Archaeozoological evidence of subsistence strategies during the Gravettian at Riparo Mochi (Balzi Rossi, Ventimiglia, Imperia - Italy)

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ABSTRACT

This paper presents the results of the archaeozoological and taphonomic study on a sample of about 55,000 bone remains collected in the Gravettian occupation levels (Layer D) of Riparo Mochi (Balzi Rossi, Ventimiglia - Italy). Humans are the main agent responsible for the accumulation of the faunal remains as indicated by the presence of impact cones, butchering striae, burned bones and by the almost complete absence of carnivore traces. The faunal assemblage includes an association rich in artiodactyls and, to a lesser extent, lagomorphs, rodents, and carnivores adapted to different environments and climates. Hunting focused mainly on red deer and ibex, and the site was occupied mainly during winter-spring. The whole faunal sample was divided into "phases" in order to recognize possible paleontological, paleoecological, and palaeoeconomic variations which may have occurred in the area of the rock-shelter during the investigated period.

1. Introduction

Riparo Mochi is one of the sites of the important archaeological complex of the Balzi Rossi located next to the border between Italy and France, on the Mediterranean Sea. The first excavations (1938, 1941, 1942, 1949, and 1959) were carried out by the Istituto Italiano di Paleontologia Umana (Blanc, 1938; Cardini and Biddittu, 1967). Research was resumed only in 1995 by the Soprintendenza per i Beni Archeologici della Liguria with the collaboration of the Dipartimento di Biologia Animale e dell'Uomo of the Sapienza - Università di Roma and the Istituto Italiano di Paleontologia Umana, focusing mainly on the Mousterian levels (Alhaique et al., 2000; Bietti et al., 2001). Starting in 2007, the investigations continued, coordinated by S. Grimaldi (Università di Trento). Some results have been published: on lithic industries (Blanc, 1953; Laplace, 1977; Kuhn and Stiner, 1992, 1998; Palma di Cesnola, 1993; Negrino, 2002; Bietti, 2004; Bietti and Negrino, 2006, 2008), on ornaments (Kuhn and Stiner, 1998), on pollen (Renault-Miskovsky, 1974), and on faunal remains (Abbassi, 1999; Stiner, 1999; Alhaique, 2000; Stiner et al., 2000; Arellano, 2009; Zeppieri, 2009).

This paper presents the results of the archaeozoological and taphonomic study of a sample of about 55,000 bones remain recovered during the "old excavations" (1938–1959) in the Gravettian occupation levels (Layer D). The aim is to recognize possible paleontological, paleoecological and paleoeconomic variations which may have occurred during the deposition of the Gravettian layer. Thish analysis is particularly interesting also in consideration of the scarcity of research carried out with adequate methodologies on the faunas from Italian Gravettian sites. The results will be compared with those of a very small faunal assemblage from the same layer, collected during the 1995–96 excavations (Alhaique, 2000) and with those of the nearby cave of the Arene Candide (Alhaique, 1994; Cassoli and Tagliacozzo, 1994).

2. Materials and methods

The Balzi Rossi complex, also known as Grimaldi Caves, includes more than ten sites (Villeneuve et al., 1906–19) that yielded abundant archaeological remains spanning a wide chronological range from the Middle Pleistocene to the Early Holocene (Fig. 1). Riparo Mochi is located between Grotta di Florestano and Grotta del Caviglione. Characterized by a not very prominent overhang, Riparo Mochi was identified only in 1938, in contrast to the other cavities which had been explored and "emptied" between the end of the nineteenth and the beginning of the twentieth century.

The stratigraphic sequence (Fig. 2), about 10 m long, was divided into nine archaeological units in agreement with the study of the lithic industries (Blanc, 1938). The lowest unit (layer I) is 4.30 m

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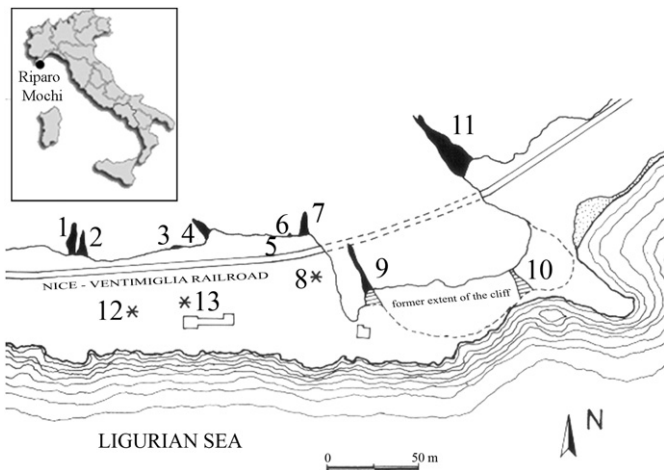E-mail address: antonio.tagliacozzo@beniculturali.it (A. Tagliacozzo).

Fig. 1. The archaeological sites of the Balzi Rossi complex: 1 Grotta Costantini; 2 Grotta dei Fanciulli; 3 Riparo Lorenzi; 4 Grotta di Florestano; 5 Riparo Mochi; 6 Riparo Blanc - Cardini; 7 Grotta del Caviglione; 8 Riparo Bombrini; 9 Barma Grande; 10 Barma da Baousso da Torre; 11 Grotta del Principe; 12 Sito dell'ex Casinò; 13 Sito dell' ex Birreria. (Modified by figure 1, page 7, from Del Lucchese, 1996).

thick and is referred to the Middle Palaeolithic (Mousterian). Layer H, about 50 cm thick, is defined as semi-sterile and separates the Upper Palaeolithic phases from the underlying Middle Palaeolithic. Layer G is about 50 cm thick and contains Proto-Aurignacian industries, characterized by abundant *Dufour* bladelets. Layer F, about 1 m thick, is associated with the Middle Aurignacian (Laplace, 1977) or Classic Aurignacian (Bietti and Negrino, 2006). Layer E, about 20 cm thick, is defined as almost sterile. Layer D is characterized by a thick deposit with abundant artifacts attributed to the Gravettian with *Noailles* burins. Layer C, 55 cm thick, according to Laplace (1977) contains Final Gravettian industries without *Noailles* burins, while according to Palma di Cesnola (1993) the lithic tools may be already referred to the Early Epigravettian. Layer B, about 60 cm thick, with scarce lithic industry is defined as almost sterile. Layer A, the topmost of the series, is about 60 cm thick and contains lithic industries associated with the Proto-Mesolithic (Laplace, 1977) or Geometric Epigravettian (Palma di Cesnola, 1993).

The dates for the earliest Aurignacian layers are 37.4 ± 1.3ka, and 27.23 ± .57ka for the recent ones (Hedges et al., 1994; Bietti and

Fig. 2. Schematic stratigraphy of Riparo Mochi (in gray Gravettian Layer D). (Modified from an original drawing of 1949 by A. G. Segre)

Negrino, 2006). This latter date may represent the beginning of the Gravettian occupation.

The osteological analyses on the large fauna from the Mousterian levels of Riparo Mochi (Layer I), carried out on the remains from the 1941 and 1949 excavations (Arellano, 2009), determined that ungulates represented the most frequent species (mainly red deer, wild boar, horse, and ibex) dominating the assemblage with 93% of the identified specimens, in contrast to carnivores (including bear, lion, panther, wolf, and hyena). *Alces alces* has been recognized only in the lower part of the deposit, while *Dama dama* was recovered in the upper portion. Therefore Layer I is in general characterized by a cold climate with a shift to milder conditions toward the top of the deposit.

The large mammal sample from the Upper Palaeolithic Layers C-G of the 1995–1996 excavations (Alhaique, 2000) is not very abundant, also for the small dimensions of the investigated area, but still provides interesting general information on climate and environment. In particular, in the Aurignacian Layer G cervids are markedly prevalent over caprines. The semi-sterile Layer E yielded mainly red deer remains. In Layer D, cold species such as marmot and ibex are present, but cervids, mainly *Cervus elaphus*, are abundant. Layer C, although poor in remains, is characterized only by cold species (*Marmota marmota* and *Capra ibex*). In general, large carnivores are almost absent in all layers and carnivore gnawed bones are rare as well, suggesting that faunal remains had been accumulated almost exclusively by humans.

This paper presents the results of the archaeozoological and taphonomic study of the macrofauna from layer D recovered during the "old excavations" (1938–1959), which were already the subject of an unpublished dissertation (Zeppieri, 2009).

During the 1938 and 1941–1942 excavation campaigns, the sediments of layer D were excavated by thick layers, probably natural (strata: $f \approx 30$ cm, $f1 \approx 30$ cm, $f2 \approx 50$ cm, and $f3_{(1-6)} \approx 60$ cm). In 1959 the excavation was instead carried out by artificial spits of about 10 cm (cuts 12–31bis East sector; cuts 12–25 West sector). On the whole, layer D has a thickness of about 2 m for a not well definable extension, but surely not less than 7.5 m² as it is possible to infer from the excavation journals. Because of the considerable thickness of the deposit, at the beginning of the present investigation on the faunal materials, there was a need to diversify the osteological remains on a stratigraphic basis according to their position within the deposit. Therefore, the Gravettian Layer D was divided into phases mainly taking into account the stratigraphic descriptions of the deposit reported in the journals and the excavation methodology employed by Blanc and Cardini in 1938/1942. In particular, the description and the location of the different "*focolari sparsi e sovrapposti*" (scattered and superimposed hearths) recovered throughout the layer have been taken into account. Hearths and burned bones were reported corresponding to the strata and cuts correlated below. Furthermore, the hearths seem to be located only in particular "parts" of the sediment and are absent in other, forming real "structures" or, in any case, representing probably a single action repeated through time. The phases have also been related to the artificial cuts of the 1959 excavation campaign.

The suggested stratigraphic division of layer D is:

- Phase I: stratum f (1938/1942 excavation) corresponding to cuts 12–14 E and 12–14 W (1959 excavation), ≈ 30 cm thick.
- Phase II: stratum f1 (1938/1942 excavation) corresponding to cuts 15–17 E and 15–17 W (1959 excavation), ≈ 30 cm thick.
- Phase III: stratum f2 (1938/1942 excavation) corresponding to cuts 18–22 E and 18–22 W (1959 excavation), ≈ 50 cm thick.
- Phase IV: stratum $f3_{(1-6)}$ (1938/1942 excavation) corresponding to cuts 23–30 E and 23–25 W (1959 excavation), ≈ 70 cm thick.
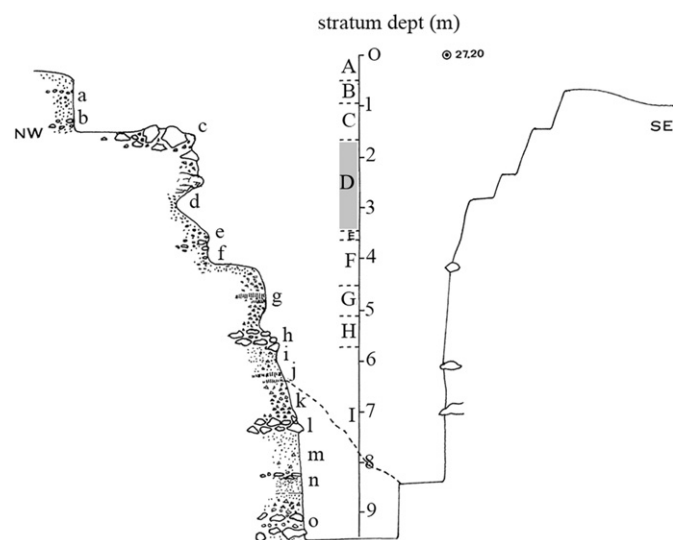
Table 1
NISP and NISP % by Phases and for Total Layer D, and MNI and MNI % for Total Layer D.

TAXA	I Phase		II Phase		III Phase		IV Phase		Base-layer D		Total		Total	
	NISP	%	NISP	%	NISP	%	NISP	%	NISP	%	NISP	%	MNI	%
Erinaceus europaeus	1	0.48	2	1.04			6	0.66	3	1.12	12	0.63	6	3.5
Marmota marmota	8	3.85	14	7.25	23	7.21	9	0.98	1	0.37	55	2.89	10	5.84
Lepus sp.	1	0.48	1	0.52	7	2.19	10	1.09	1	0.37	20	1.05	7	4.09
Oryctolagus cuniculus	5	2.4	16	8.29	48	15.05	51	5.57	10	3.72	130	6.82	17	9.94
Leporidae	1	0.48			6	1.88	2	0.22			9	0.47		
Vulpes vulpes	3	1.44	1	0.51	4	1.25	6	0.66			14	0.73	5	2.92
Felis silvestris					4	1.25	3	0.33			7	0.37	3	1.75
Lynx Lynx					1	0.31	5	0.55			6	0.31	2	1.16
cfr *Panthera pardus*							1	0.11			1	0.05	1	0.58
cfr *Crocuta crocuta*							1	0.11			1	0.05	1	0.58
Martes sp.	1	0.48			1	0.31					2	0.1	2	1.16
Mustelidae							3	0.33			3	0.16		
Ursus sp.							2	0.22			2	0.1	1	0.58
Sus scrofa	1	0.48	3	1.55	1	0.31	9	0.98			14	0.73	7	4.09
Cervus elaphus	76	36.54	66	34.2	99	31.03	383	41.81	94	34.94	718	37.69	39	22.8
Cervus/Megaloceros	2	0.96	1	0.52	1	0.31	6	0.66			10	0.52	4	2.33
Alces alces	6	2.88									6	0.31		
Cervidae grande	14	6.73	21	10.88	27	8.46	7	0.76	4	1.49	73	3.83	1	0.58
Capreolus capreolus	13	6.25	19	9.84	19	5.96	52	5.68	17	6.32	120	6.3	12	7.01
Cervidae	35	16.83	7	3.63	29	9.09	175	19.1	70	26.02	316	16.59		
Bos primigenius					1	0.31	11	1.2	2	0.74	14	0.73	6	3.5
Bovinae			1	0.51	1	0.31	10	1.09	1	0.37	13	0.68		
Capra ibex	35	16.83	36	18.65	36	11.29	138	15.07	47	17.47	292	15.33	34	19.88
Rupicapra rupicapra	2	0.96	2	1.04	2	0.63	7	0.76	7	2.6	20	1.05	7	4.09
Caprinae	3	1.44	2	1.04	9	2.82	10	1.09	8	2.97	32	1.68		
Rupicapra/Capreolus	1	0.48	1	0.51			9	0.98	4	1.49	15	0.79	6	3.5
Tot. Species/Family	208	100	193	100	319	100	916	100	269	100	1905	100	171	100
Tot. Species/Family	208	80	193	66.55	319	57.17	916	58.79	269	56.51	1905	60.63		
Ungulate	1	0.38	1	0.34	1	0.18			1	0.21	4	0.13		
Ungulate large size					5	0.9	10	0.64	2	0.42	17	0.54		
Ungulate large-medium size	3	1.15	5	1.72	3	0.54	8	0.51			19	0.6		
Ungulate medium size	12	4.62	43	14.83	78	13.98	205	13.16	71	14.92	409	13.02		
Ungulate medium-small size	14	5.38	23	7.93	96	17.2	305	19.58	97	20.38	535	17.03		
Ungulate small size	22	8.46	23	7.93	51	9.14	108	6.93	36	7.56	240	7.64		
Carnivorous					1	0.18	1	0.06			2	0.06		
Carnivorous small size			1	0.34	4	0.72	5	0.32			10	0.32		
Carnivorous large size			1	0.34							1	0.03		
Total Determinate	260	100	290	100	558	100	1558	100	476	100	3142	100		
Total Determinate	260	25.6	290	12.2	558	6.1	1558	4.4	476	6.5	3142	5.7		
Total Indeterminate	755	74.4	2095	87.8	8540	93.9	34137	95.6	6839	93.5	52366	94.3		
TOTAL	1015	100	2385	100	9098	100	35695	100	7315	100	55508	100		

- Base-layer D: cuts 31and 31bis (1959 excavation). This last group is characterized by a slight change in lithic industries, and therefore it is attributed to a phase of the Early Gravettian (Palma di Cesnola, 1993; Onoratini, personal communication).

In general, the lithic industry of Layer D is characterized by prismatic cores, end-scrapers on blade and on small flakes, as well as by numerous *Noailles* and *para-Noailles* burins. Studies on raw material provenience indicate that there is a great variety in the flint employed: there is raw material from the Vaucluse in Provence (about 200 km away); there are tools made on radiolarite from eastern Liguria, Emilia and Tuscany (from about 180 km to 250 km away), and on "Scaglia" from Central Italy (about 500 km away) (Bietti, 2004; Bietti and Negrino, 2006, 2008).

The taxonomic and skeletal identification was based on the reference collection of the Laboratorio di Paleontologia del Quaternario e Archeozoologia of the Museo Nazionale Preistorico-Etnografico "L. Pigorini" (Rome, Italy), where all the research was carried out.

The analyses of bone surfaces were made using small magnification (15–35×) lenses and a stereomicroscope (Nikon 1000). In order to identify and ascertain the nature of the alterations on bone surfaces, such as human or animal traces, trampling abrasion, and modern mechanical modifications produced by excavation tools,

reference was made to the well established and described information available from the wide taphonomic literature (Binford, 1981; Brain, 1981; Potts and Shipman, 1981; Shipman, 1981; Shipman and Rose, 1984; Blumenschine and Selvaggio, 1988; Capaldo and Blumenschine, 1994; Lyman, 1994; Blumenshine, 1995; Fisher, 1995). The degree of combustion was evaluated employing the methodology by Stiner et al. (1995).

In order to estimate the degree of fragmentation in the examined assemblage, bone fragments have been divided into dimensional classes (maximum length: $a < 3$ cm, $b = 3–4$ cm, $c = 4–5$ cm, $d = 5–6$ cm, etc.; maximum width: $a < 1$ cm, $b = 1–2$ cm, $c = 2–3$ cm, $d = 3–4$ cm, etc.; maximum thickness: $a < 0.5$ cm, $b = 0.5–1$ cm, $b = 1–1.5$ cm, $c = 1.5–2$ cm, $d = 2–2.5$ cm, etc.).

In order to reconstruct the strategies of exploitation of the different species age at death was determined (Aitken, 1974; Mariezkurrena, 1983; Vigal and Machordom, 1985; Stiner, 1994; Fiore and Tagliacozzo, 2006) and sex was identified (D'Errico and Vanhaeren, 2002). Measurements were taken following von den Driesch (1976). In order to evaluate species abundance the count of the number of remains (NISP) (Grayson, 1984), of the minimum number of elements (MNE) (Binford, 1981; Klein and Cruz-Uribe, 1984; Stiner, 1994) and the estimate of the minimum number of individuals (MNI) (Bökönyi, 1970) have been employed. In order to evaluate the skeletal representation of the different animals, the %
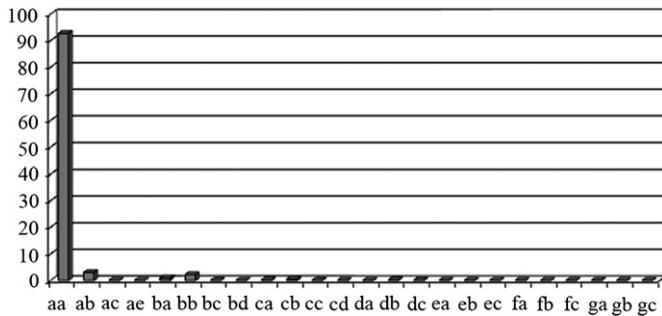
Fig. 3. Dimensional classes: Length/Width Ratio. Class *aa*: maximum length 3 cm and maximum width <1 cm. For the other classes see text, chapter 2 Materials and methods.

skeletal survival rate, the fragmentation index, and the bone mineral density (Binford, 1981; Brain, 1981; Lyman, 1994) have been calculated. The quantities of the various anatomical elements and individuals were recognized and calculated separately for each phase (I, II, III, IV and Base/layer D) and then totaled.

3. Results

The faunal assemblage from layer D includes 55,508 animal bone remains; only 3142 of these (about 6%, Table 1) have been identified to taxonomic level. Eighteen genera and fifteen species, belonging to five orders of mammals (insectivores, rodents, lagomorphs, carnivores and artiodactyls), have been recognized. However, some of these mammals are represented only by very few specimens (cfr. *Panthera pardus*, cfr. *Crocuta crocuta*, Mustelids, *Ursus* sp., *A. alces*), while others by very abundant bone elements (*C. elaphus*, *C. ibex*, *Capreolus capreolus*, *Oryctolagus cuniculus*, *M. marmota*). Differences in faunal composition among the different phases considered are not particularly evident for the most frequent species: red deer is always prevalent over ibex and roe deer. In contrast, *Erinaceus europaeus*, *M. marmota*, *O. cuniculus*, *Sus scrofa*, and *Bos primigenius*, for example, are absent or very rare in some phases, while particularly frequent in others, possibly suggesting different environmental conditions within the chrono-cultural period considered (Table 1).

The bones are very fragmented, and the data obtained from the length/width ratio show that over 90% of the specimens fall in the smallest dimensional class *aa*, with a maximum length of 3 cm and a maximum width <1 cm (Fig. 3).

Over 55% of the analyzed remains are burned and distributed in all phases. Furthermore, it should be stressed that over 98% come from the sector of the shelter where the hearths have been identified. The remains have been divided according to the variations in color in order to infer the temperatures to which they had been exposed. Over half (56.7%) shows a yellow-brown color (temperature about 200 °C), 36.3% is black (300°C-400 °C), while the remaining 7% is calcined and with a gray-whitish color (temperature >700 °C). This assemblage includes mainly small diaphysis fragments and the few fragments of spongy bone are concentrated mainly among the bones affected by the lowest temperatures. These data indicate not only that fires were constantly lit in the shelter, but also the use of bones as fuel (Costamagno and Thèry-Parisot, 2005).

The analyses on the state of preservation of bone surfaces indicated that in general bone specimens are strongly or partially coated with concretion. Many remains present abraded surfaces that sometimes affect the whole fragment; others, instead, are characterized by erosion traces also produced by corrosive substances dissolved in the percolating water. Other specimens show exfoliations and micro-fissures, alterations that are probably connected to weathering phenomena and/or weathering cracks. Traces of minerals (manganese), rafting, trampling, and roots are almost completely absent. It seems that the bad state of preservation of the osteological material analyzed is mainly due to pedo-genetic processes that contributed also to the high degree of fragmentation of the specimens, already affected by butchering activities and by burning.

Surface alterations probably compromised the observation of the traces produced before the abrasive and erosive phenomena. Rodent gnaw marks have been noted only on 8 elements, while carnivore ones, almost exclusively scoring, were detected just on 6 specimens. It is therefore possible to suggest that carnivores did not play a significant role in the accumulation of bone remains at Riparo Mochi.

Because of the poor state of preservation, human modifications have been recognized on 4.6% of the identified specimens and only on 0.2% of the unidentifiable fragments (Table 2). As far as the identified specimens are concerned, human traces include striae and impacts. Many of the butchering traces found on unidentifiable remains are impact cones (53 out of 102 specimens), suggesting that bone fragmentation is also due to marrow extraction.

Layer D (phase II) yielded also a fragment of worked bone obtained from a long bone diaphysis of a medium-small sized ungulate (red deer or ibex). This specimen is characterized by small impacts associated with use wear traces, localized mainly on one side of the tool.

3.1. Mammals

The following section describes in more detail the bone specimens belonging to rare species, while for the more common animals, the account will be more general. In addition, comparisons will be made with the coeval levels of the nearby cave of the Arene Candide.

Insectivora
Erinaceidae G. Fischer, 1817

Table 2
Butchering marks for Identified (NISP) and Unidentifiable (NR).

LayerD	Total Identified	Striae		Intentional fractures		Total Butchering marks		Bone tool	Total Unidentified	Butchering marks Total	
	NISP	NISP	%	NISP	%	NISP	%	NISP	NR	NR	%
I Phase	260	6	2.3	1	0.4	7	2.7		750	2	0.3
II Phase	290	6	2.1	6	2.1	12	4.1	1	2095	6	0.3
III Phase	558	17	3	10	1.8	27	5		8540	33	0.4
IV Phase	1558	43	2.7	32	2	75	5		34137	42	0.1
Base D	476	10	2.1	15	3.1	25	5.2		6839	19	0.3
Total	3142	82	2.6	64	2	146	4.6	1	52366	102	0.2

Erinaceus europaeus Linnaeus, 1758

The hedgehog is the only micromammal analyzed in this study because in the nearby and "coeval" site of the Arene Candide the presence of butchering traces suggested the exploitation of this species (Alhaique, 1994). On the whole there are 12 specimens, none of these shows human traces. The estimated individuals are mainly adults: 5 out of 6 (Table 1). The biometric study shows bone elements referable to animals slightly larger than modern ones.

Rodentia
Sciuridae Hemprich, 1820
M. marmota (Linnaeus, 1758)

The Alpine marmot is present in all phases with a variable number of specimens (Table 1). Among the bones there is a prevalence of cranial portions (mainly loose upper and lower incisors). There are only two remains belonging to young individuals while the remaining specimens may all be attributed to adult animals. The skeletal elements show in general larger dimensions compared to those of modern western alpine populations. This characteristic was already evident in the marmot remains recovered in the Late Pleistocene levels at the Arene Candide (Cassoli and Tagliacozzo, 1994). The absence of bones with butchering traces and gnaw marks, as well as the very few burned specimens (only 4 out of 55 specimens), associated with the presence of young individuals, leaves some uncertainty about the agent of accumulation of this animal that may have simply used the shelter as a den during the cold period, seeking refuge at lower altitude.

Lagomorpha
Leporidae G. Fischer, 1817
Lepus timidus Linnaeus, 1758 or *Lepus europaeus* Pallas, 1778

In the sample analyzed, it was not possible to distinguish the alpine hare from the brown hare. Twenty specimens have been identified, almost half of them burned, attributed to 7 individuals: two young and five adults (Table 1).

Oryctolagus cuniculus (Linnaeus, 1758)

Wild rabbit, with 130 specimens (45 burned), is the third most frequent species in layer D at Riparo Mochi. It is present in all phases, but it is more common in phases IV and III. The remains analyzed have been attributed to 17 individuals: 4 young and 13 adults. Presently in Europe there are two subspecies of rabbit: *O. cuniculus cuniculus*, of larger dimensions, and *O. cuniculus huxleyi*, of smaller size, living mainly in Mediterranean regions and on islands. Metric data of the rabbit bones from layer "D" at Riparo Mochi fall in the range of the smallest Mediterranean subspecies *O. cuniculus huxleyi*. Also the bone remains from the Arene Candide have been attributed to the smallest form of wild rabbit (Cassoli and Tagliacozzo, 1994).

Carnivora
Canidae G. Fischer, 1817
Vulpes vulpes (Linnaeus, 1758)

Fox is represented by a total of 14 bone remains, 6 of them burnt. The individuals recognized are mainly adults, and only one of them young. A mandible fragment from phase III presents a stria produced by a lithic tool on the mandibular ramus at the level of the masseteric fossa; the trace is deep and sharp and is referred to skinning (Fig. 4). The fox, very common in Italian Upper Palaeolithic sites, is often considered a typical fur animal.
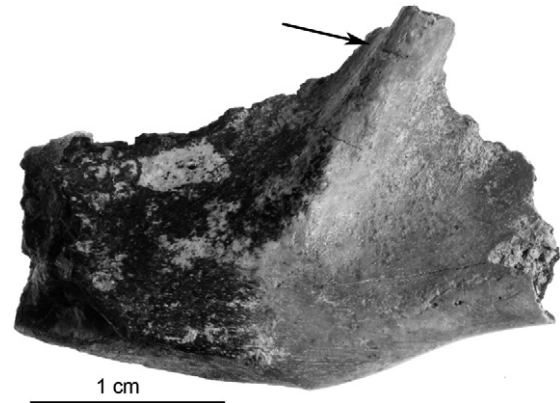

Fig. 4. Mandible fragment of *Vulpes vulpes* with cut marks.

Felidae G. Fischer, 1817
Felis silvestris Schreber, 1775

There are only 7 wildcat remains, 5 of them burned; the specimens come only from phase IV (3 elements, one individual) and phase III (4 remains and 2 individuals). A right hemi-mandible, completely burned (Fig. 5) presents clear skinning traces both on the mandibular ramus and on the carnassial (M_1) at the base of the crown on the buccal side. The striae are in both places short, deep, and parallel to the mandibular corpus. The bone specimens may be referred to medium-small sized animals. At the Arene Candide there are instead large sized specimens (Cassoli and Tagliacozzo, 1994).

Lynx lynx (Linnaeus, 1758)

The Eurasian lynx is present only with 6 remains distributed in phase III, with a single specimen belonging to an adult individual, and in phase IV with the remaining elements referable to another adult animal. The metric values of the remains place these remains within the variability of *L. lynx*. In the nearby cave of the Arene Candide, together with the Eurasian lynx there are also remains of a smaller lynx tentatively attributed to the cave lynx (Cassoli and Tagliacozzo, 1994). On a first phalanx, just below the distal epiphysis on the posterior face, there are cut marks produced by a lithic tool, placed transversally to the main axis of the bone; the traces are very deep, but the bottom is abraded and covered by concretion.
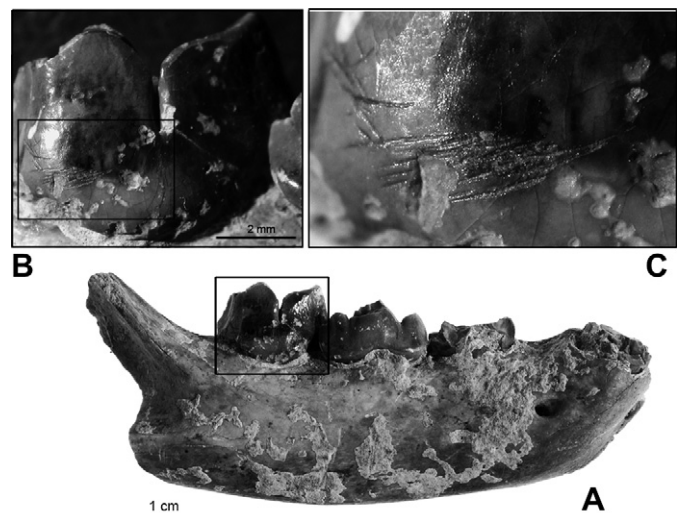

Fig. 5. Right mandible of *Felis silvestris* with cut marks.

Probably these cuts may be associated to skinning, although it is not possible to exclude a disarticulation process.

cfr. *P. pardus* (Linnaeus, 1758)

Only a distal epiphysis of a 1st phalanx from phase IV is referable to a probable adult leopard. The element is completely burned and exposure to fire may have modified (reduced) the original size of the specimen, not allowing a sure identification.

In Liguria and South-Eastern France leopard remains have been recovered at Grotta del Principe, Grotta dei Fanciulli (Boule, 1906–1910), Grotte de l'Observatoire, Monaco (Boule and De Villeneuve, 1927), Grotta del Pastore near Toirano (Mochi, 1914) and in the Gravettian levels of the Arene Candide (Cassoli and Tagliacozzo, 1994). Several leopard remains have also been identified in the Mousterian levels of Riparo Mochi (Arellano, 2009).

Hyaenidae Gray, 1821
cfr. *C. crocuta* (Erxleben, 1777)

The spotted hyena is represented only by a distal epiphysis of a first phalanx, completely burned, probably of an adult individual. A fragment of hyena was found also in the sample from layer D of the 1995–1996 excavations (Alhaique, 2000).

Mustelidae G. Fischer, 1817
Martes sp. Pinel, 1792

Only two elements have been attributed to this genus: an unburned astragalus that does not allow the determination of the age of the individual, and a first phalanx slightly altered by fire and belonging to an adult individual of pine or beech marten.

Mustelids

Phase IV yielded a lower canine and two distal epiphyses of the femur (of a young individual) belonging to a mustelid whose size is referable to that of pine marten, beech marten, ermine, or European polecat.

Ursidae G. Fischer, 1817
Ursus sp. Linnaeus, 1758

Two specimens, a fragment of lower first molar and a femur diaphysis, not surely referable to *Ursus spelaeus* Rosenmüller, 1794 or to *U. arctos* Linnaeus, 1778, have been documented. In Liguria both species have been identified at the Arene Candide (Cassoli and Tagliacozzo, 1994). The cave bear is also present in the Mousterian levels of Riparo Mochi (Arellano, 2009).

Artiodactyla
Suidae Gray, 1821
S. scrofa Linnaeus, 1758

There are only 14 wild boar remains, half of them burned. The sample is characterized by the presence of loose teeth, both upper and lower, and by distal limb elements, mainly short bones. A total of 7 wild boar individuals were estimated; five of them are juvenile animals. The presence of individuals that died at 6–12 months and at 18–24 months indicates that these animals were killed between the end of autumn and the beginning of spring.

Cervidae Goldfuss, 1820

Cervid remains are particularly numerous and may be referred to three different species: red deer, elk, and roe deer, plus the

Table 3
Number of red deer remains by anatomical element, MNE, number of expected elements (NEE), % skeletal survival rate, and breakage index.

Anatomical elements	NISP	%	MNE	%	NEE	% Skeletal survival rate	MNE/NISP
Cranium	71	9.9	36	10.3	39	92	0.51
Mandible	125	17.4	51	14.6	78	65	0.41
Frag. Teeth	8	1.1					
Atlas-Axis							
Vertebrae	2	0.3					
Ribs	1	0.1					
Scapula	4	0.6	4	1.1	78	5	1
Humerus	23	3.2	13	3.7	78	17	0.57
Radius	24	3.3	11	3.1	78	14	0.46
Ulna	14	1.9	12	3.4	78	15	0.86
Carpals	5	0.7	5	1.4	468	1	1
Metacarpus	78	10.9	18	5.1	78	23	0.23
Metacarpus rud.	4	0.6	4	1.1	78	5	1
Pelvis	1	0.1	1	0.3	39	3	1
Femur	20	2.8	7	2.0	78	9	0.35
Tibia	34	4.7	17	4.9	78	22	0.5
Malleolar bone	4	0.6	4	1.1	78	5	1
Calcagnus	9	1.3	9	2.6	78	12	1
Astragalus	3	0.4	3	0.9	78	4	1
Tarsals	7	1.0	7	2.0	234	3	1
Metatarsus	94	13.1	30	8.6	78	38	0.32
Metapod	41	5.7					
Phalanx I	43	6.0	31	8.9	312	10	0.72
Phalanx II	43	6.0	31	8.9	312	10	0.72
Phalanx III	15	2.1	10	2.9	312	3	0.67
Phalanx I rud.	7	1.0	7	2.0	312	2	1
Phalanx II rud.	7	1.0	7	2.0	312	2	1
Phalanx III rud.	11	1.5	10	2.9	312	3	0.91
Sesamoids	20	2.8	19	5.4	624	3	0.66
Total	718	100.0	350	100.0	4290	8	0.49

intermediate category "*Cervus elaphus/Megaloceros giganteus*". Furthermore, two other groups have been defined, mainly based on the size of the specimens: *large cervids* that include elk, giant deer and large sized red deer, and *cervids* that essentially contain medium-small sized red deer and roe deer.

Cervus elaphus Linnaeus, 1758

There are 718 red deer remains (about 37.7% of the total) and this is the best represented species in all the Gravettian phases at Riparo Mochi (Table 1).

These specimens belong to a total of 39 individuals, identified almost exclusively on the basis of tooth eruption and wear: 6 young animals (6–18 months), 6 young-adults (about 2–3 years), 9 prime adults (3–6 years), 9 older adults (6–9 years), and 7 elderly individuals (>9 years).

Analyzing the age at death, there is no evidence for differences among the age classes exploited. Considering that hinds give birth at the end of spring, it is possible to estimate the capture period for young red deer mainly between winter and spring.

Data on sex do not indicate selective hunting, because there are antler fragments and large sized specimens, including some lower M3, representing at least 4 male individuals, and the vestigial canines of 5 females. The information obtained from age classes and seasonality indicates that hunting occurred mainly in the periods when the two unisexual aggregations were separated. Therefore it is possible to suggest that prey were represented by females with fawns and yearlings (as indicated by the presence of young animals), that were more defenseless and almost certainly easier to hunt, as well as by bucks that were more desirable for their higher meat yield and for the antlers.

Traces of exposure to fire have been detected on almost half of the red deer remains (331 out of 718) and were identified on all the different anatomical elements except rare fragments of rib, pelvis, and vestigial metacarpal. The bones presenting the highest combustion values are those of the distal limbs (45–55%). They reach percentages up to 80–100% for the short bones of the carpus, the vestigial phalanges and the sesamoids. Long bone shafts commonly show high percentages of burned elements. These data show that the faunal remains were systematically employed as fuel, affecting the skeletal composition of the analyzed sample (Table 3).

In general the anatomical composition of red deer includes mainly teeth as well as large portions of long bone diaphyses (Table 3). The epiphyses, except those of the metapodials, are not well represented or almost absent, while the short bones of the extremities, in particular phalanges, are relatively abundant. The bones of the axial skeleton are scarcely represented and the complete absence of the first and second cervical vertebrae (atlas and axis) should also be remarked. Among the long bones, metapodials are particularly abundant. Such quantitative variability among limb long bones, especially between metapodials and the other anatomical elements (humerus, radius, femur, and tibia) may be explained by the morphology of the first elements which may be recognized even from minute fragments.

Among the distal limb bones, the presence of vestigial phalanges and sesamoids should be mentioned, suggesting the introduction of complete limbs into the site. The NISP/MNI ratio indicates that each individual is represented by about 19 specimens. This value is higher than that obtained for ibex that is characterized only by 9 specimens per individual.

All the diaphysis portions belong to elements with high mineral density, those that are therefore more resistant to post-depositional agents: tibia (density 0.74, measured by Lyman (1994) on bones of deer *Odocoileus* sp), metapodials (0.72–0.74), humerus (0.53–0.63), radius (0.62–0.68), and femur (0.37–0.57). As already noted, the

epiphyses are rare, but for example, the distal epiphysis of the humerus with a density of 0.63 is fairly well represented.

The considerations about the anatomical composition of red deer do not change when the minimum number of elements is used (Table 3), The calculation of the % skeletal survival rate, namely the ratio between the minimum number of elements and the number of expected elements (NEE) based on the 39 estimated individuals, indicates that only for some skeletal elements there are significant values (a value close to 100% indicates more complete skeletal elements, close to 0% means less complete). Table 3 shows that cranial (92%) and mandibular elements (65%) are the best documented portions; also some long bones are fairly well represented compared to the expected elements, especially the metatarsal (38%), followed by the metacarpal (23%) and by the tibia (22%); humerus, radius and ulna have values between 17% and 14%. Much less frequent is the femur with a survival index of 9%. Scapula, pelvis, phalanges (including the vestigial ones that from a simple count seemed quite numerous), tarsal and carpal bones, and sesamoids are strongly underrepresented compared to the calculated individuals (all values are between 12% and 2%).

The breakage index (ratio between MNE and NISP: values close to 1 indicate elements that are less fractured, values close to 0 those that are very fractured) shows that the long bones with marrow cavities and the cranial bones, with values close to or below 0.50 are very fractured, and even phalanges are not complete. All other anatomical elements have values equal or close to 1. This is true in particular for carpal and tarsal bones as well as for vestigial ones (metacarpals and phalanges) that for their morphology, hardness and density are more resistant to breakage. In the case of the scapula and the pelvis, the value of 1 is due to the better survival of particular portions of such bones (neck and glenoid fossa, and acetabulum) that are also the most easily identifiable ones.

On the whole (Fig. 6), the data on the skeletal composition of red reed indicate that in the Gravettian levels of Riparo Mochi there are almost all the bones of the carcass and that the quantitative oscillations of each bone or anatomical regions, shown by the different calculations (NISP, MNE, NEE), may be referable to various factors: different treatment by humans (more or less intense fracturing, use of bones as fuel), different response to pre- and post-depositional processes and "differential identifiability". Considering humans as the main agent of the accumulation of red deer remains, the scarce presence of elements of the axial skeleton as well as the low frequency of girdles (scapula and pelvis) may suggest a preliminary treatment of the carcasses at the kill site with the transportation to the shelter only of meaty portions together with marrow-rich bones. It is possible that some of the captured red deer were transported as complete carcasses to the site where butchering activities occurred both for alimentary use and for the possible collection of secondary products (tendons, antlers for the production of artifacts, etc.).

The low frequency of bones belonging to the axial skeleton together with the numerous fragments of the masticatory apparatus and, to a lesser degree, of the distal limbs, may indicate a "cleaning" of the site after the butchery of the prey, with a discard zone outside the shelter.

This hypothesis may be supported by the numerous impact flakes recovered that outnumber the impact scars; such flakes for their smaller dimensions remained on the ground surface of the shelter when larger fragments were taken away and discarded. There are numerous impact flakes (over 50), that on the basis of the thickness of the diaphysis may be attributed to red deer sized animals, and only 19 impact scars. Given the very high content in burned remains, it is also possible to suggest that the missing or scarcely represented anatomical elements were thrown into the
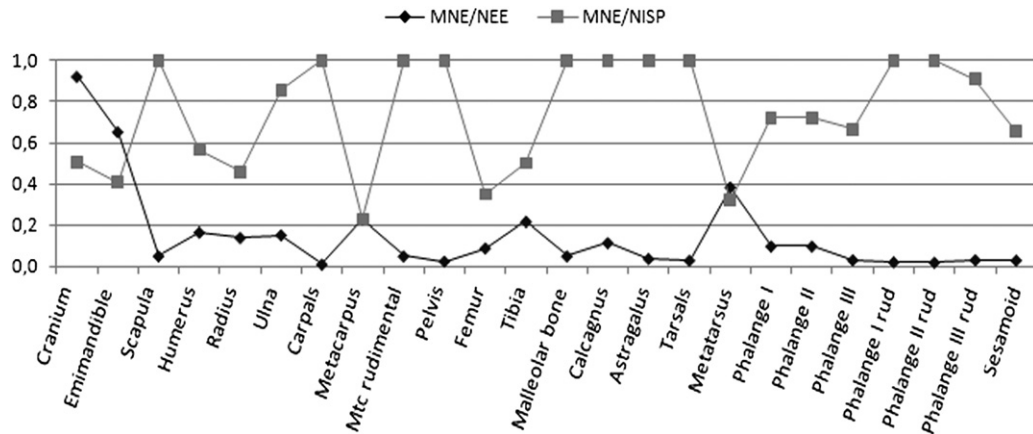
Fig. 6. Skeletal survival rate and breakage index for *Cervus elaphus*.

fire with the aim of procuring fuel, but also, at the same time, in order to keep the shelter clean.

Human traces of exploitation of red deer carcasses have been detected on 36 specimens, equivalent to 5.0% of the total. Striae have been recognized only on 15 elements, 8 of them also burned. Only 17 specimens, of which 11 were burned, present impact scars, while two bones, also burned, display both striae and impacts (diaphyses of a metacarpal and a femur). Although not numerous, the striae indicated all the phases of carcass exploitation (skinning, disarticulation and filleting). Phalanges, especially first and second ones (Fig. 7), show traces, often short and shallow, referable to skinning and to the collection of tendons.

Red deer/Giant deer, *Cervus elaphus/Megaloceros giganteus* (Blumenbach, 1799)

The necessity of defining this category stems from the impossibility to attribute some skeletal fragments of large sized deer (NISP 10) to one of these two species, while it was possible to exclude *A. alces*. The giant deer has been rarely found in Upper Pleistocene sites of Southern Europe, and in Liguria it has been reported, with few remains, only at the Arene Candide.

A. alces (Linnaeus, 1758)

A total of 6 specimens, all from phase I, were referred to this species. Specifically there are 5 incisors: the complete left series,
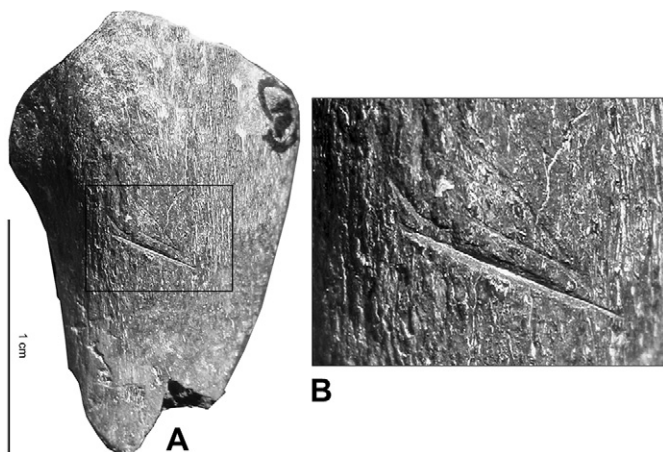
and a right I₄; the roots are very exfoliated and the teeth are quite worn, belonging to an adult individual. There is also a hemi-mandible fragment, covered with concretion, with a probable M_1 or M_2.

Large Cervids

In the sample examined there are other remains of large cervids that could not be attributed to elk, giant deer or large red deer. In addition to a few remains of the trunk and distal limbs, there are mainly some tips of antler tines which may belong to large red deer, elk, or giant deer, being the "accessory tines" of their antlers.

Capreolus capreolus (Linnaeus, 1758)

Roe deer is the second best represented cervid in all the Gravettian phases with 120 remains, 73 burned (Table 1). The most frequent elements are those of the extremities, in particular phalanges, including vestigial ones, followed by the elements of the masticatory apparatus, specifically mandibular fragments as well as loose teeth, both upper and lower. Among the limb bones there is an abundance of metapodials that are more easily recognizable. Human hunting is demonstrated by some cut marks detected especially on burned phalanx fragments (skinning and disarticulation actions). The presence of 12 roe deer individuals has been estimated: neonates, very young, and young animals are completely absent in favor of young-adults (2 individuals), prime adults (3), adults (6) and elderly (1) animals. The scarce presence of juveniles limited data on the season of site occupation. A roe deer was killed at 12–16 months, therefore between the end of the spring and the summer, while another individual was captured just before the age of 2 years, therefore presumably between the end of winter and the spring. These data agree with those obtained from red deer.

Cervids

In Layer D of Riparo Mochi, there are numerous remains (316, equivalent to 16.6% of the identified sample) that could be only referred to the general "Cervid" category; although very likely they mainly belong to red deer. More than 90% of these items are small fragments of tooth crown. In addition there are 15 remains of the tip of small antler tines (almost all burned), which may belong to either red or roe deer.

Bovidae Gray, 1821
Bovinae Gray, 1821

Fig. 7. Epiphysis of the second phalanx of *Cervus elaphus* with skinning/dismemberment traces.

Table 4
Number of ibex remains by anatomical element, MNE, number of expected elements (NEE), % skeletal survival rate, and breakage index.

Anatomical elements	NISP	%	MNE	%	NEE	% Skeletal survival rate	MNE/NISP
Cranium	39	13.36	14	7.14	34	41	0.36
Emimandible	67	22.95	38	19.39	68	56	0.57
Frag. Teeth	5	1.71					
Atlas-Axis							
Vertebrae							
Ribs							
Scapula	4	1.37	4	2.04	68	6	1
Humerus	10	3.42	7	3.57	68	10	0.7
Radius	14	4.79	11	5.61	68	16	0.79
Ulna	10	3.42	9	4.59	68	13	0.9
Carpals	4	1.37	4	2.04	408	1	1
Metacarpus	10	3.42	9	4.59	68	13	0.9
Pelvis	3	1.03	2	1.02	68	3	0.67
Femur	11	3.77	6	3.06	68	9	0.55
Rotula							
Tibia	6	2.05	6	3.06	68	9	1
Malleolar bone	1	0.34	1	0.51	68	1	1
Calcagnus	2	0.68	2	1.02	68	3	1
Astragalus	1	0.34	1	0.51	68	1	1
Tarsals	5	1.71	5	2.55	204	2	1
Metatarsus	15	5.14	12	6.12	68	18	0.8
Metapod	6	2.05					
Phalange I	27	9.25	21	10.71	272	8	0.78
Phalange II	25	8.56	17	8.67	272	6	0.68
Phalange III	5	1.71	5	2.55	272	2	1
Sesamoid	22	7.53	22	11.22	884	2	1
TOTAL	292	100	196	100	3230	6	0.67

Bos primigenius Bojanus, 1827

Only 14 aurochs remains were found, mostly fragments of lower molariforms, some of them also burned, and characterized by the presence only of the inner part of the lobe (covered with dentine), missing the external enamel. Six individuals have been estimated: a young animal (about 1 year old, killed between the end of the winter and the spring), a young-adult (about 1.5–2 years old), two prime adults and two older adults. A fragment of antero-medial diaphysis of a metatarsal has been identified: it displays a series of impacts on the edges and some series of short striae, in general oriented parallel to the longitudinal axis of the bone and scattered on the entire surface. These may suggest both skinning and filleting.

Bovines

For 13 remains (0.68%) it was not possible to assess the species differentiating between *B. primigenius* and *Bison priscus* (Bojanus,

1827) mostly because of the high degree of fragmentation (these are mainly very small tooth crown fragments and two metapodial portions), although presumably these specimens may belong to the aurochs.

Caprinae Gray 1821
C. ibex Linnaeus, 1758

Ibex is one of the most frequent species, representing the second taxon among the ungulates (Table 1). Slightly less than half of the analyzed remains (137) are burned. From the 292 specimens, 34 individuals have been identified, a value slightly lower than that of red deer (MNI 39) although the latter species is documented by a much larger number of remains (NISP 718). The estimated individuals are: 5 young animals (about 6–14 months old), 4 young-adults (about 18–36 months old), 16 prime adults (3–8 years), 8 older adults (aged 8–12 years) and one elderly individual. In general, ibexes are represented mainly by adults followed by young and young-adult animals,
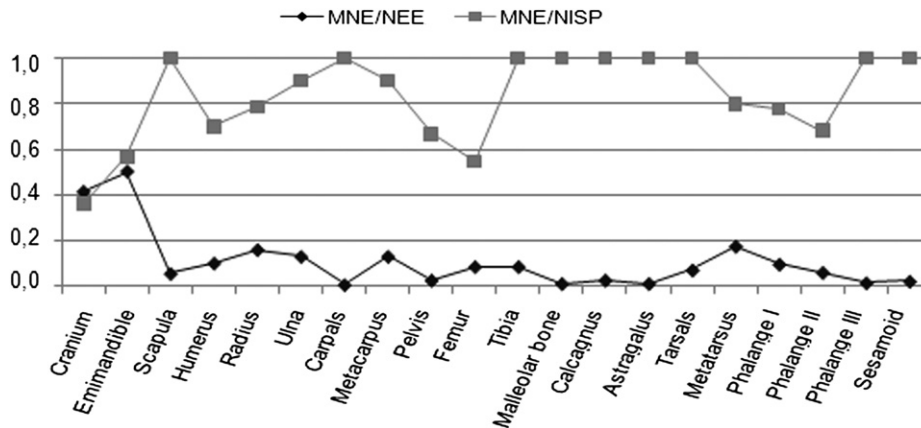
Fig. 8. Skeletal survival rate and breakage index for *Capra ibex*.

while elderly individuals are scarce. Alpine ibex too has a social organization based on a clear distinction between sexes. Females form their own group together with kids and young males, about 1 year old. The latter may also group together with other 2–3 years old individuals, while adult males, over 4 years, represent a further unisexual group. Elderly adults, 12–15 years old, tend to be isolated (Perco, 1981). The data on the season of capture of young ibexes indicate that kills occurred mainly in the winter-spring and spring-summer periods, when the herd disperses.

The 292 remains belong mainly to the distal limb elements (123 specimens, equal to 42% of the total) and to the cranium (111, equal to 38% of the total). Distal limb bones are very fractured: there are only 4 complete phalanges out of 54, indicating marrow acquisition even from small elements. The minimum number of elements (Table 4) indicates that the most common parts are those of the masticatory apparatus. In general, the front limb is more represented (40 elements) than the posterior one (26 elements), mainly because of the greater presence of radius and ulna. It is important to note the complete absence of vertebrae, including the most important ones (atlas and axis), and of ribs.

The calculation of the % skeletal survival rate, that is the ratio between the minimum number of elements and the number of expected elements (NEE) on the basis of the complete carcasses of the 34 estimated individuals shows that the skeleton is markedly incomplete (Table 4). Only the values of the hemi-mandibles and of the cranium range between 56% and 41%. The other anatomical elements are all scarcely represented: the metatarsal is the most common bone, but it has a value of just 18%, followed by the radius (16%) and the ulna (13%). Distal limb elements that from a first calculation appeared to be very abundant, actually have a very low percentage survival, ranging between 10% and 2%.

With the exception of the cranium, the breakage index does not show very fragmented elements, because the values are equal or close to 1, indicating an overestimated result. Strangely, long bones rich in marrow have values that are always over 0.5, and even the tibia reaches a value of 1. This is due both to the distribution of ibex remains in the different phases and to the survival in each element of the most resistant portions that are usually more easily identifiable.

On the whole (Fig. 8), the data on the anatomical composition of the ibex show that in the Gravettian levels of Riparo Mochi there are almost all the bones of the carcass, but there are strong quantitative variations among the different elements or anatomical regions, shown by the different calculations (NISP, MNE, NEE). Such variations may be explained both by the different response of each bone to the post-depositional processes and by the "differential identifiability".

A significant role is also played by the selective introduction, operated by humans, only of some anatomical portions and by the intense bone breakage, as indicated by the high number of long bone diaphyses - 532 remains referable to animals matching the size of this caprine. From the results obtained from the different analysis performed, it is possible to hypothesize that ibex was transported to the shelter only after a primary butchery at the kill site, with a selection of meat-rich anatomical portions and therefore of carcass parts that included the long bones of front and hind limbs. Selection of anatomical portions is plausible considering that the natural habitat of the ibex was probably not very close to the site. Significant is also the limited presence of the girdles (scapula and pelvis): it is possible to hypothesize the abandonment of parts of the carcass that are less rich in meat, with the disarticulation of the hid limb at the level of the acetabulum of the pelvis and with the possible removal of the meat from the scapula.

For the ibex, very few bones with butchering traces have been identified: just 3.8% of the total number of remains, with a marked prevalence of striae (9 remains) over impacts (3 specimens). Striae are evident mainly on the long bones of the anterior limb (humerus, radius, ulna, and metacarpal), while they are almost completely absent on the hind limb. Impacts have been noted on the humerus and the femur. Among the distal limb bones, only a first phalanx shows butchering marks. For ibex, the highest number of human modifications is located on specimens that also show clear burning traces, showing the effects of fire on the better preservation of the of bone surfaces. Although not numerous, the striae indicated all the main phases of carcass exploitation: skinning, disarticulation, and filleting.

Some not measurable portions of long bones belong to very large ibexes, very similar to those recovered at the Arene Candide. It

Table 5
Seasonality of occupation for the Gravettian Layer D.

is possible that these elements belong to male individuals. The dimension of the M_3 (length ranges between 22.6 and 28.6 mm), compared to the data from several Italian sites dated to the Late Glacial and to the Early Holocene (Fiore and Tagliacozzo, 2006), confirms that the ibex of Riparo Mochi falls perfectly within the size range of the earliest fossil specimens, while it is larger than modern animals.

Rupicapra rupicapra (Linnaeus, 1758)

The specimens referable to chamois are very rare: only 20 remains, 9 of them burned (Table 1). There are 7 estimated individuals: 2 prime adults, 2 older adults and 1 elderly animal, while it was not possible to estimate the age of two other individuals. On a completely burned pelvis fragment deep and subparallel cut marks have been identified; such modifications are referable to disarticulation for the cutting of the coxofemoral capsule.

At present in Italy, the genus *Rupicapra* is represented by two species: *Rupicapra rupicapra*, widespread in the Alps and Northern Apennines, and *R. pyrenaica* present in the Central Apennines (Masini and Lovari, 1988). Osteologically the distinction between the two species is possible only on complete skulls or large portions of frontal bones with horns that are instead completely absent in our sample. For this reason, the attribution of the specimens to *R. rupicapra*, is only based on the geographic location of the site.

Caprines

For 32 elements of the sample (1.68%) attribution to the subfamily Caprinae was only possible. These are mainly tooth fragments as well as minute portions of diaphyses of humerus, metacarpus, femur, phalanges and sesamoids.

4. Discussion and conclusions

The analysis involved a total of more than 55,000 macro-mammal remains from the "old excavations" (1938, 1941–42 and 1959) carried out by A.C. Blanc and L. Cardini in the Gravettian layer "D" of Riparo Mochi. To date, there are no radiometric dates for this layer, which is about 2 m thick. Therefore, on the basis of the sedimentology of the deposit and of the descriptions reported in the excavation journals, the layer has been divided into 5 "phases" in order to identify possible variations in the osteological sample. A total of 18 genera belonging to 5 mammal orders (insectivores, rodents, lagomorphs, carnivores, and artiodactyls) have been identified. Almost all the identified species are characterized by few remains (*E. europaeus*, Carnivora, *S. scrofa*, *A. alces*, *B. primigenius*,) and only *C. elaphus*, *C. ibex*, *C. capreolus*, and *O. cuniculus* exceed a hundred specimens. In general, the faunal spectrum indicated mainly a forest environment, with conifers and deciduous trees, characterized by a temperate, tending to cool, climate. Such type of ecosystem alternated with moments when the upper limit of the forest left space to the Alpine prairie, with colder temperatures and dry climate (mainly in the central phase of layer D), or times when the forest cover was thicker, with climatic conditions that were always temperate-cool, but more humid (phases I and II). However, in all periods, there is a contemporaneous presence of temperate and forest fauna (red deer, wild boar, roe deer, well adaptable also to more harsh temperatures) that probably lived in the immediate surroundings of the site, together with "cold" and open habitat species (ibex, chamois, marmot) that were present in mountain areas above the tree line. These habitats were well connected to the shelter, considering the orography of the area characterized by long and narrow valleys rapidly ascending to very high elevations. The

shelter, very close to the sea, in an area protected by high cliffs, had favorable climatic conditions even during the rigors of the winter.

It is possible to note some differences in faunal composition between the osteological sample from level D of the 1995–1996 excavations (Alhaique, 2000) and this data. The materials recovered during the excavations by Bietti show a reduced number of identified species, especially among the carnivores with the complete absence of felines, mustelids and bear, while for the ungulates wild boar and elk were not identified. Furthermore, also the ratios between the identified species are different: red deer represents half of the sample and is quantitatively followed by roe deer and then by ibex, so that the author suggests relatively mild climatic conditions during this occupation period. However, the discordant results obtained from the analyses of these two assemblages are probably mainly related to differences in sample size (3142 specimens for the 1938–1959 excavations vs. only 100 identified remains for the 1995–1996 digs).

The taphonomic analysis does not show great differences among the various phases: the whole sample presents the same kind of fragmentation and "bad" preservation of the bone surfaces. The modifications recorded on the bones allow the hypothesis that humans were the main agent of bone accumulation and that they occupied the site seasonally, lighting fires always in the same area in front of the shelter, where also butchery of hunted animals occurred, using then the bone waste and/or food debris as fuel. The specimens, besides suffering heavy modifications due to the action of fire, underwent pedogenetic transformations, especially chemical and physical ones, as well as sudden changes in humidity and temperature both before and after burial.

In general, no relevant differences in subsistence strategies have been noted among the various phases, and during the whole Gravettian occupation hunting focused mainly on red deer and ibex. Definitive evidence of exploitation has been detected also on roe deer, chamois, aurochs, and, among the carnivores, on fox, wildcat and lynx. These latter were captured mainly for their fur, as supported by the prevalence of skinning traces recovered on distal limb elements and on cranial bones, although it is not possible to rule out that also their meat was exploited. On the bones of hedgehog, marmot and leporids there are no sure indications of butchery, and therefore it is not certain that these species had been introduced by humans into the rock-shelter. However, there are no carnivore gnaw marks on these remains. It is therefore possible that the presence of marmot and rabbit remains may be related to the use of the rock-shelter as a den, as suggested also by the presence of numerous juveniles.

From the analysis of the skeletal elements of red deer and ibex two hypotheses on carcass processing are plausible, even in the same phase and on the same animal, on the basis of variables that are difficult to verify (distance from the kill site, number of people in the hunting party, weight of the prey, and quantity of hunted animals). The first hypothesizes that the complete carcasses of these artiodactyls were introduced in the site where all the butchering phases occurred (form skinning to marrow exploitation). The second suggests that a first selection of the carcasses occurred at the kill site and then only the portions with higher nutritional return were transported to the shelter.

From the few bone elements recovered, it is difficult to outline models of carcass treatment for the other artiodactyls. It is possible that roe deer and chamois, on which traces produced by lithic tools have also been detected, have been treated similarly to red deer and ibex.

The absence or the lower frequency of some elements or of portions of such bones, besides the high fragmentation, may be attributed to the human activity of cleaning the shelter of bulky fragments. This may be indirectly confirmed by the finding of

abundant percussion flakes that outnumber the impact scars. The high percentage of burned specimens suggests that the debris of the butchered bones or the food waste were used to feed the hearths, and this may also explain the absence or the underrepresentation of small short bones of the carpus and tarsus and of the sesamoids, introduced to the shelter as indicated by the finding of the bones that are anatomically articulated to them (radius-metacarpal and tibia-metatarsal). The traces of the action of fire are usually widespread and tend to cover the whole bone not allowing the identification of roasting of prepared food portions.

The absence of particular anatomical portions, the consistent presence of minute fragments and the relative abundance of burned specimens had been already noted in the analysis of the materials from layer D of the recent excavations (Alhaique, 2000). This author suggested that such absence could be related to the differential introduction of anatomical portions or to fragmentation; this latter may, in turn, be due to post-depositional factors or to human activities such as grease extraction from spongy bone portions by fragmentation and then by boiling. The relatively large quantity of burned remains, which in that sample was 17%, was attributed mainly to accidental factors rather than to direct human cooking practices.

Using the data on the age at death of the juvenile animals for each species and phase, it is possible to hypothesize that humans occupied the shelter on a seasonal basis, mainly in spring. It is also probable that the settlement choices changed in relation to the climatic conditions. As shown in Table 5, during the earliest Gravettian phases (Base-layer D and phase IV) it seems that the site was occupied more during the winter-spring season. The rock-shelter, thanks to its geographic location, was an optimal place to overcome the probable winter climatic harshness. Occasional presence during this period also occurred in summer and late autumn. In the remaining phases of this layer and mainly in the final moments of the Gravettian with *Noailles* burins, site occupation seems to be concentrated during the spring-summer period and only occasionally in the late winter.

Besides the occupation of the site, slight differences have been also recorded in the way red deer and ibex were captured. For red deer, hunting was undifferentiated, focusing on animals of all ages, starting from the "young" class, and of both sexes. For ibex there is a more selective hunting focusing on adult animals, but, also in this case, without distinction between males and females. Because of the presence in both species of young animals about 6—12 months old and for the prevalence of captures between winter and spring, it is possible to hypothesize that red deer and ibex were presumably hunted when the herds were unisexually separated. These data are much more detailed compared to those obtained from the analysis of the materials from the recent excavations (Alhaique, 2000), where different exploitation strategies between the two species had already been suggested with a non-selective capture of red deer compared to a selection of young-adults and prime adults for the ibex. It should be noted that this hypothesis for ibex is based on a very small sample. A comparison with the nearby cave of the Arene Candide, based mainly on the faunal composition, indicates that the two sites reflect different occupation profiles, although the faunal associations outline a relatively similar ecological situation.

The earliest Gravettian levels of the Arene Candide (P13-P9) have dates referred to the period between the Kesselt and Tursac interstadial (P13 = 25,620 ± 200 BP and P12 = 23,450 ± 220 BP) which may be correlated to the medio-basal phases of the Gravettian layer D at Riparo Mochi.

At the Arene Candide (Alhaique, 1994; Cassoli and Tagliacozzo, 1994), in the lower levels, there is a marked prevalence of carnivores (hyena, leopard, cave bear) that used the cave as a shelter and den, while the site was only occasionally used by humans, mainly in

the summer-autumn period, hunting animals of all age classes. Only in the P8—P1 levels, with more recent Gravettian dates (20,470 ± 320 BP—18,560 ± 210 BP), there seems to be an intensification in human frequentation of the cave, with the same seasonal occupation. More comprehensive and exhaustive comparisons with the Arene Candide and with other Italian sites with Gravettian levels will be possible when the new numerical dates, at the moment still in progress, will be available for layer D of Riparo Mochi.

In conclusion, the study of the faunal sample related to the Gravettian occupation at Riparo Mochi demonstrated small environmental changes during the period of the deposition of the sediments, with a colder phase in the central part of the deposit followed by a more humid one in the terminal part. The faunal remains are mainly the result of human activity, as indicated by the presence of butchering traces, the abundant burned bones used as fuel, and the type of fragmentation, associated to the almost complete absence of carnivore traces. Hunting focused mainly on red deer and ibex, but roe deer, chamois, aurochs and some carnivores, such as fox, wildcat and lynx also were exploited. Different capture strategies were adopted: a more opportunistic hunting without prevalence of a particular age class or sex was used for red deer, while a more selective one focusing on adult individuals was employed for ibex. The rock-shelter was occupied mainly between winter and spring in the oldest phases and between spring and summer in the most recent ones, with probable abandonment during autumn.

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