

# The role of small carnivores in the accumulation of bones in archaeological deposits: the case of the Fucino Basin sites (Central Italy)

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**ABSTRACT:** Small carnivores have often been neglected as possible agents of bone accumulation in archaeological deposits. The analysis of the osteological remains from some Upper Paleolithic sites of the Fucino Basin in Central Italy allowed to shed some light on the influence of foxes, wild cats and mustelids on the presence of small prey in caves. Previous hypotheses regarding human behavior at these sites, based only on species lists, suggested that around 13,500 years B.P. there was a dramatic change in human diet with a sharp increase in the exploitation of small mammals (mainly hare, but also marmot and hedgehog) and birds, in contrast to earlier periods in the same area. Recent re-analysis of these faunal assemblages using a taphonomic and zooarchaeological approach indicated instead that in most cases these animals were the result of predation by small mammalian carnivores and raptors. This is based on the age composition (striking prevalence of young and very young individuals), the high frequency of carnivore marks and characteristics of bone damage (e.g., puncture mark size and location matching teeth of small mustelids, foxes and wild cats). Only in a few instances, cut-marks and other modifications indicated human involvement in the accumulation of these small-sized prey.

**KEY WORDS:** SMALL CARNIVORES, HARE, CARNIVORE DAMAGE, LATE UPPER PALEOLITHIC, CENTRAL ITALY

**RESUMEN:** Los pequeños carnívoros son raramente tomados en consideración como posibles causas de la acumulación de huesos en los depósitos arqueológicos. El análisis de los restos óseos en algunos yacimientos del Paleolítico Superior en la cuenca del Fucino en Italia central, permiten comprender la influencia de zorros, gatos silvestres y mustélidos en relación con la presencia de pequeñas presas en las cuevas. Hipótesis precedentes referidas a la actividad humana en estos yacimientos, fundadas solamente sobre las listas de las especies presentes, sugerían que cerca de 13,5 Ka B.P. se había verificado una variación muy importante en la dieta de las poblaciones humanas locales con un acentuado aumento en la explotación de pequeños mamíferos (principalmente liebres, pero también marmotas y erizos) y aves, en contraste con períodos precedentes de la misma zona. Recientes análisis de estos conjuntos faunísticos, realizados utilizando métodos tafonómicos y zooarqueológicos, indicarían que en muchas ocasiones la presencia de estos restos óseos serían el resultado de la depredación de pequeños mamíferos carnívoros y de rapaces como lo evidenciarían la edad de las presas (marcada abundancia de individuos jóvenes y muy jóvenes), la elevada frecuencia de trazas de carnívoros y las características de las modificaciones óseas (por ejemplo, marcas de tamaño y forma correspondientes a los dientes de mustélidos, zorros y gatos silvestres). Sólo en algunos casos la presencia de trazas de herramientas de corte y otras alteraciones en los restos óseos sugieren una participación humana en la acumulación de estas pequeñas presas.

**PALABRAS CLAVE:** PEQUEÑOS CARNÍVOROS, LIEBRES, ALTERACIONES PROVOCADAS POR CARNÍVOROS, PALEOLÍTICO SUPERIOR FINAL, ITALIA CENTRAL

## INTRODUCTION

In zooarchaeological studies small carnivores have often been neglected as possible agents of bone accumulation in archaeological deposits. The main reason for this exclusion is that, being not able to kill large game, they did not compete with humans. Therefore, they are usually dismissed as natural background and not regarded as active agents of bone accumulation or conversely they are all considered as animals hunted by humans, in most cases solely for their pelts. However, in some periods of human prehistory, such as the end of the Upper Palaeolithic, it has been suggested that the range of resources exploited by humans (including small mammals, carnivores and birds) widened (e.g., Binford, 1968; Flannery, 1969; Edwards, 1989; Neeley & Clark, 1993; Stiner *et al.*, 1999, 2000); therefore it is relevant to assess on a scientific basis the origin of this portion of the faunal assemblage.

The taphonomic analysis of the osteological remains from some Late Upper Palaeolithic sites in the Fucino Basin, Central Italy, may shed some light on the influence of small carnivores on small-sized prey in caves where human occupation has also been documented.

## MATERIALS AND METHODS

Grotta La Punta, Grotta di Ortucchio and Grotta Maritza are located in the Fucino Basin around an ancient lake which has been completely drained in the 19<sup>th</sup> century (Figure 1). The caves were excavated and studied by Radmilli and co-workers between the '50s and the '60s (Radmilli, 1959, 1997; Grifoni & Radmilli, 1964; Cremonesi, 1968). These sites were occupied by humans during the Upper Palaeolithic between about

14,500 and 10,500 years B.P. (Ferrara *et al.*, 1959, 1961; Bietti, 1990, in press) (Table 1), but later Neolithic, Eneolithic, Bronze, and Iron Age levels are also represented. Faunal remains had already been studied after the excavation, but only from a taxonomic point of view. Based on species lists, Radmilli (Radmilli, 1960; Cremonesi *et al.*, 1973) suggested that around 13,500 years B.P. there was a dramatic change in human diet with a sharp increase in the exploitation of small mammals and birds, in contrast to earlier sites in the same area (Radmilli, 1956a, 1956b, 1963, 1997; Alhaique & Recchi, in press). According to Radmilli, such an "economic crisis" should have marked the transition to what he defined as "Mesolithic" although there are no marked changes in the lithic industries. In contrast, Barker (1975, 1981), reporting on these same caves, dismisses all the microfauna as the result of natural accumulations mainly produced by raptors as suggested by the recovery of pellets. However, he does not specify if "microfauna" includes larger-sized small mammals such as hare and marmot. In any case, according to this second author, human subsistence was always based on ungulates and no changes in human diet are attested to in these caves at the end of the Upper Palaeolithic.

In order to test the contrasting hypotheses regarding human behavior at these sites, the faunal remains (both mammals and birds) have been re-analyzed using a more modern zooarchaeological and taphonomic approach (Alhaique & Recchi, 2001a, b; Recchi, 2001; Alhaique, in press). Given the research question, particular attention has been devoted to the analysis of possible modifications detectable in the small mammal assemblages. These analyses were facilitated by the excellent state of preservation of the faunal specimens.

The present research is part of a wider project which includes other Fucino Basin sites (Alhaique & Recchi, 2001a, b, in press; Recchi, 2001; Alhaique, in press, in prep.).

<b>Grotta La Punta</b>	cut 26	10,581±100	(Pi-153)	Ferrara <i>et al.</i> 1961
	cuts 27-31	11,770±70	(R-1272)	Bietti 1990; Bietti in press
	cut 39	14,488±800	(Pi-152)	Ferrara <i>et al.</i> 1961
<b>Grotta di Ortucchio</b>	cut 11	12,619±410	(Pi-23)	Ferrara <i>et al.</i> 1959
<b>Grotta Maritza</b>	cuts 30-39	10,420±50	(R-1270)	Bietti 1990; Bietti in press

TABLE 1

Uncalibrated radiocarbon dates for the three Fucino Basin sites.

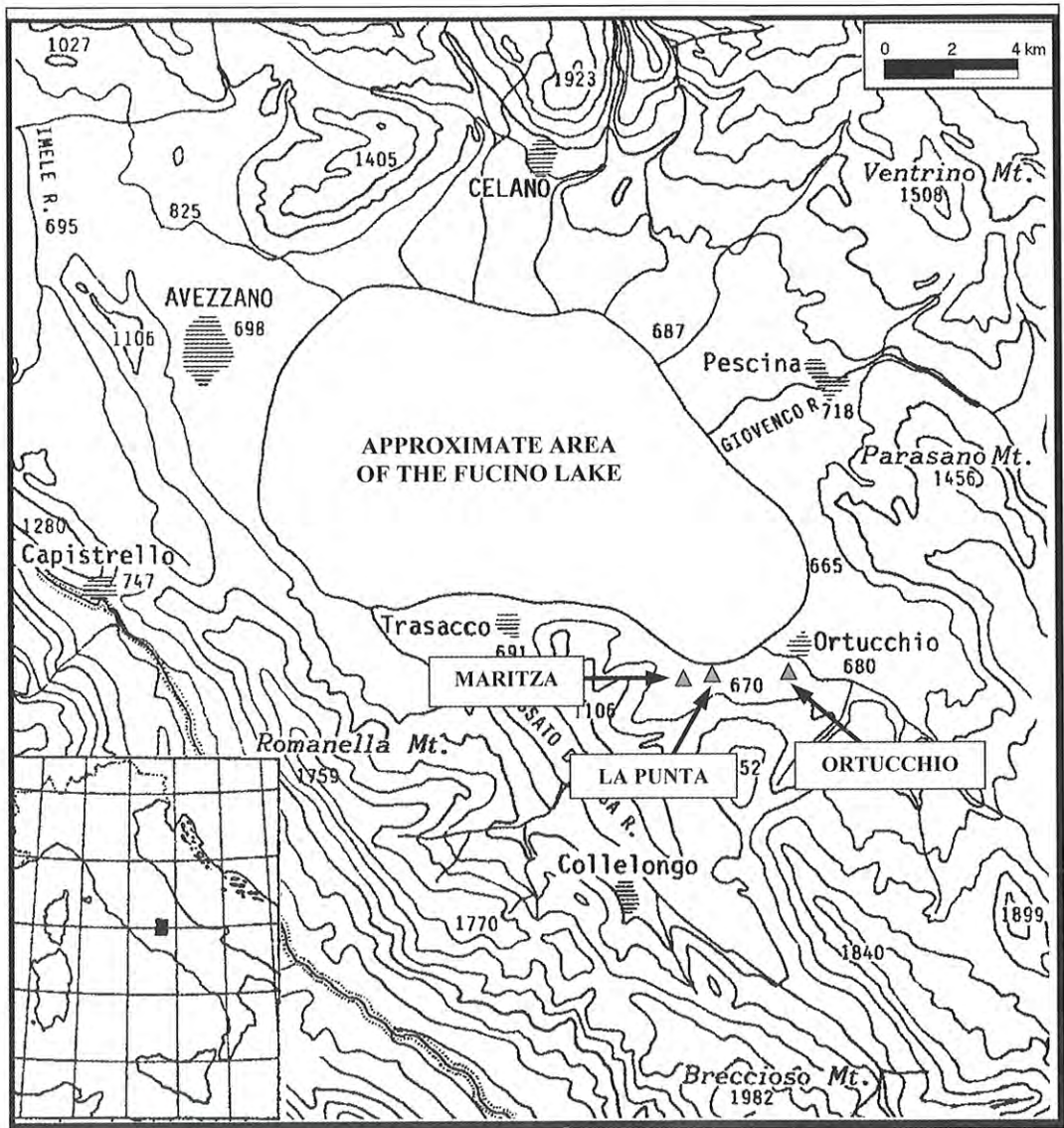


FIGURE 1

Map of the Fucino Basin area with the localization of the sites analyzed.

## RESULTS AND DISCUSSION

The study of the macromammals from the Palaeolithic levels of the three caves (Table 2), shows that there is a high frequency of small mammals (mainly hare, but also marmot and hedgehog), while ungulate remains were not abundant especially in the case of La Punta and Ortucchio (Fig-

ure 2). Among the carnivores wolf, fox, and wild cat are present, as well as small mustelids (weasel and ermine) which are relatively abundant at Ortucchio. It is interesting to note the presence of three subspecies of weasel: *Mustela nivalis boccamela*, *M. nivalis nivalis*, and *M. nivalis minuta* (Figure 3). In particular the latter one, which is considered by some authors as a separate species (*Mustela minuta*; Delpech, 1973; Kurten, 1968), has been

SPECIES	LA PUNTA				ORTUCCHIO				MARITZA			
	NISP	%	MNI	%	NISP	%	MNI	%	NISP	%	MNI	%
<i>Erinaceus europaeus</i>	7	2.6	5	10.2	641	8.8	104	13.9	41	2.3	16	5.5
<i>Lepus europaeus</i>	162	59.8	18	36.7	6034	82.8	485	64.8	450	24.9	63	21.8
<i>Marmota marmota</i>	4	1.5	3	6.1	113	1.6	24	3.2	40	2.2	9	3.1
<i>Vulpes vulpes</i>	19	7.0	4	8.2	17	0.2	6	0.8	174	9.6	18	6.2
<i>Canis lupus</i>	15	5.5	2	4.1	6	0.1	3	0.4	18	1.0	6	2.1
<i>Mustela nivalis</i>	5	1.8	2	4.1	100	1.4	34	4.5	30	1.7	12	4.2
<i>Mustela erminea</i>	5	1.8	1	2.0	87	1.2	23	3.1	2	0.1	1	0.3
<i>Mustela putorius</i>									9	0.5	4	1.4
<i>Martes martes</i>									23	1.3	6	2.1
<i>Meles meles</i>					1	0.01	1	0.1	77	4.3	12	4.2
<i>Felis silvestris</i>					6	0.1	4	0.5	157	8.7	20	6.9
<i>Lynx lynx</i>					3	0.04	2	0.3	16	0.9	5	1.7
<i>Equus hydruntinus</i>	1	0.4	1	2.0					59	3.3	11	3.8
<i>Equidae</i>					2	0.03	2	0.3				
<i>Sus scrofa</i>	1	0.4	1	2.0	46	0.6	15	2.0	59	3.3	16	5.5
<i>Capreolus capreolus</i>					2	0.03	2	0.3	24	1.3	8	2.8
<i>Cervus elaphus</i>	28	10.3	5	10.2	88	1.2	14	1.9	191	10.6	24	8.3
<i>Rupicapra rupicapra</i>	19	7.0	4	8.2	110	1.5	18	2.4	362	20.1	38	13.1
<i>Capra ibex</i>	4	1.7	2	4.1	30	0.4	10	1.3	63	3.5	15	5.2
<i>Bos primigenius</i>	1	0.4	1	2.0	3	0.04	2	0.3	10	0.6	5	1.7
<b>TOTAL</b>	<b>271</b>	<b>100</b>	<b>49</b>	<b>100</b>	<b>7289</b>	<b>100</b>	<b>749</b>	<b>100</b>	<b>1805</b>	<b>100</b>	<b>289</b>	<b>100</b>

TABLE 2  
Number of Identified Specimens (NISP) and Minimum Number of Individuals (MNI) for the different species in the Fucino Basin caves.

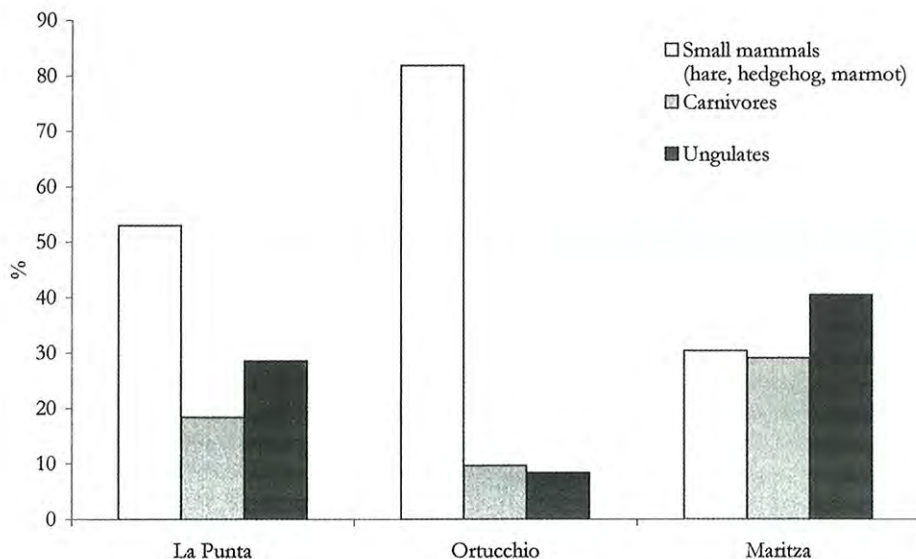


FIGURE 2  
Proportions of the different taxonomic groups in the three caves.

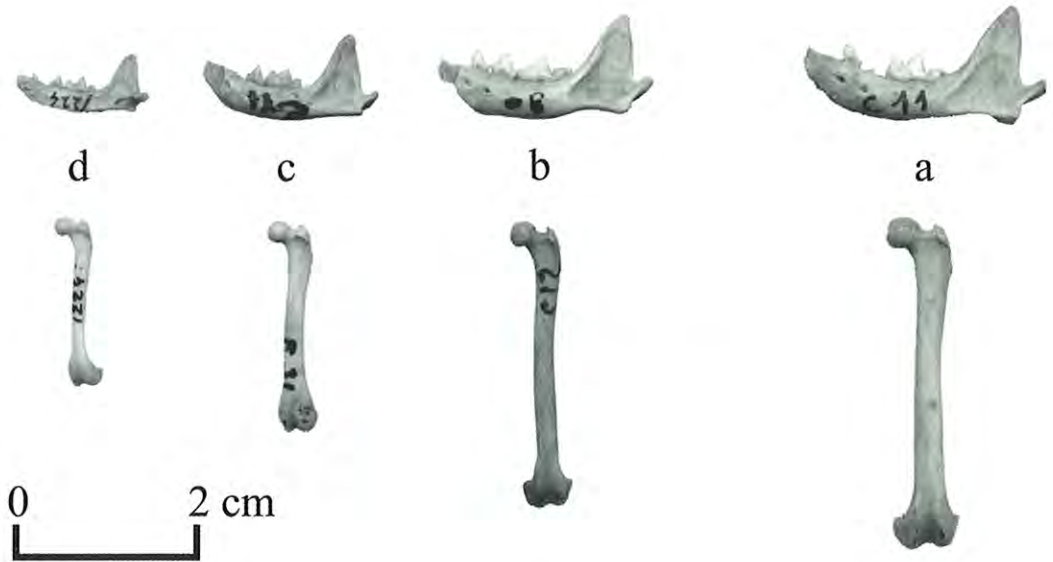


FIGURE 3

Grotta di Ortucchio – Mandibles and femurs of small mustelids: a) *Mustela erminea*, b) *M. nivalis boccamela*, c) *M. nivalis nivalis*, d) *M. nivalis minuta*.

recovered so far only in Northern Italy at Arene Candide (Cassoli & Tagliacozzo, 1994). The analysis of the avian remains is still being completed by A. Recchi, but bird bones appear to be very abundant at Ortucchio and Maritza (Alhaique & Recchi, 2001a, b; Recchi, 2001).

Considering the frequencies of body portions for hare, marmot and hedgehog all parts of the skeleton are represented in the assemblages indicating that complete animals “entered” the caves. The most abundant carnivores such as fox, wild cat and small mustelids are also represented by almost complete carcasses. The analysis of anatomical elements for Anseriformes and Galliformes at Ortucchio documents two completely different situations: for the latter group, metacarpals and metatarsals are dominant suggesting the activity of carnivores and raptors, while for ducks the high frequency of coracoids and humeri indicates human involvement in the accumulation of these species (Ericson, 1987; Mourer-Chauviré, 1983). The ungulates show differences between the caves: at Ortucchio and La Punta, these species are represented mainly by anatomical segments with low nutritional value, while at Maritza the carcasses of these animals are more complete.

The age at death of the small mammals (hare, marmot and hedgehog) consistently shows very high frequencies of young and very young individuals (Figure 4) in contrast to other Italian sites of the Late Upper Paleolithic (e.g., Grotta Polesini, Grotta Romanelli, Arene Candide; Alhaique, 1994, 1996; Cassoli & Tagliacozzo, 1994; Tagliacozzo & Fiore, 1998). In particular, it is interesting to note that at all sites over 50% of the hare remains are referable to individuals a few months old, reaching in some levels peaks over 70%. Also for the hedgehog more than 50% of the bones recovered belong to young animals; the mandibles often show the erupting fourth premolar corresponding to individuals about 3–4 months old, just independent of their mother (Reeve, 1994). The marmot is represented by a high proportion of young animals at Ortucchio and La Punta, while the percentage is much lower at Maritza. Carnivores include mainly adults although young animals were identified. Also in the avifauna, young birds have been recovered; the specimens belong mainly to some Galliformes (gray partridge and black grouse) and ducks. The age at death for the ungulates suggests again differences between Ortucchio and La Punta, where there is an abundance of young and

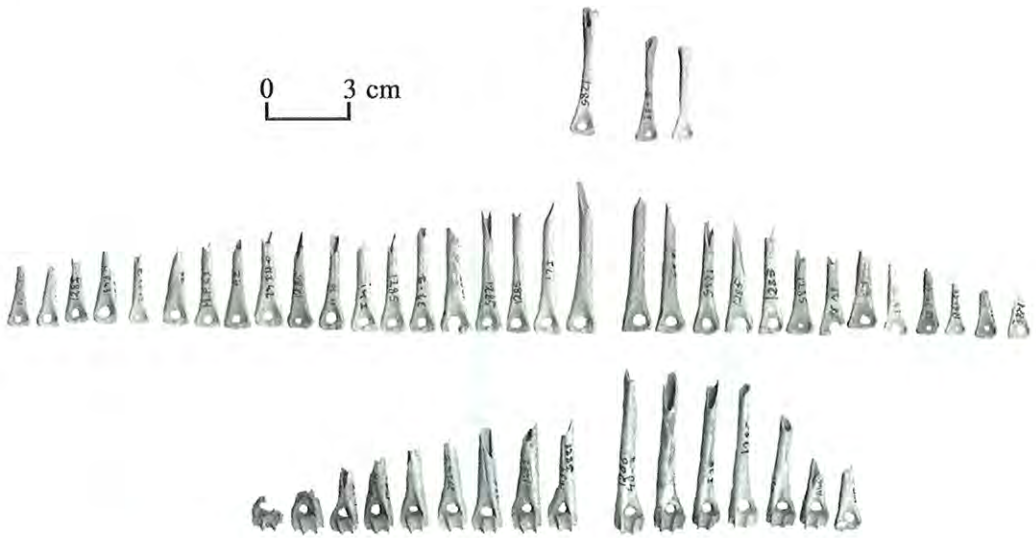


FIGURE 4

Grotta Maritza – *Lepus europaeus*: complete sample of humeri. The two upper rows represent very young individuals with the distal epiphysis still unfused.

even very young individuals, and Maritza where prime age animals are dominant.

In all caves small mammals present high frequencies of modifications produced by carnivores (Figure 5). In many cases puncture marks referable to fox, wild cat and small mustelids have been recognized (Figure 6). In fact, fox and wild cat are known to prey on small mammals, but weasel and ermine also hunt larger species such as hares; they focus especially on young animals, accumulating their carcasses in caches (King, 1989). This behavior could also explain the anomalous over-representation of young and very young small mammals in the assemblages analyzed. Other kinds of modifications could have been produced by raptors (Hockett, 1991). In fact these species also selectively hunt young hares, marmots and insectivores as well as some birds of larger size (Cramp & Simmons, 1980).

At La Punta and Ortucchio human modifications are absent or rare on the remains of small mammals (Figure 5). In these few cases, such traces have been identified only on adult individuals and seem to be related to skinning rather than to the exploitation of these species as food. In contrast at Maritza, cut marks were identified on sev-

eral species of small mammals as well as on small carnivores: hare (1.6%), marmot (2.6%), fox (9%), wild cat (2.8%), and badger (2.4%). Similarly, in this case modifications occur on adult individuals, but suggest the use of these animal both as food and for their pelts. Also at Maritza two decorated hare metatarsals have been recovered (Figure 7). The diaphyses of two other hare metapodials had been carefully scraped as in preparation for the production of a tool or object. This species selection suggests that this animal may have been of cultural importance among the populations living in the Fucino Basin at the end of the Upper Palaeolithic. This has been suggested for some species of small mammals, such as hare, hedgehog and beaver as well as birds, also in other Late Upper Palaeolithic sites (e.g., Arene Candide and Grotta Polesini; Cardini, 1980; Alhaique, 1994, 1996). Bone tools were usually made out of ungulate bones, mainly red deer but also roe deer, wild boar and wild ass, while only in two cases bones of small mammals, probably fox, have been used.

In the bird sample from Ortucchio and La Punta analyzed so far (Alhaique & Recchi, 2001a, b; Recchi, 2001) cut marks are absent, while traces of burning were detected primarily on bones of Anse-

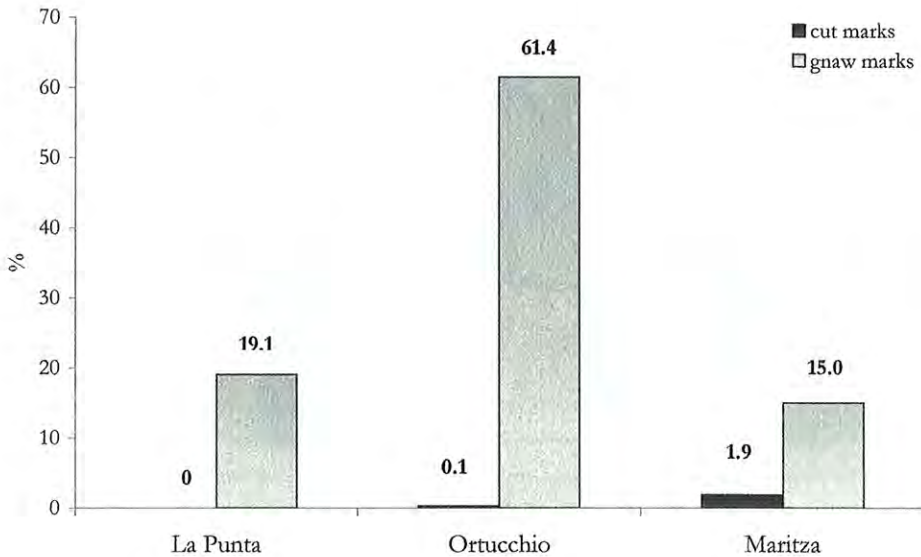


FIGURE 5

Percentages of cut marks and gnaw marks on the remains of hare, marmot and hedgehog in the three caves.

riformes. Carnivore and raptor modifications are instead abundant on the whole avian sample.

In contrast to the small mammals and carnivores, the ungulate assemblage in the three caves mainly represents the result of human accumulation, and modifications related to different stages of carcass processing are relatively frequent (between 16% and 24%). Gnaw-marks are instead less abundant and usually localized on distal limb elements suggesting carnivore intervention after these parts had been discarded by humans.

In the caves analyzed, data on seasonality based on ungulates, seem to indicate differences between the upper levels, where animals were killed between spring and autumn, and the lower ones where summer is not represented. Data from migratory birds suggest instead in all levels their capture mainly in the warm period of the year. The only exception is the Brent goose, typical of Northern regions, which should have used the Fucino Basin as a wintering ground. The seasonal information from both mammals and birds indicates the exploitation of different animal resources according to the season as well as changes through time in the period of occupation and possibly site function within the Late Upper Palaeolithic settlement system of the Fucino Basin. However, La Punta and Ortucchio appear to have always been used eph-

merally while Maritza may have represented a "residential site" as suggested by the abundance of ungulates, the relatively complete anatomical pattern and the age selection of these prey species. The fact that in some cases small mammals and carnivores were also exploited could be a further indication of a longer and more intense occupation because this often occurs at Late Upper Palaeolithic sites that, on the basis of other faunal and archaeological evidences, could be defined as "residential" (e.g., Grotta Romanelli, Grotta Pole-sini; Stiner, 1994; Alhaique, 1996; Cassoli & Tagliacozzo, 1997; Tagliacozzo & Fiore, 1998).

## CONCLUSION

In contrast to Radmilli's hypothesis, the taphonomic analysis of the faunal remains from these Fucino Basin sites indicates that human diet was based mainly on ungulates while hares, marmots and hedgehogs were accumulated almost exclusively by small carnivores. Even in the case of Grotta Maritza, where there are human modifications on part of the small mammal and carnivore assemblage, these species represented only a marginal source of food for the human groups. Therefore

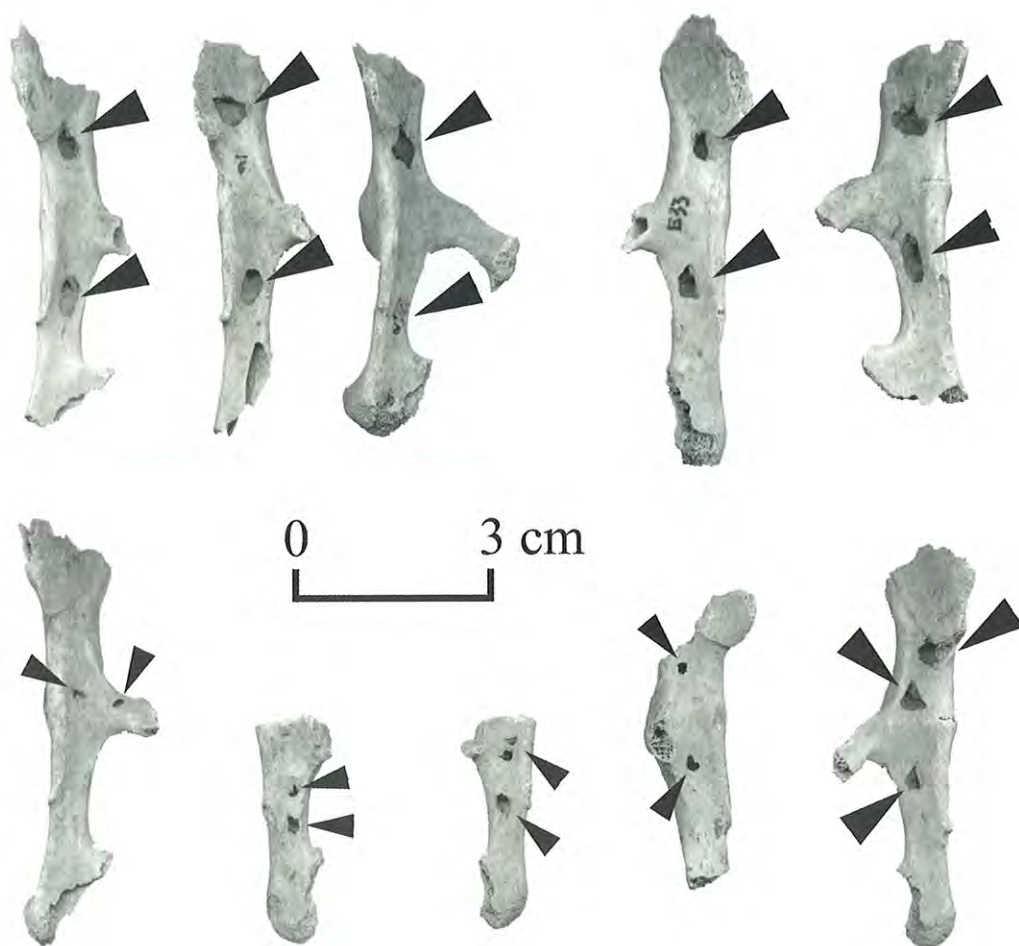


FIGURE 6

Grotta di Ortucchio – Pelvises of *Lepus europaeus* with carnivore marks. In the upper row puncture holes produced by the canines of fox or wild cat. In the lower row, from the left, the first 4 specimens present traces of smaller teeth probably of ermine and weasel; the triangular holes on the last pelvis may have been instead produced by raptors. Note that the 5<sup>th</sup> specimen in the upper row and the 2<sup>nd</sup>, 3<sup>rd</sup> and 5<sup>th</sup> bone in the lower one are still unfused or just fused.

the hypothesis of a dramatic change in human diet at the end of the Upper Palaeolithic in this area is not supported.

There are other Italian sites such as Grotta Romanelli, Grotta Polesini (Stiner, 1994; Alhaique, 1996; Cassoli & Tagliacozzo, 1997; Tagliacozzo & Fiore, 1998) where a clearer broadening in the range of resources exploited by humans following the introduction of small mammals and birds, is attested to. Nevertheless, even in these caves, the contribution of small-sized species is not so dramatic especially when differences in body size are

considered in comparison to the ungulates present in the same assemblages. Only in a few, mainly later, sites, such as Riparo Mochi (Level A), Riparo Blanc, Grotta La Porta (Radmilli & Tongiorgi, 1958; Radmilli, 1960; Taschini, 1964; Bietti, 1981; Stiner, 1999), do “minor” species (in all these cases molluscs) compose the majority of the faunal samples. However, these localities may represent specialized places and therefore the “anomaly” may be related to site function rather than to a real change in human behavior during this period in Italy.



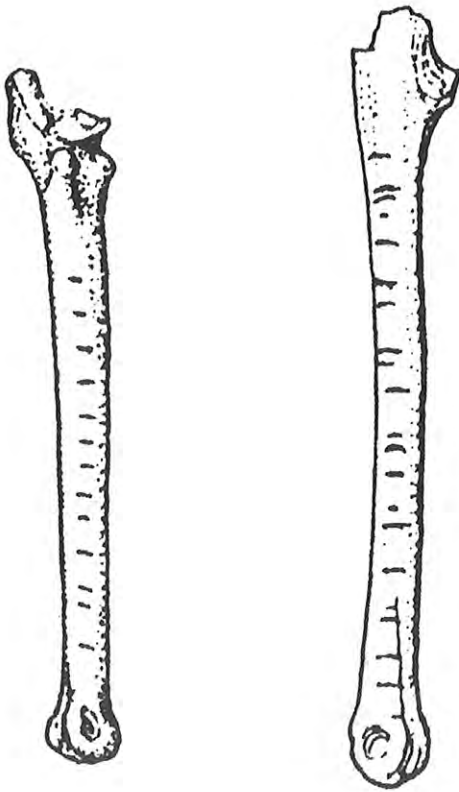


FIGURE 7

Grotta Maritza – Decorated metatarsals of *Lepus europaeus* (from Grifoni & Radmilli, 1964).

Barker's idea of an assemblage produced by raptors is only partially true because small mammalian carnivores seem to have played a more important role in the accumulation of hare, marmot and hedgehog bones. Therefore this study facilitated the identification of the main agents of small bone accumulation in the Fucino Basin caves. In particular, besides fox and wild cat, for the first time the contribution of small mustelids to site formation processes has been considered.

Finally, the pattern evidenced in the small mammal sample (many young individuals and high percentages of gnaw-marks associated with few human modifications) may represent a clear signature for an assemblage accumulated by small carnivores and therefore could be used as a reference for future studies.

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