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UPPER PLEISTOCENE SMALL MAMMAL FAUNA FROM SALNOVA QUARRY (SALTRIO – VARESE – NORTHWESTERN LOMBARDY): PALEOENVIRONMENTAL RECONSTRUCTION AND *CHIONOMYS NIVALIS* POPULATION STUDY

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Key words: Upper Pleistocene, small mammals, Palaeoenvironment, MIS 3, Northewestern Lombardy, Italy.

Abstract. The small mammals collection described in the present paper has been collected during three field small excavation at the Upper Pleistocene site of Cava Salnova (Saltrio - VA -). The collection consists of 501 determined remains of small mammals coming from all 17 stratigraphical levels and belonging at least to 26 species. Two ^{14}C datings (AMS) has been made on small mammals bones belonging to the lev. 1b: 1- 34315 ± 200 yr BP; 2- 35101± 250 yr BP.

The interpretation of faunal data enables us to propose the following palaeoenvironmental framework: lower levels, lev. b and liv. c, are characterized by a cool weather with a high degree of plant cover. The deposition of lev. e to the lev. g coincided with an important reforestation occurred at the same time of the hottest Wurmian interpleniglacial. In lev. m, n, o, the snow vole, although rare, reappears. This may indicate the beginning of the climatic cooling, which is the prelude to the Last Glacial Maximum.

Riassunto. Il sito oggetto di questo lavoro si trova sul versante meridionale del monte Pravello all'interno della cava Salnova a Saltrio (Varese), situato ad una quota di 775 metri slm.

Sono stati determinati 546 reperti provenienti da 17 livelli stratigrafici, appartenenti ad almeno 26 specie. Sono state commissionate 2 datazioni con il metodo del radiocarbonio. Entrambi i campioni provengono dal liv. 1b: 1- 34315 ± 200 yr BP; 2- 35101± 250 yr BP.

L'interpretazione di questi dati permette di proporre il seguente quadro paleoambientale: i livelli inferiori liv. b e liv. c sono caratterizzati da un ambiente fresco con un buon grado di copertura. I livelli intermedi, dal liv. e fino al liv. g indicano un netto rimboschimento dell'area avvenuto in concomitanza della fase più calda dell'interpleniglaciale wurmiano. I livelli superiori, liv. m-n-o, indicano, forse, l'inizio del raffreddamento climatico che prelude all'ultimo massimo glaciale.

Introduction

The small mammals collection described in the present paper has been collected during three field small excavation at the Upper Pleistocene site of Cava Salnova (Saltrio - VA -).

The deposit of Cava Salnova opens in the Jurassic limestone of "Formazione di Saltrio", in the Northwestern Lombardy (Northern Italy) on the top of Pravello mountain at 775 m a.s.l., near the boundary between Italy and Switzerland (Fig. 1).

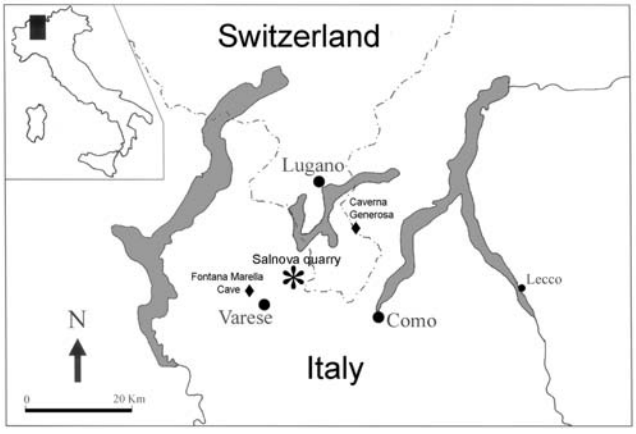

Fig. 1 - Geographical position of the Salnova quarry where the small cavity object of this paper opened. Also indicated position of Caverna Generosa e Fontana Marella cave.

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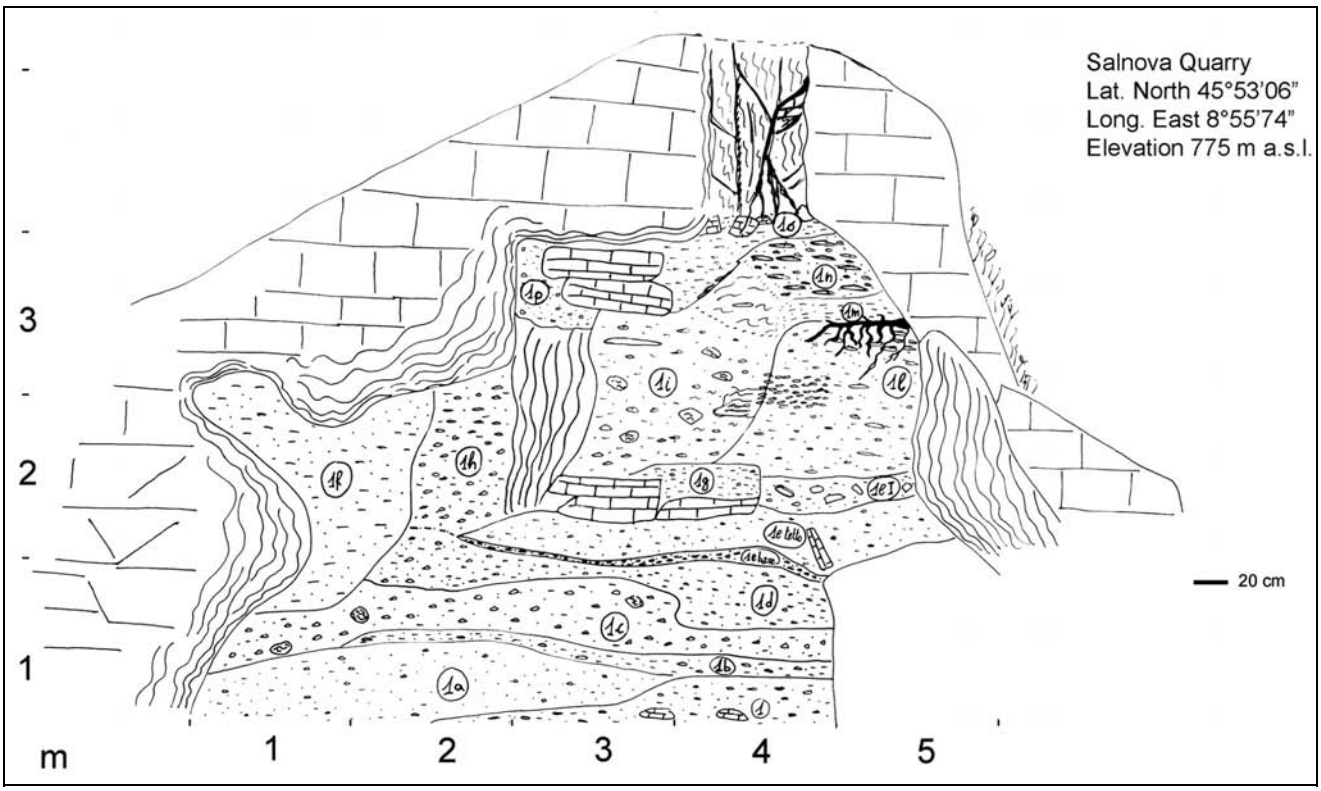

Fig. 2 - Stratigraphical sketch of the small cavity situated at the top of Salnova quarry (Saltrio, Varese, North-Western Lombardy).

Today, because of the activity of Saltrio limestone extraction, only the north wall of the small cavity is visible. The wall of the cave is covered by strong concretions.

Before the extraction activity, probably, the cavity was a vertical structure with a vertical chimney (Fig. 2).

This paper increases the palaeoenvironmental knowledge for the NW Italy, because it gives new data about Upper Pleistocene of Lombardian Pre-Alps, studied during the last ten years by the author (Bona et al. 2007; Bona et al. 2008; Bona et al. 2009).

This manuscript presents the analysis of mammal remains belonging to two orders, Insectivora and Rodentia, and four families, Soricidae, Talpidae, Muridae and Gliridae. Remains of the order Chiroptera will be not described here.

Material and methods

The collection consists of 501 determined remains of small mammals coming from all 17 levels and belonging at least to 26 species (Tab. 1). The three best-represented species are: *Myodes glareolus*, *Glis glis* and *Chionomys nivalis*. It is important to underline the presence of *Sciurus vulgaris* and *Eliomys quercinus*. In Tab. 1 every species have been reported level by level with their number of identified specimens (n) and the minimum number of individuals (MNI).

Large mammals are represented by 31 remains belonging to four species of carnivorous animals: *Vulpes vulpes*, *Martes* sp., *Mustela nivalis* and *Mustela putorius*; one specimen of *Lepus* sp. Only one bone fragment has been attributed to a bird (Tab. 2).

The method used to collect the small remains consists of two phases: 1- the sieving of sediments during field work, with 1 mm mesh sieves; 2- the sifting and the accurate picking of samples in the laboratory of the Milan University.

The specimens have been identified following mainly Chaline et al. (1974) and Niethammer & Krapp (1978, 1982, 1990).

Stratigraphy

The deposit is characterized by two different phases:

1- the older one is characterized by the heavy concretions formation, which covered completely the inner surface of the cavity.

2- the second phase corresponds to the fossiliferous deposits of the small cave.

Seventeen levels characterize the stratigraphy of the small cavity; each represents a single depositional event. They differ for cementation degree, clast content, colour and matrix. Each level shows a conoid shape which means the way of deposition: mudslides from the chimney.

Levels description, bottom to top (Fig. 2):

Lev. 1: well cemented rubble with small and sharp clasts (max diameter 1 cm). Clasts of "Formazione di Saltrio" limestone with maximum diameter of 20 cm are rare. The colour of the matrix and of the cement is yellow cream. This level represents the basis of the fossiliferous deposit.

TAXA	Lev 1			Lev 1 a			Lev 1 b			Lev 1 b/c			Lev 1 c			Lev 1 d			Lev 1 d/e			Lev 1 e			Lev 1 f			Lev 1 g			Lev 1 i			Lev 1 l			Lev 1 m			Lev 1 o		
	n	MNI	MNI %	n	MNI	MNI %	n	MNI	MNI %	n	MNI	MNI %	n	MNI	MNI %	n	MNI	MNI %	n	MNI	MNI %	n	MNI	MNI %	n	MNI	MNI %	n	MNI	MNI %	n	MNI	MNI %	n	MNI	MNI %	n	MNI	MNI %	n	MNI	MNI %
Apodemus gr. *sylvaticus/ flavicollis*							13	4	4.5				6	3	12																		2	1	7.7	1	1	7.1						
Arvicola terrestris							12	4	4.5				6	2	8										1	1	5.9																	
Chionomys nivalis							42	23	25.8	3	1	100	9	5	20																	1	1	7.7	2	1	7.1	1	1	100			
Chiroptera indet.							6	3	3.4																1	1	5.9								1	1	7.1						
Clethrionomys glareolus	1	1	33.3	1	1	100	47	17	19.1				16	5	20	3	1	20				6	3	42.9	11	2	11.8	2	1	20	1	1	25	8	2	15.4	2	1	7.1			
Crocidura cf *leucodon*							4	3	3.4																																	
Crocidura leucodon							1	1	1.1				3	2	8																											
Crocidura sp.													2	1	4																											
Eliomys quercinus																																	2	1	7.7							
Glis glis	1	1	33.3				13	4	4.5				2	1	4	13	3	60	5	2	66.7	9	4	57.1	57	10	58.8	13	3	60				35	6	46.1	25	3	21.4			
Marmota marmota																3	1	20	1	1	33.3																					
Microtus agrestis							3	2	2.2																1	1	5.9				1	1	25									
Microtus arvalis							2	1	1.1				1	1	4																											
Microtus sp.							3	1	1.1																																	
Myotis bechsteinii							4	2	2.2																																	
Myotis emarginatus							1	1	1.1																																	
Myotis sp.																																											
Neomys fodiens																															1	1	25									
Rhinolophus hipposideros																									3	2	11.8															
Sciurus vulgaris																																	1	1	7.7							
Sorex alpinus							3	2	2.2																																	
Sorex araneus							3	2	2.2				1	1	4																											
Sorex cf. *araneus*																																											
Sorex minutus							9	5	5.6																																	
Sorex sp.	1	1	33.3				1	1	1.1				1	1	4													1	1	20												
Talpa caeca							32	7	7.9				1	1	4																							3	2	14.3			
Talpa europea							17	4	4.5																						1	1	25				1	1	7.1			
Talpa sp.							1	1	1.1				3	2	8																							2	2	14.3			
Terricola gr. *multiplex/ subterraneus*							1	1	1.1																									1	1	7.7							
Tot.	**3**	**3**	**100**	**1**	**1**	**100**	**218**	**89**	**100**	**3**	**1**	**100**	**51**	**25**	**100**	**19**	**5**	**100**	**6**	**3**	**100**	**15**	**7**	**100**	**74**	**17**	**100**	**16**	**5**	**100**	**4**	**4**	**100**	**50**	**13**	**100**	**39**	**14**	**100**	**1**	**1**	**100**

Tab. 1 - List of taxa of microfauna from each level: Number of specimens (n), Minimum Number of Individual (MNI) and its percentage (MNI%).

Taxa	n	MNI
Aves sp.	1	1
Lepus sp.	1	1
Martes sp.	1	1
Mustela erminea	2	2
Mustela putorius	1	1
Mustela sp.	4	3
Vulpes vulpes	24	2
Tot.	**34**	**11**

Tab. 2 - List of taxa of large mammals and bird: Minimal Number of Individual (MNI) and its percentage (MNI%).

Lev. 1a: brown-green silty matrix with angular clasts (maximum diameter of 1 cm). In the texture there are voids, even large one centimeter, partly filled by cement. Sometimes very small mammelonar concretions (diameter less than a centimeter) are present. The smaller voids may occur without cement.

Lev. 1b: about 15 cm thick; slightly cemented; dark brown clay-silty matrix with few angular clasts (diameter of 2-3 centimeter). It is the most fossiliferous level of the deposit, in fact the small bones are visible along the section. The more compact portion is divided into millimetric polyhedra. The matrix in the eastern side of the level becomes more yellowish.

Lev. 1c: well-cemented rubble. Brown matrix and large voids unfilled. Angular clasts with maximum diameter of 3-4 centimetres are present. Accumulations of cemented small mammal bones are visible.

Lev. 1d: slightly cemented with clasts smaller than 1 centimeter of diameter. Reddish-yellow silt-clay matrix. Millimetric structure characterized by polyhedral aggregates.

Lev. 1e: this level presents a very irregular distribution along the site. It is very similar to lev. 1c but with more yellow-reddish matrix, there are much more angular clasts (maximum diameter 15-20 centimeters). Fragments coming from the concretioned walls of the cave are present. The level can be divided into three horizons:

– *Lev. 1e base:* thickness 8-12 centimeters, rather cemented and with clasts with maximum diameter of 2-3 centimeters

– *Lev. 1e tetto:* thickness 40-50 centimeters. Discontinous cementation along the development of level. Clasts cemented or not with dimensions of 10x10 centimeters.

– *lev. 1e I:* it is present only in the eastern portion of the top of lev. e (Fig. 2). Thickness about 20 centimetres. It is less cemented than other portions of the level, with brown matrix and clasts with maximum diameter of 10-12 centimeters.

Lev. 1f: very similar to lev. 1d, probably separated to it by erosion of the deposit (Fig. 2)

Lev. 1g: mudslides of silty-clay materials. It is similar to lev. 1d and 1f.

Lev. 1h: well cemented rubble similar to lev. 1c, but there are clasts with an average diameter less than 4 - 5 centimeters. Few matrix and white cement are present.

Lev. 1i: lithological body irregular cemented, with large blocks of altered limestone fragments and concretions. Sharp edges clasts with an average diameter of less than 6-7 centimeters. Well cemented, matrix light brown.

Lev. 1l: lithological body slightly cemented. It is composed primarily of dark brown silt and clay. There are clasts with an average diameter of 2-3 centimeters. Sometimes present clasts with larger diameter. The presence of roots does not allow complete hardening. Thickness of about 1 m. The sediment breaks up into millimeter aggregates. In the extreme west there is a sedimentary body (size about 50x30 cm) composed of oriented limestone.

Lev. 1m: silty clay body about 15-20 cm thick. There are few clasts of 4-5 centimeters of diameter.

Lev 1n: very cemented body, almost composed exclusively by large angular clasts, very cemented, the size of clasts is about of 3-4 cm maximum diameter. Between clasts voids are present, unfilled of cement. The structure of this level suggests that it could be the result of the collapse of the cave ceiling.

Lev 1o: residual mudslide with limestone clasts and concretions of 10 cm in diameter. It is located in the central area beneath limestone blocks.

Lev 1p: this level is located in direct contact with *lev 1i*. It seems to be flowed from the same direction of *lev 1i*, as indicated by the orientation of clasts.

Age of the remains

Two ^{14}C datings (AMS) has been made by the CEDAD (Salento University – Department of Engineering of Innovation – Lecce) on small mammals bones belonging to the *lev 1b* (Tab. 3).

According to the results of these analyses, the second stratigraphical level (see above), the filling of the Cave of Saltrio, could be attributed to the middle part of MIS 3.

Sample	Radiocarbon Age (BP)	$\delta^{13}C$ (‰)
LTL3912A	34315 ± 200	-16.3 ± 0.3
LTL3913A	35101 ± 250	-31.7 ± 0.3

Tab. 3 - ^{14}C datings of the Salnova quarry site.

Accumulation modality and taphonomic considerations

The accumulation of the small mammals remains in the sediments of this site is most likely due to the decomposition of owls' pellets (these birds probably used the cave as shelter or/and perch). According to Contoli (1980) the owls are considered species with low selection of prey, so in this paper the collected samples have been considered as reflecting quite faithfully the real mammalian community of owls hunting area.

As a result of owls activity it is possible to recognized: 1- heavy fragmented small mammals bones; 2- bones and teeth with strong traces of acidification due to the owls gastric reworking of preys.

Stratigraphical distribution of small mammal remains

All data discussed below have been resumed in Tab. 1.

Level 1: few remains, only three, have been found in this level. They belong to: *Myodes glareolus*, *Glis glis* and *Sorex* sp.

Level 1a: this level, particularly scarce in findings, has allowed the discovery of only one lower jaw of *Myodes glareolus*.

Level 1b: the *level 1b* is undoubtedly one of the most interesting levels of this site. It is the level with the largest number of determined finds and the greater variety of taxa. The large part of the remains belongs only to three species: *Myodes glareolus* is the species that has returned more determined specimens (46 remains), followed by *Chionomys nivalis* (42) and the *Talpa caeca* (32). In addition to dominant species above, in this level were found remains of *Apodemus* gr. *sylvaticus/flavicollis* (13), *Arvicola terrestris* (12), *Crocidura* cf. *leucodon* (4), *Glis glis* (13), *Sorex minutus* (9); the level has also returned few remains of *Microtus agrestis* and *Microtus arvalis*, *Sorex araneus* and *Sorex alpinus*, *Microtus* (*Terricola*) gr. *multiplex/subterraneus*, and two species of bats (*Myotis beichsteinii* and *Myotis emarginatus*). In overall, the *level 1b* has returned 218 determined rodents remains belonging at least to 89 individuals (Tab. 1).

Level 1c: the remains collected in this level allowed to recognize 53 specimens belonging to 12 taxa of small mammals. The most frequent species are *Chionomys nivalis* and *Myodes glareolus*, followed by *Apodemus* gr. *sylvaticus/flavicollis* and *Arvicola terrestris* (Tab. 1).

Level 1d: only 19 specimens have been determined, they belong to 3 species: *Glis glis*, *Myodes glareolus* and *Marmota marmota*. The species better represented, with 13 remains, is the dormouse. The other two taxa have been represented by one individual each.

Level 1d/e: the remains found in a portion of the deposit where it was difficult to recognize clearly the transition between *level 1d* and *1e* have been marked as coming from *level 1d/e*. In this portion of sedimentary succession 6 determinable specimens were found, five of which belong to *Glis glis* and one to *Marmota marmota*.

Level 1e: this level is one of the most articulate; it was divided into several subdivisions (Fig 2). For this reason the analysis of the findings required attention. Finally we decided to assemble, for the palaeoenvironmental analysis, all these subdivisions in a single layer named *level 1e*.

Here 15 specimens belonging to two taxa were found: *Myodes glareolus* (6 specimens) and *Glis glis* (9 specimens).

Level 1f: this level, with 74 determined remains, is the second for speciments abundancy. The biggest part of bones belongs to *Glis glis* (57 teeth), 11 remains belong to *Myodes glareolus*, 3 to the bat *Rhinolophus hipposideros* and only one determined specimen each for *Microtus agrestis*, *Arvicola terrestris* and an undetermined bat.

Level 1g: for this level were determined 16 specimens belonging to 3 species: *Glis glis* is the most frequent species with 13 specimens; *Myodes glareolus* and *Sorex* sp. are represented respectively by 2 and 1 determined find.

Level 1i: this level has returned only 4 specimens of determinable mammals, 1 each for the following species: *Myodes glareolus*, *Microtus agrestis*, *Neomys fodiens* and *Talpa europea*.

Level 1l: fifty-one specimens belonging to this level were determined; most of them belong to *Glis glis* (35 remains). Particularly interesting is the presence of 2 remains of *Eliomys quercinus* and 1 of *Sciurus vulgaris*. The remaining rests belong to *Apodemus* gr. *sylvaticus/flavicollis* (2 remains), to *Chionomys nivalis* (1), to *Myodes glareolus* (8) and *Microtus* (*Terricola*) gr. *multiplex/subterraneus* (1).

Level 1m: even in this level most of the finds determined belong to *Glis glis*; in fact 25 remains of this species have been found. The remains found belonging to other taxa are less numerous: 3 specimens of *Talpa caeca*, 2 of *Chionomys nivalis*, *Talpa* sp. and *Myodes glareolus*, and only 1 specimen for *Apodemus* gr. *sylvaticus/flavicollis*, *Talpa europea*, *Sorex* cf. *araneus*, *Sorex* sp., *Myotis* sp. and another undetermined bat.

Level 1o: this level has yielded only a lower first molar of *Chionomys nivalis*.

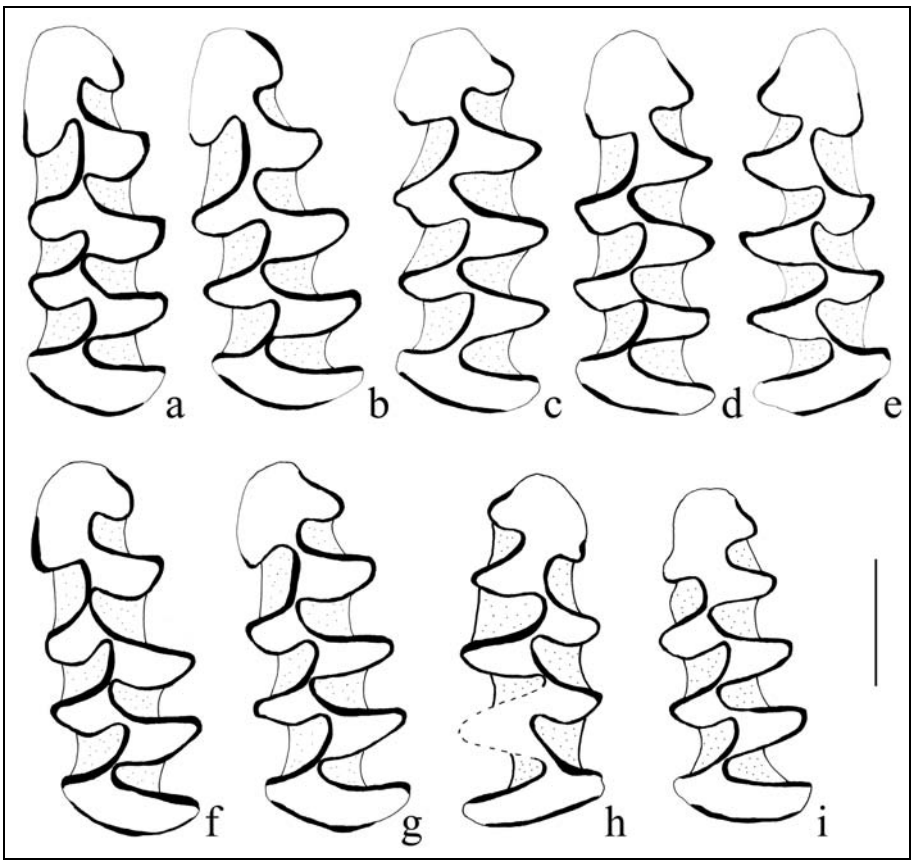

Fig. 3 - *Chionomys nivalis* morphotypes. a-b: "nivalis" morphotype; c-e: "abulensis" morphotype; f-g: "aquitanius" morphotype; h-i: "saltrio" morphotype. Scale bar represents 1 mm.

Chionomys nivalis M_1 variability

During the analysis of findings of *Chionomys nivalis* it has been noticed a considerable differentiation in the dental morphology of M_1. It results from three major factors:

– Conservation: mainly due to the action of the juice stomach of raptors that deeply corrode the teeth.

– Age of individuals: for example, teeth of juveniles present enamel poorly developed and sometimes they are very difficult to determine. In these cases, only the analysis of the roots can help for the determination.

– Frankly intraspecific variability: this is the most interesting component of variability which occurs between the teeth of adults.

This last type of variability can be analyzed to identify the evolution trends of populations of *Chionomys* (Nadachowski 1991).

Today, populations of *Chionomys nivalis* are geographically isolated and they show a high intraspecific variability in M_1.

Based on the works of Nadachowski (1984, 1985) it is possible to list the current morphotypical distribution in *Chionomys nivalis*:

– The Iberian Peninsula populations are the most characteristic and particular, when compared with the populations of the rest of the Europe and the Asia continents. In those animals, the most represented morphotype is defined "nivalis", followed by a good percentage of "lebrunii" and "aquitanus".

– The Alpine populations are characterized by a high frequency of the "nivalis" morphotype and a lower percentage, if compared to the Iberian populations, of the "lebrunii" morphotype. The Alpine populations are characterized by a good presence of transitional forms between the described morphotypes and a size increasing trend that follows a gradient from the West to the East.

– The populations of the Carpathians, the Balkans and the Dinaric regions show little variances in the first molar morphotype with an absolute predominance of the "nivalis" morphotype. The "lebrunii" and "oeconomus" morphotypes are very rare.

– A high percentage of the "oeconomus" was found in Asian populations within the morphotype "leucurus".

On the basis of the above mentioned papers, the dental morphotypes belonging to Saltrio specimens of *Chionomys nivalis* were analyzed.

Forty-four first lower molars of *Chionomys nivalis* have been analyzed, suitable for the purposes of our analysis.

The diagnostic factors used in this paper are those proposed by Nadachowski (1991).

1 - Confluence of T4 and T5; 2 - Confluence of T5 and T6; 3 - Development of BSA4;

4 - Development of LSA5; 5 - Development of BRA4; 6 - Confluence of T6 and T7; 7 - Development of a "*Mimomys*-ridge" on BSA4; 8 - Development of LRA5; 9 - Development of BRA5.

The analysis of the 44 M_1 of *Chionomys nivalis* allowed us to identify 4 morphotypes characterized by a different combination of the considered factors (fig. 3):

1 – **"nivalis" morphotype**: 11 specimens (25%) have been attributed to this morphotype. The "nivalis" morphology is characterized by having T5 and T6 always separate, BSA4 and LSA5 well developed, BRA4 and LRA5 incipient and a short anterior cap.

2 – "**aquitanius" morphotype**: 16 specimens (36%). In this morphotype T5 and T6 are markedly separated, BSA4 and LSA5 are well developed and BRA4 and LRA5 are absent.

3 – **"Saltrio" morphotype**: 14 specimens belong to this group (32%). These specimens have a morphology similar to "nivalis", but with T5 and T6 largely confluent and BRA4 and LRA5 developed. These considerations allow us to ascribe this morphology to a new morphotype (Fig. 3 h-i). This is, probably, one of the transitional forms, typical of the Alpine region populations of the *Chionomys nivalis*, noticed by Nadachowski (1991) or a variant of a "primitive" morphotype "lebrunii" (Nadachowski, pers. com.).

4 – **"abulensis" morphotype**: 3 specimens (7%) were attributed to this morphotype. This morphotype is characterized by having T5 and T6 a little confluent or completely separate, with BSA4 well-developed and LSA5 incipient or absent.

The frequencies of M_1 morphotypes of *Chionomys nivalis* found in Saltrio site show a trend comparable with that of the today living isolated populations of this species (Nadachowski 1991). It is possible to suggest that about 35,000 yr BP, Mount Pravello (where the rubble of Saltrio is located) hosted an isolated population of snow voles: this interpretation well fits with the paleoenvironmental interpretation.

Conclusions

The results of ^{14}C analyses allow to attribute the age of deposition of the rubble of Saltrio to the MIS 3. The interpretation of faunal data enables us to propose the following palaeoenvironmental framework: lower levels, *lev. 1b* and *lev. 1c*, are characterized by the dominance of *Myodes glareolus* and *Chionomys nivalis* indicating a cool weather characterized by a high degree of plant cover (the great variety of *Chionomys nivalis* M_1 morphotypes allowed us to hypothesize a late stage of the first glacial maximum with isolation of snow vole populations (Nadachowski 1991)). The middle part of the deposit, from *lev. 1e* to the *lev. 1g* (in *lev. 1d* the marmot is still present), is characterized by the disappearance of *Chionomys nivalis* and the dominance of *Glis glis* and *Myodes glareolus*; this indicates that an important reforestation occurred at the same time of the hottest Wurmian interpleniglacial. In the higher levels, *lev. 1m*, *1n*, *1o*, the snow vole, although rare, reappears. This may indicate the inception of the climatic cooling which prelude the Last Glacial Maximum (Fig. 4).

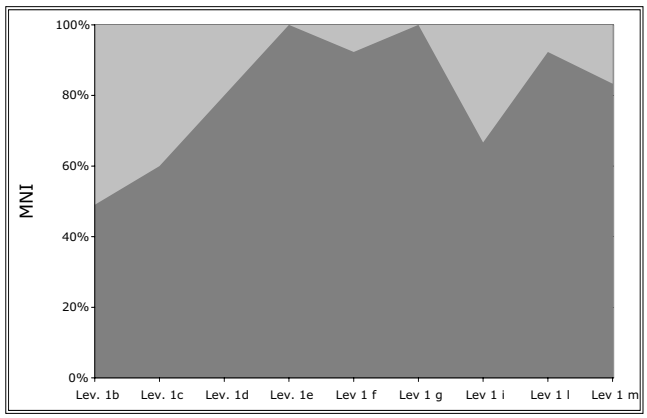

Fig. 4 - Relation between "Bush" taxa (*Apodemus*, *Microtus* (*Terricola*), *Myodes*, *Glis*, *Sciurus* and *Elyomis.* Grey colour) and "Prairie" taxa (*Microtus, Chionomys* and *Marmota*. Light grey colour) from the bottom (left) and the top (right) of the Cava Salnova.

It is possible to compare the situation at Salnova quarry during the MIS 3 and, probably, the beginning of MIS 2 with other two sites not far from this one: the Fontana Marella cave (Perego et al. 2001; Bona et al. 2008) and the Caverna Generosa cave (Bona 2005; Bona et al. 2009) (Fig. 1). These three sites show a similar situation but with few differences probably due to their geographical position (The Fontana Marella opens at 1040 m a.s.l., the Caverna Generosa opens at 1450 m a.s.l. and the Salnova quarry at 750 m a.s.l). The small mammal fauna of the first 4 levels of Fontana Marella, dated to the upper part of the Upper Pleistocene (Perego et al. 2001), testified a trend quite similar to Salnova quarry. Levels 4 and 3 of Fontana Marella (very few remains) show a probably warm climate with some open areas that clearly changed, about 26,000 yr BP, in a cold climate with dominant open areas, this change probably testify the beginning of the Last Glacial Maximum (Perego et al. 2001, Bona unpublish data). The Fontana Marella palaeoenvironmental trend fits well with Salnova quarry where levels 1e, 1f, 1g seem to present some affinities with levels 3 and 4 of Fontana Marella, even if the scarcity of data on levels 3 and 4 doesn't permit a firm correlation. The Caverna Generosa MG 13-15 presents a trend of paleoenvironment evolution quite different from that of the Salnova quarry; in fact, the Caverna Generosa small mammal faunas represent an important climatic deterioration which

started about 35,000-32,000 yr BP and culminated with the Last Glacial Maximum without any warm phase (Bona et al. 2009). The Caverna Generosa MG 13-15 doesn't show the warmer phase, younger than 35,000 yr BP, registered in Salnova quarry sediments. The altitude, 1450 m a.s.l., of the Caverna Generosa cave could have determined a trend from warm MIS 3 to cold MIS 2 without other registered climatic fluctuations. The elevation could justify the difference between the sites.

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REFERENCES

Bona F. (2005) - I depositi del Pleistocene Superiore della Caverna Generosa (Lo Co 2694): Analisi Paleontologica ed Interpretazioni Paleoambientali. Unpublished Ph.D. thesis, Università degli Studi di Milano, 266 pp., Milano.

Bona F., Peresani M. & Tintori A. (2007) - Indices de fréquentation humaine dans les grottes à ours au Paléolithique moyen final. L'exemple de la Caverna Generosa dans les Préalpes lombardes, Italie. *L'Antropologie*, 111: 290-320.

Bona F., Sala B. & Tintori A. (2008) - Early Toringian small mammals fauna from Fontana Marella cave (Varese, Lombardy, North Italy). *Riv. It. Paleont. Strat.*, 114(1): 133-144.

Bona F., Laurenti B. & Delfino M. (2009) - Climatic fluctuations during the Last Glacial in the North-Western Lombardian Prealps: the Upper Pleistocene faunal assemblages of the Caverna Generosa (Como, Italy). *Riv. It. Paleont. Strat.* 115(2): 253-267.

Chaline J., Baudvin H., Jammot D. & Saint Giron M. C. (1974) - Les proies des rapaces. Doin ed., 141 pp., Paris.

Contoli L. (1980) - Borre di strigiformi e ricerca teriologica in Italia. *Natura e Montagna*: 73-94.

Nadachowski A. (1984) - Morphometric variability of dentition of the Late Pleistocene voles (Arvicolidae, Rodentia) from Bacho Kiro Cave (Bulgaria). *Acta Zool. Cracov.*, 27(9): 149-176.

Nadachowski A. (1985) - Biharian voles (Arvicolidae, Rodentia, Mammalia) from Kozi Grbiet (Central Poland). *Acta Zool. Cracov.*, 29(2): 13-28.

Nadachowski A. (1991) - Systematics, geographic variation and evolution of snow voles (*Chionomys*) based on dental characters. *Acta Theriologica*, 36: 1-45.

Niethammer J. & Krapp F. (1978) - Handbuch der Sàugetiere Europas. Band 1. Rodentia I (Sciuridae, Castoridae, Gliridae, Muridae). *Akad. Verl. Ges.,* 475 pp., Wiesbaden.

Niethammer J. & Krapp F. (1982) - Handbuch der Säugetiere Europas, Bd 2/1, Rodentia II (Cricetidae, Arvicolidae, Zapodidae, Spalacidae, Hystricidae, Capromidae). *Akad. Verl. Ges.,* 649 pp., Wiesbaden.

Niethammer J. & Krapp F. (1990) - Handbuch der Sàugetiere Europas. Band 3/1. Insektenfresser - Insectivora, Herrentiere - Primates. AULA - Verlag: 484 pp., Wiesbaden.

Perego R., Zanalda E. & Tintori A. (2001) - *Ursus spelaeus* from Grotta sopra Fontana Marella, Campo dei Fiori Massif (Varese, Italy): Morphometry and paleoecology. *Riv. It. Pal. Strat.,* 107(3): 451-462.