarily to exploit the remaining scraps of flesh, which is shown by butchery marks being relatively frequent in comparison with traces of biting and percussion. On the contrary, if many carnivores are involved in the access to a carcass, the part of the resources exploitable by man markedly decreases. As flesh is consumed before marrow (Blumenschine, 1986), on carcasses intensely attacked by carnivores only the marrow may remain, which is shown by a low incidence of butchery marks in comparison with percussion traces (Selvaggio, 1994). The work conducted by M. Domínguez-Rodrigo (1997, 1999), although within the frame of this line of research, poses something of a challenge to the results of these different researchers. According to this work, it is not the percentage of carnivore traces on the shaft fragments which is significant in identifying the order in which man and carnivores have intervened, but the relative frequency of butchery marks on the fleshy bones. Although the studies on bone assemblages accumulated by the Hadzas have shown that the link between the frequency of butchery marks and the quantity of flesh on the bones was not really clear, the proportion of shaft fragments from the humerus and the radius (the most fleshy long bones) showing butchery marks remains a good indicator of the state of a carcass exploited by man: frequencies of over 20 % are indicative of an exploitation of highly-fleshed extremities, whereas percentages of under 15 % show that the bones have been defleshed before the intervention of man (Lupo & O'Connell, 2002). As far as carnivore traces are concerned, the critical examination conducted by K. D. Lupo and J. F. O'Connell reveals that, as thought, the shaft fragments initially consumed by carnivores show higher frequencies of teeth traces than those noted

on bones initially fractured for the marrow. Only the observations made by M. Domínguez-Rodrigo (1999) on bones consumed by baboons seem to go against these results.

Although on some deposits interpretation remains delicate (Lupo & O'Connell, 2002), in the present state of research, the respective frequency of carnivore traces, butchery marks and percussion marks, as well as their distribution, thus appear as reliable criteria in the identification of the primary predator.

### Study Method

In order to determine who, between man and carnivore, is the primary predator in Les Pradelles, research has been conducted on the shape of the skeletal profiles and the frequency of anthropic marks and the traces of carnivores on the bones.

As far as skeletal profiles are concerned, all the determinable fragments have been taken into account. Contrary to what C.W. Marean and his collaborators recommend (Marean, 1998; Marean *et al.*, 2001; Marean & Kim, 1998), the shaft fragments have been determined on the basis of morphological criteria and not through refitting. In fact, this method is not only costly in time but also not very rewarding on deposits, like that of Les Pradelles, where excavation has not been extensive (Costamagno, 1999b). On the basis of these determinations, the minimum number of skeletal elements (MNE) was calculated for the dominant ungulate, i.e. the reindeer. These MNE correspond to the minimum numbers of combinations (Flannery, 1967). The dental remains have been excluded from the counts. To discuss the differential representation of the skeletal elements, the MAU percentage of each skeletal portion has been calculated. For a better visualisation of the profiles, the skeletal elements have been grouped by large anatomic segments: cranial elements (cranium, mandible) post-cranial axial skeleton (vertebrae, ribs), girdle bones (scapula, pelvis), upper-limb long bones (humerus, radio-ulna, femur, tibia), lower-limb long bones (metacarpal, metatarsal) lower-limb compact bones (carpal, tarsal, malleolus bones, phalanges). For bovines and equids, only the presence/absence of



the different segments is discussed while, for the other species represented, the weakness of the samples does not allow this type of approach.

As far as traces are concerned, only long bones were selected for the discrimination of the original agents of the accumulations. All the bone surfaces were examined with a magnifying lens (X 12 enlargement). The criteria used for the identification of traces correspond to those listed by R.J. Blumenschine and his collaborators (1996). Concerning the traces not described by these authors (*punctures, furrows, tooth notches, impact notches, regurgitated bones*), the reader may refer, notably, to the works of L.R. Binford (1981), T.D. White (1992), S. Capaldo and his collaborators (1994), J.W. Fisher (1995), F. d'Errico et P. Villa (1997) or indeed S. Costamagno (1999b). It was not possible, because of the morphology of the notches present on certain shaft fragments to determine the original agent (Capaldo & Blumenschine, 1994): these marks were therefore not counted. The frequencies of the traces were calculated on the basis of the number of remains, excluding from the counts those bones whose surface was not observable (Delpech & Villa, 1993). As R.J. Blumenschine recommends (1988a), long bones were divided into three parts: epiphyseal bones (EPH) that contain at least one fragment of proximal or distal articular surface; shaft fragments close to the epiphyses (NEF) which have no articular surface but spongy tissue at the level of the medullar cavity and, finally, the middle shaft fragments (MSH) with no spongy tissue. For each type of trace, frequencies are given by skeletal portions (for all types of bones) but also, for shaft fragments, by type of long bone. In order to suggest hypotheses concerning the acquisition strategies implemented by Neandertals on the Les Pradelles site, these frequencies were then compared with those obtained in the above-mentioned studies. Where the samples allowed, the reindeer bones were studied separately. The other ungulates present in these levels were analysed by class-size in order to increase the sample. Class III (90-300 kg) includes boar, deer and

*Equus hydruntinus* and all bone fragments assigned to this class, while Class IV (300-1000 Kg) includes large bovinds, equids and fragments belonging to Class IV ungulates (Costamagno, 1999b).

## Results

### *General presentation of the bone assemblages*

Globally, the bone assemblages present four species of carnivore: wolf, fox, hyena and cavern lion, and five herbivore taxons: large bovinds, reindeer, deer, horse and *Equus hydruntinus* (tab. 2). A shaft fragment of a tibia from layer 11 could belong to a megaceros. The remains of a bird and those of lagomorphs and marmots were also identified. In all layers, the determination rate (Klein & Cruz-Urbe, 1984) which is very high (tab. 2) as well as the underrepresentation of remains smaller than two centimetres (fig.1) show a selection of the pieces in the initial study conducted by B. Lange-Badré. As can be seen in table 3, as far as the spectrum of fauna is concerned, two major assemblages can be discerned: the lower assemblage dominated by reindeer (layers 11 to 6) and the higher assemblage where the horse is preponderant (layers 3 to 5).

The presence of carnivore remains at all levels, sometimes in not negligible quantities (tab. 3), and of coprolites (levels 9 and 11) raises the question of their role in the formation of the bone assemblages (for example Binford, 1981; Brain, 1981; Fosse *et al.*, 1998; Stiner, 1994). By comparing the frequency of bones with anthropic traces and that of bones showing carnivore traces, three large assemblages are discernable. The first of these consists of the lowest levels (layers 9 to 11) and is characterised above all by the abundance of human traces on more than 30 % of the fragments (tab. 4). In the second assemblage, which includes levels 6, 7, and 8, the anthropic and carnivore impacts are similar (under 20 %) while in the third assemblage (layers 5 to 3) the carnivore impact (> 30 %) is significantly higher than that of man (< 10 %). In these three large ensembles, what are the respective role of carnivores

<sup>3</sup> - This percentage is slightly different from that of L.R. Binford(1984) as it is based on minimum numbers of combination and not on frequency as in the initial definition.



and man on the bone assemblages? Are some of them of mixed origin, others of human origin and still others of exclusively carnivore origin? In the last two cases, does the existence of carnivore and of anthropic traces indicate that prey were acquired through scavenging or that they were hunted by man and secondarily scavenged by carnivores (case of figure 2) or hunted by carnivores and secondarily scavenged by man (case of figure 3)?

#### *Representation of skeletal elements*

For bovines and the horse, the samples are too small at all levels to permit the calculation of the MAU%. However, if the simple presence/absence of skeletal elements is taken into account, certain observations are justified. Whether for bovines or for the horse, the positive and statistically significant relation, at a threshold of 5 %, between the number of identified segments and the number of determined remains ( $r_s=0,754$  et  $r_s=0,743$ ) precludes a judgment as to the significance of the absence of some segments, which could be linked to the size of the sample (Grayson, 1984). On the other hand, with the exception of the bovines in layer 6, in all levels the upper-limb long bones are always represented, which could indicate a constant provisioning of the site in meat and marrow-rich bones (tab. 5 to 13). However, only the study of the traces on the bones will determine whether these long bones arrived at the site with or without meat.

As far as reindeer are concerned, MAU % calculations are not possible at upper levels (3 to 6) because of the weakness of the samples. In these layers, the presence of all segments, except for cranial elements in level 4 and the post-cranial axial skeleton in layer 6, could indicate the introduction of complete carcasses on to the site (tab. 5 to 8). In the lower levels (7 to 11), the size of the samples allow to study the MAU %. As can be seen in

figure 2, a clear under-representation of the post-cranial axial skeleton and of short bones is observed for all levels. The not negligible action of carnivores on bone assemblages (*cf. infra*) may explain the scarcity of these skeletal elements: vertebrae, having a low density and being rich in fat are consumed by carnivores (Brain, 1976) whereas compact bones from extremities, small in size, are easily swallowed (Marean, 1991). This action does not exclude, of course, the intervention of other taphonomic processes. None of the levels is characterised by skeletal profiles dominated by cranial elements and lower-limb long bones. On the contrary, upper-limb long bones are present in not negligible quantities in all levels and these skeletal elements represent between 64,3 % and 100 % of the animal units introduced onto the site. The high determination rates reported in the previous section may show a selection of the most easily identifiable pieces by one of our number (B. Lange-Badré). This kind of sampling could be at the origin of a general underestimation of long bones, the notably difficult-to-identify shaft fragments often being excluded from studies (Bartram & Marean, 1999). The study of the rest of the bone material excavated by B. Vandermeersch should allow the correction of this methodological bias. In any event, these profiles, which already include a not negligible quantity of upper-limb long bones, are very different from those that one would expect on sites where man transported scavenged carcasses. Does the study of the traces on the bones confirm this hypothesis?

#### *Repartition between anthropic traces and carnivore traces*

Because of the relatively limited number of long bone fragments and, *a fortiori*, of middle shaft fragments (tab. 14), traces are presented in large ensembles. Only layers 9 and 10 are studied separately.

<sup>4</sup> - The paleontological study presently taking place should permit the specific identification of fox remains (Beauval *et al.* in preparation).

<sup>5</sup> - The morphology of the metacarpals (Delpech, 1972) attests to the presence of bison remains in the bone ensembles. The paleontological studies should confirm, or not, the presence of aurochs at Les Pradelles.

<sup>6</sup> - Rate of determination = number of remains determined taxonomically (NRD)/total number of remains (NRT)\*100.

<sup>7</sup> - The % human traces corresponds to the relation between the number of remains showing traces of butchery (cut marks or percussion traces) and the number of observable remains (excluding dental remains and pieces whose surface is illegible).



	3	4	5	6	7	8	9	10	11
<i>Panthera spelaea</i>	-	-	-	-	-	-	1	-	-
<i>Canis lupus</i>	-	-	-	2	15	2	3	11	6
<i>Vulpes/Alopex</i>	2	-	3	4	2	1	-	7	3
<i>Crocuta spelaea</i>	4	4	3	7	1	-	8	7	4
Carnivores indéterminés	-	1	-	-	5	1	1	1	-
<i>Sus scrofa</i>	1	-	-	-	-	-	-	-	-
Bovinae	11	5	14	1	24	17	39	54	23
<i>Rangifer tarandus</i>	9	11	23	31	137	130	800	477	144
<i>Cervus elaphus</i>	1	2	1	-	1	-	2	2	-
<i>Megaceros giganteus?</i>	-	-	-	-	-	-	-	-	1
Cervidae indéterminé	-	-	-	-	-	-	1	2	-
<i>Equus caballus</i>	34	21	32	22	27	8	39	48	13
<i>Equus hydruntinus</i>	-	-	-	-	-	-	-	1	-
Ungulata indéterminé	5	-	1	-	2	1	3	-	2
Ungulata III	2	7	6	3	7	2	260	25	8
Ungulata IV	3	3	4	2	11	1	44	46	7
Ungulata V	-	-	-	-	-	-	-	1	-
Lagomorphe	-	-	1	1	4	6	-	-	-
<i>Marmota</i> sp.	3	5	11	11	7	3	-	2	-
Aves	1	-	-	-	-	-	-	-	-
Mammifères indéterminés	6	11	2	5	7	1	18	9	3
Total	82	70	101	89	250	173	1219	693	214
Taux de détermination	80,5	68,6	87,1	88,8	87,2	96,5	73,2	87,9	90,7

tabl. 2 : Identified taxons and rate of determination by layer

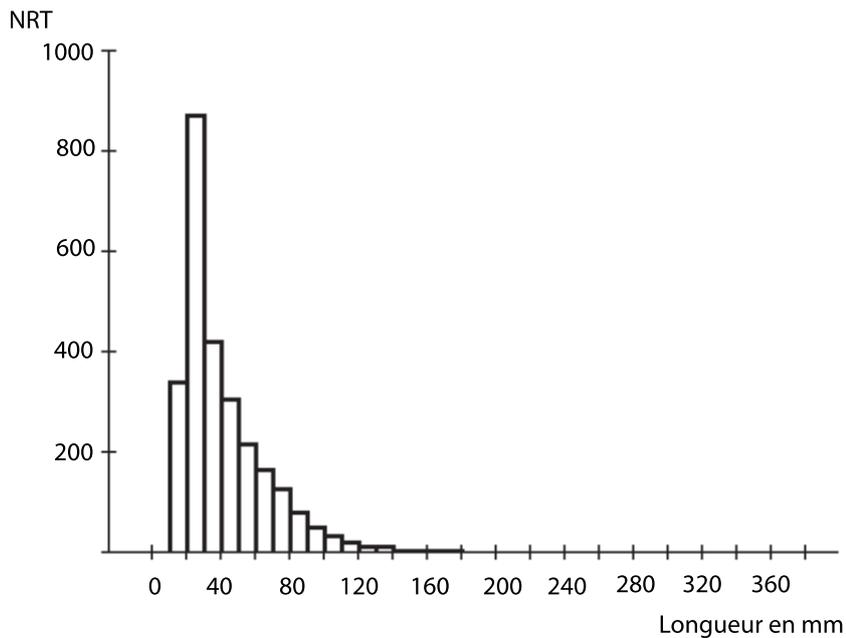


fig. 1 : Distribution of the size of fragments in mm.

Couches	Traces humaines	NRT observables	% traces humaines	Traces de carnivores	NRT observables	% traces de carnivores
3		33	0,0	27	73	37,0
4	3	41	7,3	21	60	35,0
5	1	48	2,1	31	86	36,0
6	3	40	7,5	11	83	13,3
7	19	117	16,2	44	224	19,6
8	12	70	17,1	17	159	10,7
9	264	767	34,4	137	1201	11,4
10	150	401	37,4	99	668	14,8
11	65	124	52,4	29	208	13,9

tabl. 3 : Number of determined remains (NRD), relative frequency (% NRD), of identified taxons and percentage of carnivore remains by layer



	3		4		5		6		7		8		9		10		11	
	NRD	% NRD																
<i>Panthera spelaea</i>	-	-	-	-	-	-	-	-	-	-	-	-	1	0,1	-	-	-	-
<i>Canis lupus</i>	-	-	-	-	-	-	2	2,5	15	6,9	2	1,2	3	0,3	11	1,8	6	3,1
<i>Vulpes/Alopex</i>	2	3,0	-	-	3	3,4	4	5,1	2	0,9	1	0,6	-	-	7	1,1	3	1,5
<i>Crocota spelaea</i>	4	6,1	4	8,3	3	3,4	7	8,9	1	0,5	-	-	8	0,9	7	1,1	4	2,1
<i>Sus scrofa</i>	1	1,5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Bovinae	11	16,7	5	10,4	14	15,9	1	1,3	24	11,0	17	10,2	39	4,4	54	8,8	23	11,9
<i>Rangifer tarandus</i>	9	13,6	11	22,9	23	26,1	31	39,2	137	62,8	130	77,8	800	89,7	477	78,1	144	74,2
<i>Cervus elaphus</i>	1	1,5	2	4,2	1	1,1	-	-	1	0,5	-	-	2	0,2	2	0,3	-	-
<i>Megaceros giganteus?</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	0,5
Cervidae indéterminé	-	-	-	-	-	-	-	-	-	-	-	-	1	0,1	2	0,3	-	-
<i>Equus caballus</i>	34	51,5	21	43,8	32	36,4	22	27,8	27	12,4	8	4,8	39	4,4	48	7,9	13	6,7
<i>Equus hydruntinus</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	0,2	-	-
Lagomorphe	-	-	-	-	1	1,1	1	1,3	4	1,8	6	3,6	-	-	-	-	-	-
<i>Marmota sp.</i>	3	4,5	5	10,4	11	12,5	11	13,9	7	3,2	3	1,8	-	-	2	0,3	-	-
Aves	1	1,5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
% Carnivores / Herbivores		9,7		9,3		7,9		19,4		8,7		1,9		1,3		4,1		6,7

tabl. 4 : Frequency of anthropic traces and carnivore traces by layer

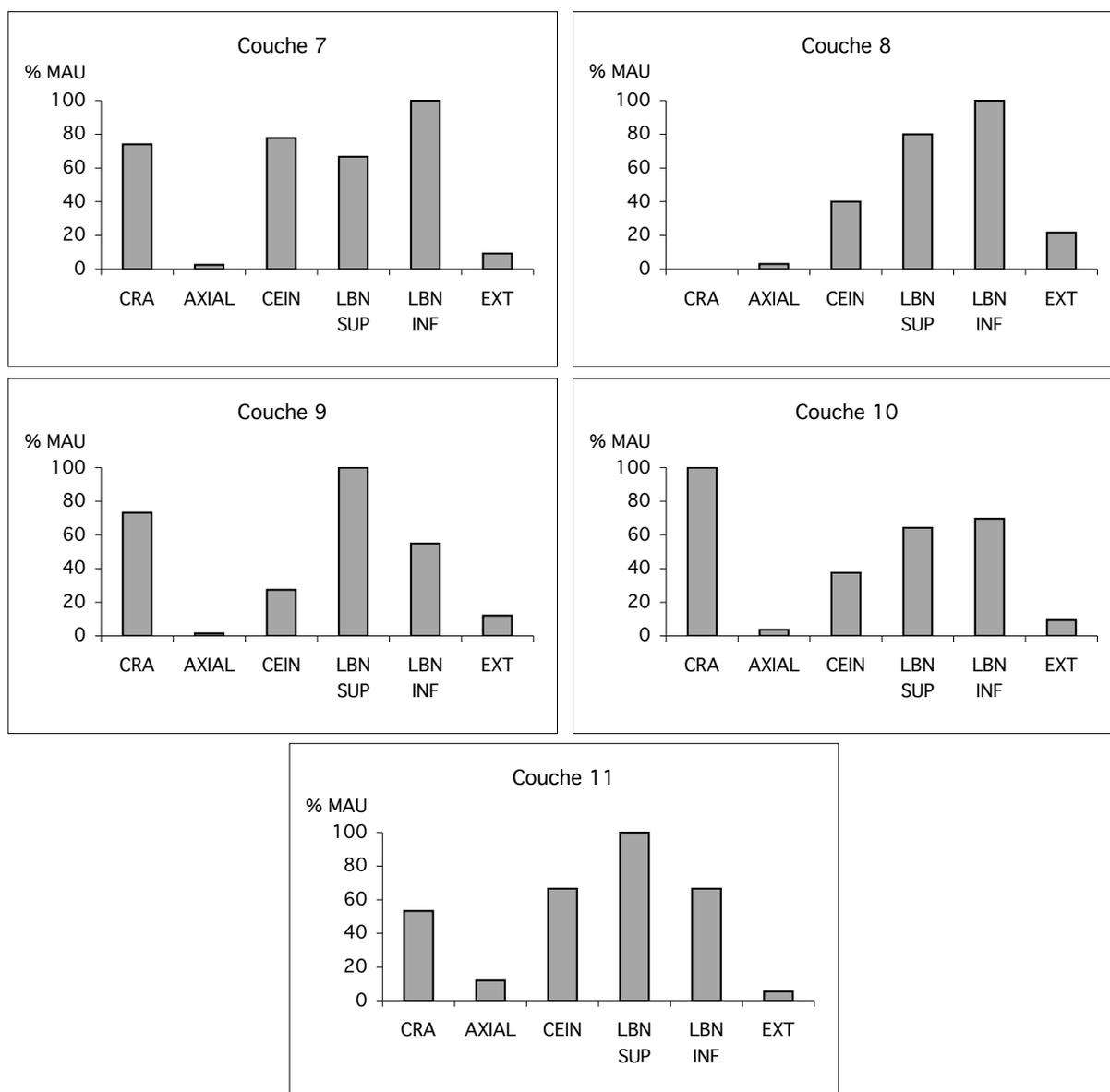


fig. 2 : Representation of the different anatomic segments of reindeer in levels 7 to 11 in %MAU (CRA: cranial elements, AXIAL: post-cranial axial skeleton, CEIN: girdle bones, LBN SUP: upper-limb long bones, LBN INF: lower-limb long bones, EXT: bones of the limb extremities).



### Upper Assemblage (l. 3 to 5)

In this assemblage, more than 33 % of the middle shaft fragments bear carnivore traces (tab. 15). As can be seen in figure 3, this value comes into the area of frequency variation of traces of carnivores noted on experimental or natural bone assemblages where carnivores have a primary access to carcasses. Moreover, except for the data of M. Domínguez-Rodrigo (1999) obtained on bones left for baboons in their natural environment, this frequency is notably higher than that observed on bone assemblages where carnivores are mere scavengers. Butchery marks are infrequent on long bones: only one undetermined shaft fragment shows cut marks (tab.15). However, a striated first phalange of reindeer and a marmot metapodium with a mark which could be assimilated to a cut mark are to be noted in this assemblage. The long bone fragments showing percussion traces are rare: a fragment of a bovine humerus and a fragment of a reindeer tibia show percussion notches.

### Middle Assemblage (l. 6 - 8)

Traces of carnivores are present on 22 % of the middle shaft fragments (tab. 16). This frequency is among the lowest found in bone assemblages initially accumulated by carnivores and among the highest in assemblages where man is the primary predator (fig. 3). Butchery marks are much more frequent than in the upper assemblages (18,5 %). Taking into account the type of long bones, metapodes seem much more frequently to be marked (35,7 %) than the upper limb bones: humerus, femur, radio-ulna and tibia (9,1 %) (tab. 17). The scarcity of butchery marks on fleshy bones seems to suggest a late access of man to the carcasses. Percussion traces suggesting an exploitation of marrow by man are found on less than 10 % of the long-bone shaft fragments.

### Lower assemblages (l. 9 to 10)

It is in the lower assemblage that can be found the lowest proportion of carnivore traces on the middle shaft fragments (tab. 18). This proportion is typical of bone assemblages exploited by men for meat and marrow,

then secondarily scavenged by carnivores (fig. 3). The abundance of butchery marks on all the long-bone shaft fragments (39,8 %), and especially on those of humerus and femur (49,9 %), seems to confirm this hypothesis (tab. 17). Percussion traces provide little information on the taphonomic history of the bone assemblage. All that can be said is that their proportion is similar to that noted in the middle assemblage. In general levels 9 and 10, studied separately, have the same characteristics as the lower assemblage (tab. 17, 19 et 20).

In this last assemblage, the sample is large enough for a study to be made of the repartition of traces by size of herbivore. Carnivore traces are somewhat infrequent on reindeer bones and, more generally, on size-III ungulate bones (less than 30 %: tab. 21). Less than 20 % of the middle shaft fragments show carnivore traces which seems to indicate that the ungulates were first hunted by man and then scavenged by carnivores. Concerning size-IV ungulates as a whole, long-bone fragments more frequently show carnivore traces (34,7 %). However, the low frequencies noted on middle shaft fragments again suggest animals initially hunted by men. The discrepancies noted according to the size of the ungulates seem to result less from a preference for certain species on the part of carnivores than from taphonomic factors. The spongy portions of size-III ungulates, a small size, have a great chance of being swallowed while for the size-IV prey the same portions will be gnawed (Richardson, 1980), thus explaining the relative abundance of damage to spongy portions of size-IV ungulates compared with those of size III. The status of carnivores seems to be different from that of plant-eaters as 60 % of the remains show carnivore traces. However, even if the carnivore remains seem unlikely to be the result of hunting by man, certain of them have incontestably undergone human action as witness cut marks on two wolf remains.

## Discussion

### *Tentative of a reconstruction of the taphonomic history*

In the upper assemblage, the very low proportion of bones with anthropic traces and the relatively high



	Couche 3				
	<i>Bovinae</i>	<i>Equus</i>	<i>Cervus</i>	<i>Rangifer</i>	<i>Sus</i>
Eléments crâniens	■	■		■	■
Squelette axial post crânien	■	■		■	■
Ceintures	■	■		■	■
Os longs supérieurs des membres	■	■		■	■
Os longs inférieurs des membres	■	■		■	■
Os courts des extrémités	■	■		■	■

**tabl. 5 :** Presence/absence of big anatomic segments by taxon in layer 3 (a black case points to the presence of the corresponding anatomic segment)

	Couche 4			
	<i>Bovinae</i>	<i>Equus</i>	<i>Cervus</i>	<i>Rangifer</i>
Eléments crâniens	■	■	■	■
Squelette axial post crânien	■	■		■
Ceintures	■	■		■
Os longs supérieurs des membres	■	■		■
Os longs inférieurs des membres	■	■		■
Os courts des extrémités	■	■		■

**tabl. 6 :** Presence/absence of big anatomic segments by taxon in layer 4 (a black case points to the presence of the corresponding anatomic segment)

	Couche 5			
	<i>Bovinae</i>	<i>Equus</i>	<i>Cervus</i>	<i>Rangifer</i>
Eléments crâniens	■	■	■	■
Squelette axial post crânien	■	■		■
Ceintures	■	■		■
Os longs supérieurs des membres	■	■		■
Os longs inférieurs des membres	■	■		■
Os courts des extrémités	■	■		■

**tabl. 7 :** Presence/absence of big anatomic segments by taxon in layer 5 (a black case points to the presence of the corresponding anatomic segment)

	Couche 6		
	<i>Bovinae</i>	<i>Equus</i>	<i>Rangifer</i>
Eléments crâniens	■	■	■
Squelette axial post crânien	■	■	■
Ceintures	■	■	■
Os longs supérieurs des membres	■	■	■
Os longs inférieurs des membres	■	■	■
Os courts des extrémités	■	■	■

**tabl. 8 :** Presence/absence of big anatomic segments by taxon in layer 6 (a black case points to the presence of the corresponding anatomic segment)

	Couche 7		
	<i>Bovinae</i>	<i>Equus</i>	<i>Cervus</i>
Eléments crâniens	■	■	■
Squelette axial post crânien	■	■	■
Ceintures	■	■	■
Os longs supérieurs des membres	■	■	■
Os longs inférieurs des membres	■	■	■
Os courts des extrémités	■	■	■

**tabl. 9 :** Presence/absence of big anatomic segments by taxon in layer 7 (a black case points to the presence of the corresponding anatomic segment)



	Couche 8	
	<i>Bovinae</i>	<i>Equus</i>
Eléments crâniens	■	■
Squelette axial post crânien	■	■
Ceintures	■	■
Os longs supérieurs des membres	■	■
Os longs inférieurs des membres	■	■
Os courts des extrémités	■	■

**tabl. 10** : Presence/absence of big anatomic segments by taxon in layer 8 (a black case points to the presence of the corresponding anatomic segment)

	Couche 9		
	<i>Bovinae</i>	<i>Equus</i>	<i>Cervus</i>
Eléments crâniens	■	■	
Squelette axial post crânien	■	■	
Ceintures	■	■	
Os longs supérieurs des membres	■	■	
Os longs inférieurs des membres	■	■	■
Os courts des extrémités	■	■	

**tabl. 11** : Presence/absence of big anatomic segments by taxon in layer 9 (a black case points to the presence of the corresponding anatomic segment)

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	Couche 10		
	<i>Bovinae</i>	<i>Equus</i>	<i>Cervus</i>
Eléments crâniens	■	■	
Squelette axial post crânien	■	■	
Ceintures	■	■	
Os longs supérieurs des membres	■	■	■
Os longs inférieurs des membres	■	■	■
Os courts des extrémités	■	■	

**tabl. 12** : Presence/absence of big anatomic segments by taxon in layer 10 (a black case points to the presence of the corresponding anatomic segment)

	Couche 11	
	<i>Bovinae</i>	<i>Equus</i>
Eléments crâniens	■	■
Squelette axial post crânien	■	■
Ceintures	■	■
Os longs supérieurs des membres	■	■
Os longs inférieurs des membres	■	■
Os courts des extrémités	■	■

**tabl. 13** : Presence/absence of big anatomic segments by taxon in layer 11 (a black case points to the presence of the corresponding anatomic segment)



	EPH	NEF	MSH	LBN total
Couche 3	4	7	4	15
Couche 4	4	1	3	8
Couche 5	8	4	2	14
Couche 6	5	6	3	14
Couche 7	23	6	13	42
Couche 8	13	10	2	25
Couche 9	44	85	359	488
Couche 10	57	60	90	207
Couche 11	19	25	32	76

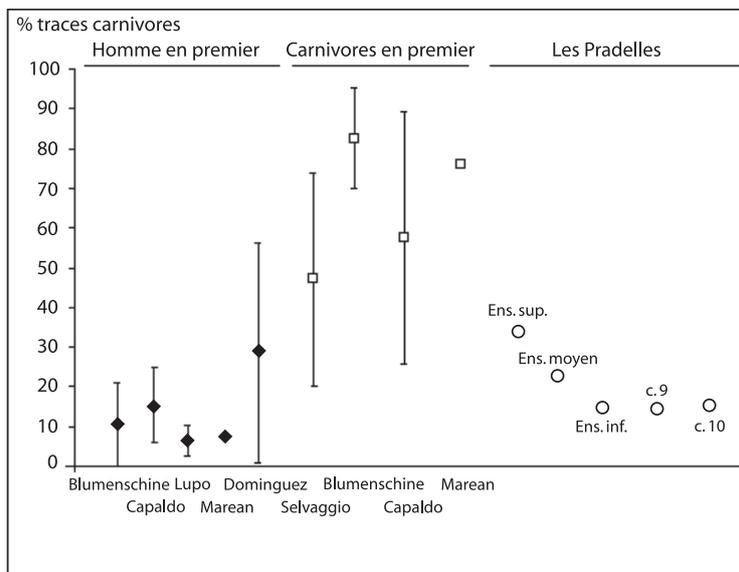
**tabl. 14** : Number of long bone remains (LBN) by portion and by layer (EPH: fragments with epiphyses, NEF: fragments of shaft fragments close to epiphyses, MSH: fragments of middle shaft fragments)

Ensemble supérieur				
	EPH	NEF	MSH	Total
% traces carnivores	56,3 (9/16)	83,3 (10/12)	33,3 (3/9)	59,5 (22/37)
% stries de boucherie	0 (0/16)	0 (0/12)	11,1 (1/9)	2,7 (1/37)
% traces percussion	6,2 (1/16)	8,3 (1/12)	0 (0/9)	5,4 (2/37)

**tabl. 15** : Frequency of carnivore, butchery and percussion traces by skeletal portion of long bone in the upper assemblage (the numbers in brackets correspond to the number of remains bearing a type of trace among the number of observable remains)

Ensemble moyen				
	EPH	NEF	MSH	Total
% traces carnivores	29,3 (12/41)	54,5 (12/22)	22,2 (4/18)	34,6 (28/81)
% stries de boucherie	19,5 (8/41)	19,5 (3/22)	22,2 (4/18)	18,5 (15/81)
% traces percussion	2,4 (1/41)	13,6 (3/22)	11,1 (2/18)	7,4 (6/81)

**tabl. 16** : Frequency of carnivore, butchery and percussion traces by skeletal portion of long bone in the middle assemblage (the numbers in brackets correspond to the number of remains bearing a type of trace among the number of observable remains)



**fig. 3** : Comparison of the frequency of traces of carnivores on fragment of middle shafts between bone assemblages of Marillac ( ), experimental bone assemblages with primary access to the carcasses by men ( ) and experimental bone assemblages with primary access to the carcasses by carnivores. Data from Lupo & O'Connell, 2002; Selvaggio, 1994; Marean, 1998; Capaldo, 1998; Blumenschine, 1995; Domínguez-Rodrigo, 1999.



frequency of carnivore traces (tab. 15), in particular at the middle-shaft level, suggest that carnivores are the primary predators at the origin of the bones assemblages. On the contrary, in the lower assemblage, the limited number of tooth marks on the middle -shaft fragments combined with the abundance of butchery marks (tab. 18, 19 and 20) clearly identify bone assemblages made by men and secondarily scavenged by carnivores. The shape of the skeletal profiles confirms this hypothesis (fig.2). Only carnivore remains could have a non-human origin. Concerning the middle assemblage, data on the traces are less conclusive. Indeed, if the rarity of cut marks on fleshy bones seems to suggest a late access by men to the carcasses (tab. 16), the frequency of carnivore traces is still low for a bone assemblage where carnivores were the primary predators (fig. 3). Several hypotheses could explain the negligible frequency of carnivore traces in the middle assemblage:

1- a mixed origin of the bone assemblage, some carcasses having been hunted by carnivores and others by man

2- little competition between carnivores

3- the over-representation of size-III ungulates compared with size IV ungulates.

The first hypothesis is barely credible since, if humans had in fact brought onto the site carcasses of animals they had hunted, there is no reason why some of the fleshy long bones show no defleshing marks. The shape of skeletal profiles corresponding to an intense action of carnivores on the bones seems not to be compatible with the second hypothesis. However, other taphonomic agents could be at the origin of such profiles (Costamagno, 1999b, 2001), therefore this argument does not seem to be conclusive. According to M. M. Selvaggio (1994), an evaluation of the amount of meat left on bones after carnivores have abandoned them is possible by comparing the proportions of cut marks and tooth marks found on them and, consequently, the degree of competition between carnivores. However if, in the case of carcasses hunted by carnivores, a high ratio of cut marks/tooth marks effectively shows that the primary predators abandoned the carcasses when there was still plenty of meat on them, a low ratio does not necessarily

indicate an intense degree of competition between carnivores since carcasses still rich in nutriment may be abandoned by carnivores without being secondarily exploited by man. The hypothesis according to which a low frequency of damage could be linked to the abundance of size III ungulates compared with those of size IV is altogether possible as current observations show that carnivores, and in particular hyenas, can totally devour small and middle-sized carcasses (Richardson, 1980). Moreover, in Lunel Viel, which is considered as a hyena lair, the frequency of damage is linked to the size of the ungulates (Fosse, 1994, 1996). Unfortunately, this aspect is rarely mentioned in the studies described above. While M.M. Selvaggio (1994) indicates that the size of prey has no incidence on the frequency of carnivore traces, the data gathered by R.J. Blumenshine (1988a) tend, on the other hand, to prove the contrary. More thorough research on the subject seems to us therefore mandatory. In Les Pradelles, therefore, if the size of carcasses has an influence on the frequency of damage on middle-shaft fragments, the increase in the number of traces of carnivores noted from bottom to top of the deposit could, at least in part, be linked to an increase of remains of size-IV ungulates within the sequence. If such were the case, these frequencies would no longer be exploitable to evaluate whether man or carnivore initially had access to the carcasses. The placement of butchery marks would then appear to be the only reliable factor.

These considerations aside, the fact of knowing in which order man and carnivores had access to the carcasses is not sufficient basis for hypothesising as to the respective roles of hunting and scavenging in the subsistence economy of Neandertals. Moreover, in the case of bone assemblages showing proof of anthropic scavenging, the status of the deposit must be researched: a carnivore den or a natural « trap » in which clues to human scavenging have been detected will not have the same significance as a residential campsite where all the carcasses appear to have been scavenged. The first case comes into the frame of J.-P. Brugal's and J. Jaubert's (1991) hypothesis which puts forward a controlled and active scavenging by groups

	HUM/FEM	RAD/TIB	MCM/MTM
Ensemble moyen	9,1 (1/11)	9,1 (1/11)	35,7 (5/14)
Ensemble inférieur	49,9 (51/104)	51,3 (100/195)	38,2 (47/123)
Couche 9	50 (38/76)	47,7 (51/107)	41,4 (29/70)
Couche 10	47,6 (10/21)	53,4 (31/58)	39,5 (15/38)

**tabl. 17** : Frequency of butchery marks according to the type of long bone in the middle and lower assemblages and in layers 9 and 10 (the numbers in brackets correspond to the number of remains bearing marks among the observable remains. HUM: humerus, Fem: femur, RAD: radio-ulna, TIB: tibia, MCM: metacarpal, MTM: metatarsal)

Ensemble inférieur				
	EPH	NEF	MSH	Total
% traces carnivores	23,3 (28/120)	32,4 (55/170)	16,4 (80/481)	21,1 (163/771)
% stries de boucherie	35 (42/120)	42,9 (73/170)	39,8 (192/481)	40,7 (307/771)
% traces percussion	2,5 (3/120)	8,2 (14/170)	11,8 (57/481)	9,6 (74/771)

**tabl. 18** : Frequency of carnivore, butchery and percussion traces by skeletal portion of long bone in the lower assemblage (the numbers in brackets correspond to the number of remains bearing a type of trace among the number of observable remains)

Couche 9				
	EPH	NEF	MSH	Total
% traces carnivores	11,4 (5/44)	27,1 (23/85)	16,4 (59/359)	17,8 (87/488)
% stries de boucherie	25 (11/44)	43,5 (37/85)	37,3 (134/359)	37,3 (182/488)
% traces percussion	15,9 (7/44)	3,5 (3/85)	5,3 (19/359)	5,9 (29/488)

**tabl. 19** : Frequency of carnivore, butchery and percussion traces by skeletal portion of long bone in layer 9 (the numbers in brackets correspond to the number of remains bearing a type of trace among the number of observable remains)

Couche 10				
	EPH	NEF	MSH	Total
% traces carnivores	26,3 (15/57)	43,3 (26/60)	16,7 (15/90)	27,1 (56/207)
% stries de boucherie	43,9 (25/57)	40 (24/60)	47,8 (43/90)	44,4 (92/207)
% traces percussion	1,7 (1/57)	20 (12/60)	13,3 (12/90)	12,1 (25/207)

**tabl. 20** : Frequency of carnivore, butchery and percussion traces by skeletal portion of long bone in layer 10 (the numbers in brackets correspond to the number of remains bearing a type of trace among the number of observable remains)

		Carnivores	Renne	Ongulés III	Ongulés IV
% Traces carnivores					
	EPH	66,7	17,3	-	47,4
	NEF	55,6	28,2	27,8	34,7
	MSH	-	18,3	13,6	19,2
	Total	58,3	28,1	14,9	34,7
% Stries boucherie					
	EPH	0	38,8	-	21,0
	NEF	22,2	59,1	33,3	31,9
	MSH	-	23,1	29,5	48,0
	Total	16,6	47,8	29,9	28,2

**tabl. 21** : Frequency of carnivore traces and butchery marks depending to the size of ungulates in the lower assemblage



from the Lower and Middle Paleolithic of natural sites delivering carcasses (aven-traps, dens, open-air traps). For these authors, because it is very discreet, the human activity on bones being very difficult to demonstrate, it is the repetitive aspect of faunal assemblages of natural origin associated with a few lithic artefacts which suggests this particular type of predation. Since then, the taphonomic studies conducted on paleontologic deposits demonstrating evidence of human presence have shown that some of these places have effectively been visited by humans (Bermúdez de Castro Risueño *et al.*, 1995; Terradas & Rueda, 1998) while in others the association between fauna and lithic remains are strictly coincidental (Bartram & Villa, 1998; Costamagno, 1999a; Villa & Soressi, 2000). Contrary to habitats rich in scavenged carcasses which lead one to wonder about the capacity of Neandertals to hunt, controlled and active scavenging on natural deposits seems to enter into the framework of a reasoned initiative, aimed at supplementing resources probably obtained by direct acquisition. Such a behaviour reveals the adaptive capabilities of Neandertals and a thorough knowledge of their environment, allowing them to exploit all the resources at their disposal.

In Les Pradelles, for the upper and middle assemblages, it is therefore necessary to ask questions on what type of deposit we are dealing with: do the bone assemblages correspond to carnivore lairs where Neandertals came to scavenge bones or to “settlement sites” to which they transported scavenged segments of carcasses? Except for level 8, the ratio of carnivores/herbivores in the upper layers (l. 3 to 7) is much higher than in the lower levels (tab. 3). These frequencies, although low for fossil carnivore dens, are very close to the ones found in Camiac and to present dens (Fosse, 1994). In the higher assemblage, the frequency of carnivore damage, more than 20 %, is compatible with the functioning of the site as a lair (Klein & Cruz-Urbe, 1984). In the lower levels, the presence of complete horse and bovine metapods is another argument in favour of this hypothesis (Fosse, 1996; Fosse *et al.*, 1998). In this case, do the fragments

with anthropic traces really indicate man scavenging or are they the reflection of carcasses of anthropic origin brought to their lair by carnivores? In our present state of knowledge, it is difficult to answer this question. If the presence of both carnivore and anthropic traces on the same bone fragments indicates the action of these two agents on at least part of the faunal stock, on the contrary, the discovery of some lithic artefacts is not a conclusive argument in favour of scavenging by men of carcasses accumulated by carnivores. The startover of the excavation should allow a better understanding of the formation processes of the site and therefore to determine the nature of the fauna/lithic association. Moreover, in spite of an increasing number of experiments whose aim is to demonstrate the respective roles played by carnivores and men in mixed bone assemblages, to our knowledge, there are no data available as to the parts potentially transported to their dens by carnivores of carcasses abandoned by man. The fact that the two only remains with percussion marks are shaft fragments close to the epiphyses could be an argument in favour of the introduction by carnivores of fragments previously fractured by humans to reach the marrow. However that may be, whether man came to scavenge carcasses in carnivore dens or carnivores brought to their lairs skeletal portions scavenged from animals hunted by man, the consequences for the bone assemblages could be major, going so far as to make the identification of these lairs problematic. Indeed, if man has had a relatively important action (initial or secondary) on the faunal stock, some criteria taken into account in the characterisation of dens may become completely inadapated, in particular the fracturing of long bones, often considered as an efficient tool to differentiate an anthropic assemblage and an assemblage created by carnivores (Bunn, 1983; Fosse, 1996). As far as the middle assemblage is concerned, the frequency of damage caused by carnivores, which is always under 20 %, and also the intense fragmentation of long bones leads us to reject the hypothesis of a den. If the frequency of carnivore traces on the middle-shaft

<sup>8</sup> - The ratio, number of remains of size-III ungulates/ number of remains of size-IV ungulates, passes from 6.6:1 in the lower ensemble to 3:1 in the middle ensemble and 0.41:1 in the upper ensemble.



fragments and of butchery marks by type of long bone are compatible with the hypothesis of a late access by men to the carcasses, on the other hand, the not negligible quantity of upper-limb long bones seems to run contrary to this proposition (fig. 2).

*Study protocol for bone assemblages showing action by both men and carnivores*

On mixed deposits, the first step is to determine if the deposit corresponds to a natural site (carnivore den, aventrap) or to an anthropic site. A low percentage of lithic artefacts compared with bone remains is not a decisive argument in favour of a den - short halts sometimes resulting in a limited number of tools. If the presence of complete skeletons, of anatomic connections and of mostly entire bones in a bone assemblage is the signature of a natural trap (Costamagno, 1999a; Oliver, 1989), on the contrary, an abundance of carnivores and their traces (over 20 %), the presence of whole metapodes and a high percentage of long-bone fragments with a complete circumference indicate the existence of a den (Bunn, 1983; Fosse, 1996; Fosse *et al.*, 1998; Klein & Cruz-Uribe, 1984). However, in reality, depending on secondary modification factors and on the intensity with which they have intervened on the assemblage, the use of these criteria is more or less relevant (see for example Costamagno, 1999a and discussion *supra*). In the same way, the frequency of human traces does not always suffice to differentiate a den and an anthropic site. Indeed whether, in the den, men have scavenged carcasses or if carnivores have brought to their dens animals originally hunted by man, the anthropic traces on the bones may be relatively abundant.

When dealing with an anthropic site, it is essential to know the order in which carnivores and man acted. Did carnivores scavenge carcasses accumulated by man or did men accumulate bones coming from animals hunted by carnivores? Apart from the study of the skeletal profiles (Binford, 1981; Marean, 2000; Marean *et al.*, 2000) which, obligatorily, take into account the shaft portions (Bartram, 1993; Bartram & Marean, 1999 ; Costamagno, 2002; Marean & Frey, 1997; Marean & Kim, 1998), the percentage of carnivore traces

present on the middle-shaft fragments, as well as the repartition of the butchery marks on the different long bones (Blumenschine, 1988a, 1995; Capaldo, 1997, 1998a, 1998b; Domínguez-Rodrigo, 1997; Lupo & O'Connell, 2002; Selvaggio, 1994, 1998a, 1998b) enable us to establish the intervention order of these two agents on the bone assemblages. Depending on their size, ungulates may have been acquired by the use of different techniques - usually scavenging for large ungulates and hunting for those of small and middle size (Binford, 1984; Patou Mathis, 1993). If the sample allows, it is important to study the skeletal profiles and the traces by size of ungulate or by taxon. However, the analysis conducted in Les Pradelles shows that, even on bone assemblages highly disturbed by the action of carnivores, coherent results can be obtained without recourse to the fastidious refitting stage recommended by C.W. Marean (Marean, 1998, 2000; Marean *et al.*, 2000) for the determination of shaft fragments. Indeed, when identifying the shaft fragments with simple morphological criteria, our results on the lower assemblage in Les Pradelles are altogether similar to those obtained by C.W. Marean and his colleagues in Kobeh (Marean & Kim, 1998) and Die Kelders (Marean, 2000).

In the case of a natural site, the problem is sometimes trickier. The existence of lithic industry associated with natural fauna is an argument in favour of human scavenging, as long as we are sure that the association is not fortuitous (Bartram & Villa, 1998; Brugal & Jaubert, 1991; Villa & Soressi, 2000). If the presence of bones with both human traces and carnivore marks proves that the two agents have intervened on the same carcasses, excepting a superposition, these traces do not tell us in which order they acted. In effect, humans may have come to scavenge carcasses inside dens, but carnivores may just as well have brought scavenged bones onto anthropic sites. Given these various options, experimental data on the frequency of traces and their distribution are not always usable as account has not been taken in the chosen scenario of all possible cases. If humans ate on the spot, we should be able to find trace frequencies comparable to those obtained



in experiments where carnivores have had access to whole carcasses. On the other hand, if they took away exploitable parts for later treatment, the experimental data will no longer be usable. In this case, the absence of those skeletal parts usually neglected by carnivores could be an argument in favour of this hypothesis. In the same way, if carnivores brought scavenged skeletal portions from habitat sites, the repartition of the anthropic traces on the bones will reflect the selection made by carnivores in the anthropic deposit and no longer the intervention order of carnivores and man. Supposing that carcasses scavenged by carnivores would previously have been exploited for their marrow, carnivores will preferably transport epiphyses and shaft fragments incorporating spongy tissue. At the den level, middle-shaft fragments will be notably under-represented. In any event, new experimentation, taking all the possible cases into account, is necessary for the interpretation of mixed bone assemblages.

## Conclusion

This taphonomic study, with the aim of documenting the respective role played by men and carnivores in the development of the bone assemblages in Les Pradelles, has shown that, depending on the period, the deposit has functioned in different ways. At the base of the sequence (l. 11 to 9), man is responsible for the bone assemblages: the deposit can be assimilated to a habitat site. At the upper level (l. 3 to 5), on the contrary, the hypothesis of a carnivore den is preferred. Additionally, if it were still needed, the lower assemblage is the proof of the capacity of Neandertals to hunt ungulates, even large specimens. In fact, the study demonstrates that the carnivore traces noted on the bones concern a secondary scavenging of ungulates hunted by men. The modalities of these hunts and their place in the subsistence economy of Neandertals will be the subject of a later study (Costamagno *et al.*, in preparation). However, questions remain concerning the taphonomic history of certain levels. Thus, in the higher assemblage, although bones with anthropic traces were found, the hypothesis of a controlled and active scavenging of the den by Neandertals can not be validated without a study

of the processes whereby the deposits were constituted. The interpretation of the middle assemblage is even more problematic. Although, in the present state of the data, it cannot be *stricto sensu* assimilated to a carnivore den, we may ponder the respective roles of man and carnivore in the bone assemblages. Is one faced here by carcasses scavenged and then accumulated by man? If so, what is the status of the site in the economic system of these Neanderthals? The hypothesis of bones scavenged by carnivores then probably accumulated in proximity to the scavenged anthropic site, although envisageable, is never mentioned in the literature. In a general manner, the study carried out at Les Pradelles shows that the actualistic data on the traces found on the surface of bones, while extremely valuable in the matter of interpretation, do not always take account of the variability and the complexity of archaeological sites. It appears indispensable that the instances of such an approach be multiplied in order to encompass the full range of possibilities.

Finally, the analysis undertaken of these bone ensembles, so intensely ravaged by carnivores, shows that refitting is not always indispensable to the discrimination of hunting and scavenging. In fact, in the lower ensemble, the inclusion in the study of shaft fragments determined on the basis of morphological criteria is sufficient to obtain skeletal profiles presenting a considerable proportion of upper-limb long bones. This remark may be reiterated for all assemblages presenting a problem of differential conservation, no matter what the cause (carnivore ravages, human treatment of carcasses, diagenetic phenomena) (Costamagno, 1999b, in press). Only those bone ensembles characterised by the most intense fragmentation (Layman & O'Brien, 1987) really necessitate the use of such a procedure. The investment in time that this study method demands is such (see, e.g., Marean & Kim, 1998) that refitting should be considered only when other analytic methods have been tried and found wanting. Even then, one must be sure that the results are susceptible to modification by the introduction of such analyses: the intensity of fragmentation but, equally, the proportion of shaft fragments in the undetermined remains can be pointers to the pertinence of this procedure.



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