

Three Late Pleistocene small mammal faunas from the Baccano maar (Rome, central Italy)

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ABSTRACT - Findings of small vertebrate remains are presented from three different localities of the Baccano maar area (Sabatini Volcanic District, Rome, central Italy), referred to as Baccano 1, Baccano 2 and Baccano 3 respectively. The first vertebrate assemblage (Baccano 1) occurs in palustrine sediments containing lignites in the southern part of the Baccano maar and contains a rich fauna of non-marine molluscs: *Bithynia tentaculata*, *Stagnicola palustris*, *Galba truncatula*, *Planorbis planorbis*, *Acroloxus lacustris*, *Succinea sp.* and *Sphaerium sp.* The small vertebrate assemblage from this site is composed of the following taxa: "*Pisces*" *indet.*, *Triturus carnifex*, *Pelophylax bergeri* or *Pelophylax klepton hispanicus*, *Rana dalmatina*, *Podarcis sp.*, *Aves indet.*, *Crociodura sp.*, *Myodes glareolus*, *Microtus (Terricola) savii*, *Arvicola amphibius* and *Apodemus sylvaticus*. The second assemblage (Baccano 2) occurs in strata of reworked pyroclastic deposits in the western-northwestern part of the Baccano maar area and includes the following taxa: *M. glareolus*, *Microtus (M.) arvalis*, *M. (T.) savii*, *A. amphibius* and *Apodemus sp.* The third assemblage (Baccano 3) occurs in the same area, however, within an alluvial deposit and comprises the following taxa: *Sorex minutus*, *S. antinorii*, *S. samniticus*, *M. (M.) arvalis* and *Chionomys nivalis*. The Baccano 1 assemblage is assigned in age to the early part of the MIS3, the Baccano 2 assemblage to the most recent part of the MIS3 or the beginning of MIS2 while the Baccano 3 assemblage is attributed to the last pleniglacial (MIS2).

RIASSUNTO - [Tre associazioni a micromammiferi del Pleistocene Superiore di Baccano (Roma, Italia centrale) - Resti di microvertebrati sono stati rinvenuti in tre diverse località all'interno del maar di Baccano (Distretto Vulcanico dei Sabatini, Roma, Italia centrale) chiamate rispettivamente Baccano 1, Baccano 2 e Baccano 3. La prima associazione (Baccano 1) è stata rinvenuta in sedimenti palustri con ligniti nella porzione meridionale del maar di Baccano. In questo deposito palustre è presente una ricca fauna di molluschi continentali: *Bithynia tentaculata*, *Stagnicola palustris*, *Galba truncatula*, *Planorbis planorbis*, *Acroloxus lacustris*, *Succinea sp.* e *Sphaerium sp.* indicativi di ambiente palustre con ricca vegetazione. I microvertebrati provenienti da questa località sono: "*Pisces*" *indet.*, *Triturus carnifex*, *Pelophylax bergeri* oppure *Pelophylax klepton hispanicus*, *Rana dalmatina*, *Podarcis sp.*, *Aves indet.*, *Crociodura sp.*, *Myodes glareolus*, *Microtus (Terricola) savii*, *Arvicola amphibius*, *Apodemus sylvaticus*. I vertebrati, dominati dagli anfibi, confermano le indicazioni paleoambientali fornite dai molluschi. La relativa abbondanza di *Myodes* e di *Apodemus* fra i micromammiferi testimonia la presenza di aree a copertura arborea nelle vicinanze. La seconda associazione (Baccano 2) proviene da strati piroclastici rimaneggiati affioranti nella porzione nord-occidentale del maar di Baccano: *M. glareolus*, *Microtus (M.) arvalis*, *M. (T.) savii*, *A. amphibius*, *Apodemus sp.* La terza associazione (Baccano 3) proviene dalla stessa zona ma da depositi alluvionali: *Sorex minutus*, *S. antinorii*, *S. samniticus*, *M. (M.) arvalis*, *Chionomys nivalis*. Le associazioni di Baccano 2 e 3 sono dominate da micromammiferi che indicano aree aperte. Baccano 1 è correlata con la prima parte del MIS3, Baccano 2 è correlata con la parte più recente del MIS3 o con l'inizio del MIS2, mentre Baccano 3 è attribuita all'ultimo pleniglaciale (MIS2).

INTRODUCTION

Field surveys carried out years ago in the vicinity of the Baccano maar (Roma, Latium, central Italy) led to the discovery of some vertebrate and mollusc fossil remains in the most recent continental sediments cropping out above the extensive volcanic deposits. The numerous volcanoes of Latium form several K-rich volcanic districts, some of which are characterized by large volcano-tectonic depressions, developed about 0.4-0.3 Ma ago, now filled with lakes (De Rita et al., 1996). The eastern sector of the Sabatini Volcanic District (SVD) where the Baccano valley lies (Fig. 1), is situated about 30 km north of Rome and 30 km east of the Tyrrhenian Sea. It is part of the K-alkalic Roman comagmatic province (Washington, 1906), bordering the eastern Tyrrhenian Sea coast and aligned along a NW-SE tectonic trend. The volcanic

activity in the SVD, mostly explosive, started around 600 ka ago, during the Middle Pleistocene, and produced several structures, the most important of which is a large depression hosting the Bracciano Lake (De Rita et al., 1996). After the formation of the Bracciano Basin, volcanic activity continued only in the eastern sector of the SVD, where the crater of Baccano developed at the western margin of the Sacrofano caldera. The Sacrofano centre, a strato-volcanic structure, was the main eruptive centre (De Rita et al., 1993, 1996), and several other minor centres are recognized. Their activity was mainly explosive, producing large volumes of pyroclastic flows and fall deposits (Buttinelli et al., 2003). The oldest dated products of the SVD are the 587 ± 9 ka Morlupo block and ash flow deposit whereas the youngest dated product is the $85 \text{ ka} \pm 8.5$ ka Baccano pyroclastic flow deposit (Cioni et al., 1993; Villa, 1993). Baccano had a complex

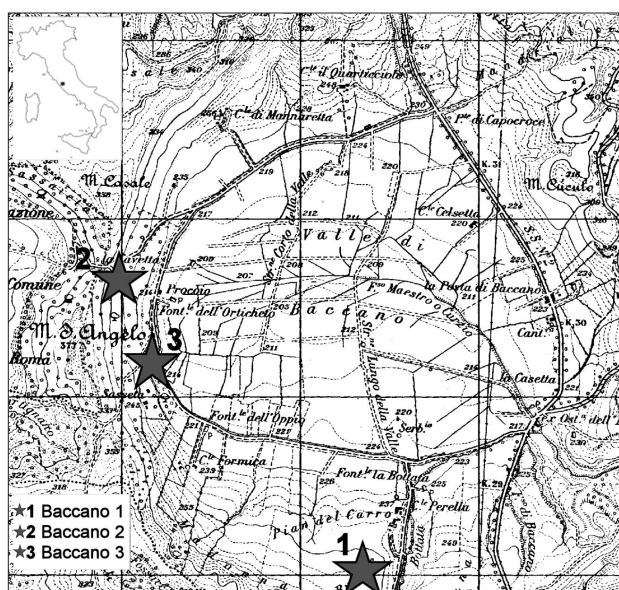


Fig. 1 - Location map of fossiliferous sites in the Baccano maar (Roma, Central Italy).

activity from 400 to 80 ka ago, when explosive activity migrated westward to Martignano crater. However, as defined by stratigraphy, the latest products of volcanism in the Sabatini district were erupted from the Martignano, Le Cese, and Stracciaccappa centres, located at the margin of the Baccano maar (Bertagnini et al., 1993; Di Filippo, 1993), during several violent phases of hydromagmatic activity.

A recent study by Giardini (2007) on the pollen content from two cores in the Stracciaccappa area, provides pollen diagrams and pollen stratigraphy distinguishing three pollen zones (Stra-1, Stra-2 and Stra-3 from bottom to top of the cores), recognized in an estimated time interval of about 58 ka. The lower part of the sequence (Str-1 and Stra-2) is dominated by non-arboreal pollen, indicative of a dry climate (with some less arid oscillations: Stra-1a, Stra-1c, Stra-1e), whereas the upper parts show an increase of Mediterranean elements, suggesting a more pronounced seasonality and an important forest expansion of the whole record in Zone Stra-3. On this ground Giardini (2007) concluded that, from a biostratigraphical point of view, zones Stra-1 and Stra-2 fall within the last pleniglacial period, while Zone Stra-3 shows the first signs of recovery of trees and shrubs marking the end of the pleniglacial period.

Present day vertebrate fauna is represented by large mammals such as badgers, wild boars and foxes whereas small mammals are represented by hedgehogs, shrews, Savi and bank voles, field mice, mice, rats, dormice and hares (Milana, 2008). Small vertebrate remains have been collected from three different localities inside the Baccano maar. They are reported here as Baccano 1, Baccano 2 and Baccano 3 respectively (Fig. 1).

The first vertebrate assemblage has been discovered in the southern part of the Baccano maar in lacustrine/palustrine sediments with lignites and charophytes of the genus *Chara*, overlying the Baccano pyroclastic flow

deposits (Fig. 1). A ^{14}C analysis of plant remains indicates an age older than 40 ka (Funicciello in Kotsakis, 1981). In this deposit a rich fauna of freshwater molluscs of lacustrine/palustrine environment has been collected (Esu in Kotsakis, 1981).

The second assemblage has been collected in reworked pyroclastic strata in the western - northwestern part of the Baccano maar (Fig. 1). Baccano 3 has been found in an alluvial deposit of the same area (Fig. 1).

MOLLUSCS

A rich fauna of well-preserved freshwater molluscs has been recovered from clayey sediments with lignites and charophytes of the genus *Chara* at Baccano 1, associated to small vertebrates. Six species of freshwater prosobranch and pulmonate gastropods and one bivalve are recorded: *Bithynia tentaculata* (Linnaeus) (with abundant opercula), *Stagnicola palustris* (Müller) (abundant), *Galba truncatula* (Müller) (frequent), *Planorbis planorbis* (Linnaeus) (abundant), *Acroloxus lacustris* (Linnaeus) (rare), *Succinea* sp. (rare), and *Sphaerium* sp. (rare). The prosobranch *B. tentaculata* is a common species in more or less large water bodies with slow-moving or stagnant water rich in aquatic vegetation, such as lakes, ponds, marshes, stream backwater, reaching 25-30 m maximum depth (Ložek, 1964; Girod et al., 1980). According to the ecological attribution stated by Ložek (1964) for the European Quaternary molluscs, this species is attributed to the ecological class 10SF. The other recorded gastropods belong to pulmonates, which, according to Ložek (1964), can be grouped in the ecological classes indicating stagnant (10S) and/or palustrine conditions (9P and 10P). *S. palustris* (10P) is typical of swamps, shallow drains with rich aquatic vegetation or places liable to dry up; more rarely it can colonize open water in ponds, lakes and rivers. *G. truncatula* (10SPp) prefers marshy grassland and shallow ephemeral ponds. *P. planorbis* (10P) is characteristic of shallow pools liable to dry up in warmer conditions where it is often associated with *S. palustris*, it can also live in all kinds of well-vegetated aquatic habitats. *A. lacustris* (10S) is typical of clean, quiet water, preferring small closed ponds. Representatives of *Succinea* sp. (9P) are typical of marshes, water meadows and are able to survive for long periods in moist ground litter. The species belonging to the bivalve *Sphaerium* are common in many aquatic habitats in stagnant or running water (Ložek, 1964; Girod et al., 1980; Kerney, 1999).

The recorded species from Baccano 1 have a wide European distribution, occurring also in the present fauna of Italy, area under study included. Some of them are Holarctic. All are known as fossils from Quaternary deposits of Europe, mainly during temperate and cool climatic phases (Ložek, 1964) and are present in several Quaternary sites of Italy (Esu & Girotti, 1991).

Taking into account the ecological requirements of the recorded taxa and the dominance of pond-marsh species, a well vegetated marsh-pond environment is envisaged for Baccano 1 deposit. Moreover considering the Quaternary fossil distribution of the recorded species a temperate climatic phase is deduced.

SMALL VERTEBRATES

The composition of the three different vertebrate assemblages is the following:

Baccano 1: “Pisces” indet., *Triturus carnifex* (Laurenti), *Pelophylax bergeri* (Günter) or *Pelophylax klepton hispanicus* (Bonaparte), *Rana dalmatina* Fitzinger, *Podarcis* sp., Aves indet., *Crocidura* sp., *Myodes* [= *Clethrionomys*] *glareolus* (Schreber), *Microtus (Terricola) savii* (De Selys-Longchamps), *Arvicola amphibius* (Linnaeus) [= *A. terrestris* (Linnaeus)], *Apodemus sylvaticus* (Linnaeus). Fishes and birds are present with very few and fragmentary remains.

Baccano 2: *Myodes* [= *Clethrionomys*] *glareolus*, *Microtus (Microtus) arvalis* (Pallas), *Microtus (Terricola) savii*, *Arvicola amphibius* [= *A. terrestris*], *Apodemus* sp.

Baccano 3: *Sorex minutus* Linnaeus, *Sorex antinorii* (Bonaparte) [= *Sorex araneus* auctorum for the Italian peninsula], *Sorex samniticus* Altobello, *Microtus (M.) arvalis*, *Chionomys nivalis* (Martins). This assemblage is characterized by the uncommon coexistence of three species of the genus *Sorex*.

Three species of amphibians, one newt of the family Salamandridae and two frogs of the family Ranidae are present in the Baccano 1 assemblage.

The crested newt, *T. carnifex* (classified as *Triturus cristatus* by Kotsakis, 1981), is present with two vertebrae in the assemblage. The dimensions of the vertebrae are very large and for this reason we ascribe these fossil remains to the largest of the Italian newts. The preferred habitat of the species is represented by permanent or semi-temporary, moderately deep ponds (Andreone & Marconi, 2006; Vanni et al., 2007). Newts are very rare in the Italian fossil record (Delfino, 2006, 2007).

A large green frog of the group of “*Rana esculenta*” is the most common vertebrate species in the Baccano 1 assemblage (Kotsakis, 1981). The systematics of the Italian green frogs is very complicated. After Capula (2006) and Capula et al. (2007) two species are present in central Italy: *Pelophylax bergeri* and a hybrid hybridogenetic form, *Pelophylax klepton hispanicus*. The abundant remains collected in this site are ascribed to this group. The green frogs are commonly found in vegetation-rich ponds and

other aquatic environments (Capula, 2006; Capula et al., 2007). Green frogs, grouped under the name *Rana* gr. *R. ridibunda*, are present in Italy since the Late Miocene (Delfino, 2006, 2007).

Two humeri belong to a red frog, the agile frog, *R. dalmatina* (cf. Kotsakis, 1981). This species is typically terricolous (Picariello et al., 2006; Bernini et al., 2007). In Italy it is known since the Early Pleistocene (Kotsakis, 1982; Delfino, 2006).

The three species of amphibians collected in Baccano 1 are still present in the extant herpetofauna of the area (Andreone & Marconi, 2006; Capula, 2006; Picariello et al., 2006; Bernini et al., 2007; Capula et al., 2007; Vanni et al., 2007).

A single dentary belonging to a small lacertid is ascribed tentatively to *Podarcis* sp. After Delfino (2006) the presence of the genus can be reported with reasonable confidence only after the beginning of the Pleistocene.

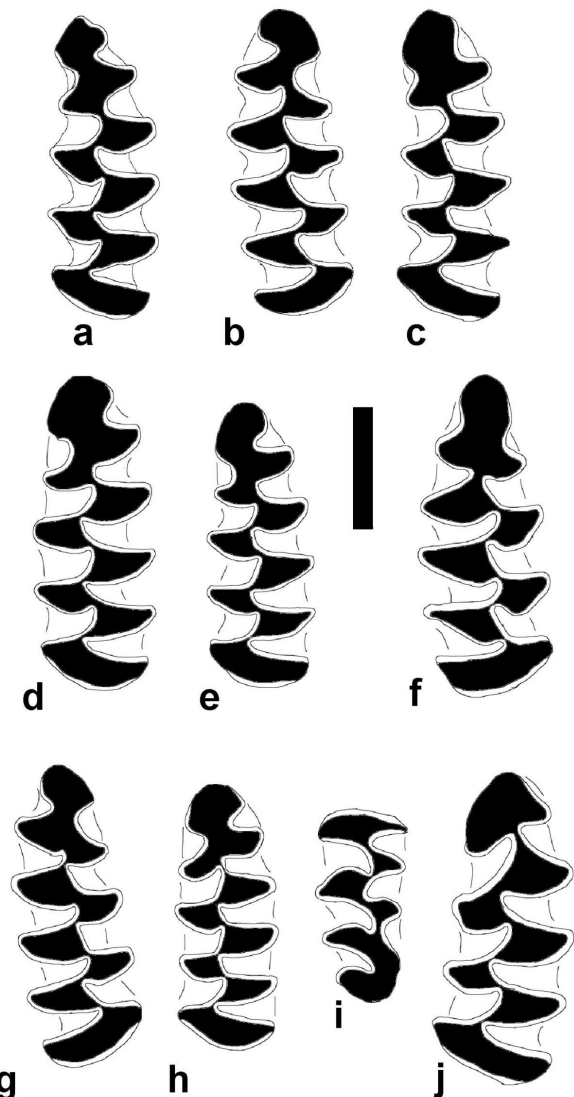


Fig. 2 - Arvicolids from Baccano3. a-h) *Microtus (M.) arvalis* M/1, a: n° 1063, b: n° 1064, c: n° 1066, d: n° 1068, e: n° 1069, f: n° 1071, g: n° 1072; i) *Microtus (M.) arvalis* M/3, n° 1074; j) *Chionomys nivalis* M/1, n° 1070. Palaeontological Collection of Dipartimento di Scienze Geologiche, Università Roma Tre. Scale bar 1 mm.

Species	Baccano 1	Baccano 2	Baccano 3
<i>Crocidura</i> sp.	1		
<i>Sorex minutus</i>			2
<i>Sorex antinorii</i>			5
<i>Sorex samniticus</i>			1
<i>Myodes glareolus</i>	6	1	
<i>Microtus (Microtus) arvalis</i>		4	14
<i>Microtus (Terricola) savii</i>	5	2	
<i>Chionomys nivalis</i>			1
<i>Arvicola amphibius</i>	4	1	
<i>Apodemus sylvaticus</i>	14		
<i>Apodemus</i> sp.		2	

Tab. 1 - Checklist of presence/absence of species in the three Baccano assemblages. Number of specimens is reported.

Only two orders of mammals are present among the fossils of Baccano 1, 2 and 3, Soricomorpha and Rodentia (Tab. 1).

The first order is present with four species of the family Soricidae: a species of the genus *Crocidura* in Baccano 1 and three species of the genus *Sorex* in Baccano 3.

The rodents are represented by five genera or subgenera of arviculids, *Myodes*, *Arvicola*, *Microtus* (*Terricola*), *Microtus* (*Microtus*) and *Chionomys*, each one with a single species (three taxa in Baccano 1, four in Baccano 2 and two in Baccano 3), and one genus of murids (*Apodemus*) occurring with a single species in Baccano 1 and 2 [for the systematics, biochronology and (palaeo) biogeography of the small mammals see Kotsakis et al., 2003; Sala & Masini, 2007; Kotsakis, 2008].

The genus *Crocidura* is present in Italy since the earliest Pleistocene, whilst the living species *C. leucodon* (Hermann) and *C. suaveolens* (Pallas) are known since the Middle and Late Pleistocene respectively. It is impossible to classify the single fragment present in the assemblage beyond the generic level.

For a discussion on the three species of the genus *Sorex* see below.

The bank vole *Myodes glareolus*, until recently referred to as *Clethrionomys glareolus*, makes its first occurrence in Italy during the Middle Pleistocene and is present in the wooded areas of the peninsula from north to south (Amori, 2008a).

Savi's vole, *Microtus (Terricola) savii* (recent genetic analyses provide evidence of *Terricola* being a subgenus of the genus *Microtus*; see Jaarola et al., 2004), is an endemic species of the Italian peninsula and Sicily, living in open country. It occurs in fossil assemblages since the Middle Pleistocene and is particularly abundant in the

Late Pleistocene assemblages of central and southern Italy.

The common vole, *M. (M.) arvalis*, now living in northern Italy, occurs in the Italian peninsula since the late Middle Pleistocene and is common in many fossil assemblages of central and southern Italy during the cool-cold phases of the late Middle and Late Pleistocene.

The European snow vole, *C. nivalis*, occurs in the Italian peninsula since the Middle Pleistocene. Its recent distribution in Italy is restricted to the Alpine region, with relict populations in some alpine prairies of Apennine peaks of central Italy (Amori, 2008b). During the cool-cold phases of late Middle and Late Pleistocene this species occupied several areas outside of its present distribution, in central and southern Italy.

The water vole, *A. amphibius*, until recently referred to *A. terrestris*, living near water bodies, is a common member of the fossil assemblages of Italy during the Late Pleistocene.

The long-tailed field mouse, *A. sylvaticus*, is present in Italy in a great variety of environments. Its first occurrence in the peninsula goes back to the later part of the Early Pleistocene.

CONCLUSIONS

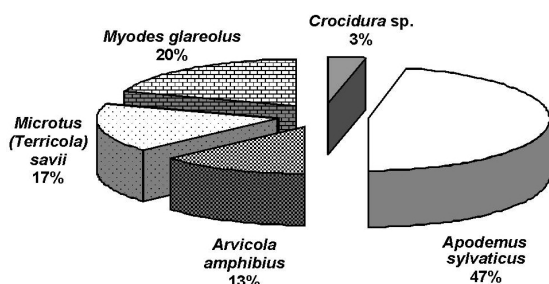
The molluscan assemblage collected in Baccano 1 testifies to the presence of a well-vegetated marsh-pond. The vertebrate assemblage confirms this indication being dominated by pond-living amphibians. Among small mammals, *A. amphibius* is a semi-aquatic species. *M. glareolus* and *A. sylvaticus* are the commonest elements (Fig. 3, Tab. 1) whilst *Crocidura* and *Microtus (Terricola)* are represented by a few specimens only. All the species are present in the living fauna of the area. The predominance of *Myodes* and *Apodemus* indicates a wooded area around the pond.

The Baccano 2 assemblage (Tab. 1) is composed by a small number of specimens "dominated" by *M. (M.) arvalis*. The open-ground species prevail. *M. arvalis* is absent from the living faunas of central and southern Italy. Its presence indicates cooler conditions.

The same species, *M. arvalis*, is the commonest element among the Baccano 3 small mammal assemblage (Fig. 3). However the Baccano 3 assemblage is very different from the Baccano 2 one as *M. arvalis* is the only one species present in both assemblages (Tab. 1). The species of open ground predominate in this assemblage too. The abundance of *M. arvalis*, the presence of *C. nivalis* and the absence of *M. (T.) savii* indicate cool-cold conditions. Three species, *S. antinorii*, *M. arvalis* and *C. nivalis* (that is 60% of the species and 86% of specimens) are absent from the living fauna of the area (Mitchell-Jones et al., 1999; Milana, 2008).

The age of the Baccano 1 assemblage must be assigned to MIS4 or early part of MIS3 (age constraints between 85 and 40 ka), but more probably belongs to MIS3 (more recent than 60 ka) because of the absence of any cold or cool element. It is tentatively reported in a forested phase of the Stra-1 pollen zone of the long sequence of Stracciaccia tuff ring crater (Giardini, 2007), between 60 and 46 ka (Stra-1a, Stra-1c or Stra-1e). More problematic

Baccano 1



Baccano 3

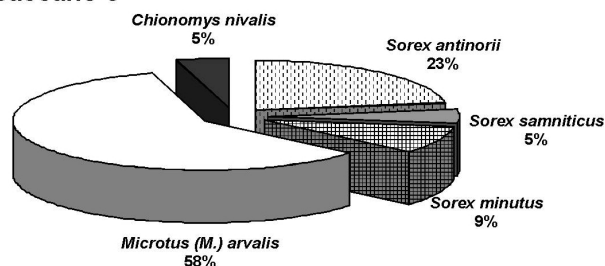


Fig. 3 - Pie charts of species frequencies in Baccano 1 and Baccano 3 assemblages.

	LTS				L				HS				H			
	n	range	mean	sd	n	range	mean	sd	n	range	mean	sd	n	range	mean	sd
<i>S. antinorii</i>	1		111.4		5	4.37-5.98	5.30	0.62	5	2.06-3.86	3.18	0.87	5	3.78-5.06	4.75	0.54
<i>S. minutus</i>	2	7.45-7.56	7.51	0.08	2	3.48-3.68	3.58	0.14	1		1.85		2	2.87-2.89	2.88	0.01
<i>S. samniticus</i>	-				1		4.72		1		2.65				3.40	
	SC				AS				Ti				P ₄ -M ₃			
	n	range	mean	sd	n	range	mean	sd	n	range	mean	sd	n	range	mean	sd
<i>S. antinorii</i>	5	1.06-1.37	1.22	0.11	5	2.40-3.42	2.85	0.49	5	1.58-1.97	1.83	0.15	5	3.97-5.34	4.86	0.61
<i>S. minutus</i>	2	0.66-0.74	0.70	0.06	2	1.95-2.26	2.11	0.22	2	0.97-1.04	1.01	0.05	1		3.70	
<i>S. samniticus</i>	1		0.83		1		2.39		1		1.30		1		4.36	
	M ₁ -M ₃				OLC				LLF				LUF			
	n	range	mean	sd	n	range	mean	sd	n	range	mean	sd	n	range	mean	sd
<i>S. antinorii</i>	5	3.11-4.36	3.90	0.55	4	1.94-2.30	2.12	0.17	4	1.15-1.39	1.30	0.09	4	0.64-1.03	0.85	0.15
<i>S. minutus</i>	1		3.04		2	1.26-1.37	1.32	0.08	2	0.79-0.80	0.80	0.01	2	0.44-0.54	0.49	0.07
<i>S. samniticus</i>	1		3.54		1		1.62		1		0.94		1		0.61	

Tab. 2 - Descriptive statistics for main measurements on mandibles of *Sorex*. LTS: Total length of the mandible from the tip of the incisor to the edge of the mandibular condyle; L: distance from the posterior rim of the mental foramen to the uppermost point of the arch in front of the angular process; HS: distance from the coronoid spicula to the uppermost point of the arch in front of the angular process; H: height of the coronoid process; SC: thickness of the condyloid process; AS: distance from the tip of the condyle to the uppermost point of the arch in front of the angular process; Ti: distance from the uppermost point of the arch in front of the angular process to the inferior-anterior margin of the internal temporal fossa; P₄-M₃: length of the tooth row from P₄ to M₃; M₁-M₃: length of the tooth row from M₁ to M₃; OLC: distance from the upper margin of the upper facet to the lower margin of the lower facet; LLF: length of the lower facet; LUF: length of the upper facet. Measurements follow Fanfani (2000).

is the age attribution of the Baccano 2 and Baccano 3 assemblages. The first assemblage belongs to a cooler phase (presence of *M. arvalis*), whilst Baccano 3 is characterised by rather cold/cool elements. Both could be referred to cooler oscillations of MIS 3, or the former may be assigned to MIS 3 and the latter to MIS 2.

Tentatively the Baccano 2 assemblage is referred to Stra-1f or Stra-2a pollen subzones of Stracciaccappa (Giardini, 2007) and the Baccano 3 one is referred to Stra-2b pollen subzone of Stracciaccappa, between 26 and 12 ka (Giardini, 2007). However an attribution of both assemblages to two distinct arid oscillations of Stra-1f or Stra-2a is possible.

REMARKS ON THE SYSTEMATICS OF THE GENUS *SOREX*

The most striking observation on the faunas of the three fossiliferous sites of Baccano regards the contemporaneous presence of three species of the genus *Sorex* in the same assemblage (Baccano 3). A similar situation is very rare in Italy and has been reported as yet, to our knowledge, in a single level of a single site, the level E4 of the Broion cave (Zanaldi, 1995). For this reason a brief systematic discussion is devoted to this genus.

Order SORICOMORPHA Gregory, 1910
Family SORICIDAE Fischer von Waldheim, 1817

Genus *Sorex* Linnaeus, 1758

Sorex minutus Linnaeus, 1766
(Figs 4a-b)

Material - Two mandibular rami (one left and one right) with teeth (nn. 1052, 1058, Palaeontological Collection of Dipartimento di Scienze Geologiche, Università Roma Tre) (Tab. 2).

Remarks - Two minuscule mandibular rami with red pigmented teeth belong to the living pygmy shrew. They are characterised by a first unicuspid with only one cuspid, the pigmented area of I/1 without interruptions and the mental foramen below the P/4 and M/1 boundary (Nappi, 2001). The dimensions of our fossils agree very well with the measurements given by Fanfani (2000) for *S. minutus*.

The pygmy shrew is reported as a fossil in very many European localities of Pliocene and Pleistocene age (Reumer, 1984; Rzebik-Kowalska, 1998 with references; Popov, 2003) and also in some Pleistocene localities of Asia (Storch et al., 1998). In Italy *S. minutus* has been reported from several fossiliferous sites, though some of these fossils have been assigned to *Sorex bor* Reumer by Fanfani (2000). The oldest presence of the pygmy shrew in the Italian peninsula goes back to the Early Pleistocene of Monte La Mesa (Verona, northeastern Italy: Early Biharian, Tasso Faunal Unit (F.U.); Marchetti et al., 2000). It is quite common during the Toringian (Kotsakis et al., 2003).

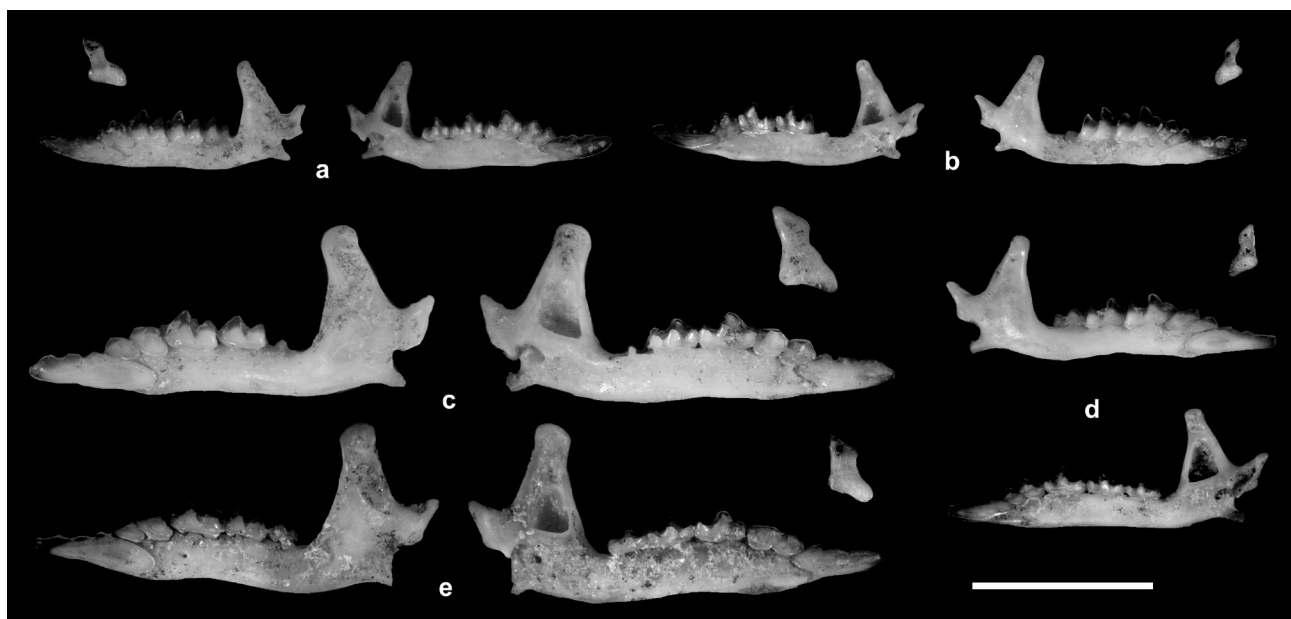


Fig. 4 - Soricidae from Baccano 3. a) *S. minutus* right mandible, n° 1058, buccal view on the left, lingual view on the right, condyle on top; b) *S. minutus* left mandible, n° 1052, buccal view on the left, lingual view on the right, condyle on top; c) *S. antinorii* right mandible, n° 1051, buccal view on the left, lingual view on the right, condyle on top; d) *S. samniticus* left mandible, n° 1057, buccal view on top, lingual view on bottom, condyle on top right; e) *S. antinorii* right mandible, n° 1059, buccal view on the left, lingual view on the right, condyle on top. Palaeontological Collection of Dipartimento di Scienze Geologiche, Università Roma Tre. Scale bar 5 mm.

Today *S. minutus* is distributed from western Europe to the Yenesei River and Lake Baikal, south to Altai and Tien Shan Mountains. The specific status of populations from China, Nepal, Kashmir, N Pakistan, Turkey and Caucasus is a matter of debate (Hutterer, 2005). In Italy the species is present on the mainland but absent from the islands. The pygmy shrew occurs in a wide range of habitats, from dunes to swamps and meadows and to montane forest (Hutterer, 1990; Mitchell-Jones et al., 1999; Aloise, 2008).

Sorex antinorii Bonaparte, 1840
(Figs 4c, e)

Material - One fragment of rostrum with A1/-M2/ on the right side and P4/-M2/ on the left side; 5 mandibular rami (four left and one right) all but one with complete tooth-row (nn. 1051, 1053, 1054, 1055, 1056, 1059, Palaeontological Collection of Dipartimento di Scienze Geologiche, Università Roma Tre) (Tab. 2).

Remarks - The five mandibular rami, with red pigmented teeth, agree very well, both morphologically and dimensionally, with the living *S. antinorii*. The first lower unicuspid is characterised by a single cuspid, the pigmented area of I/1 is interrupted while the boundary line of the pigmented area on the other teeth between I/1 and P/4 is continuous. The mental foramen is situated below the medial part of M/1, in the contact area of trigonid and talonid of this tooth. In the rostrum the lacrimal foramen corresponds to the mesostyle of M1/ (Fanfani, 2000; Nappi, 2001).

The majority of fossil remains of the genus *Sorex* of late Middle Pleistocene and Late Pleistocene age collected in Italian localities have been assigned to the living *Sorex araneus* Linnaeus, for long time considered a common species of the Italian peninsula (Hausser et al., 1990). This species is known in Europe since the Early Pleistocene (Rzebik Kowalska, 1998). Yet, such a generalised presence of *S. araneus* in Italy is quite debated and contested and, therefore, the majority of the populations previously assigned to *S. araneus* have been attributed to *S. antinorii*, a species considered valid only very recently (Brünner et al., 2002a, b). There are no reports of *S. antinorii* as a fossil. That is why a general revision of the Italian late Middle Pleistocene and Late Pleistocene fossil material assigned to the genus *Sorex* is necessary (Kotsakis, 2008). All the attributions of fossil remains from the Italian peninsula to *S. araneus* should most probably be assigned to *S. antinorii*, yet the possibility that some of the remains belong to *Sorex samniticus* Altobello, to *Sorex arunchi* Lapini & Testone (an endemic species of northern Italy) or to *S. araneus* itself, cannot be ruled out. In any case, remains assigned to *S. araneus* are present in Italy since late Early Toringian. During the Late Toringian they are very common in the fossil assemblages (Kotsakis et al., 2003). *S. antinorii*, an ubiquitous species, is present in southeastern France, southern Switzerland and Italy (Hutterer, 2005; Aloise & Nappi, 2008).

Sorex samniticus Altobello, 1926
(Fig. 4d)

Material - A right mandibular ramus with complete tooth-row (n. 1057, Palaeontological Collection of

Dipartimento di Scienze Geologiche, Università Roma Tre) (Tab. 2).

Remarks - A right mandibular ramus with complete tooth-row of red pigmented teeth, belongs to the endemic Italian species *S. samniticus*, a species very similar to *S. antinorii* (= *S. araneus* auctorum for the Italian peninsula). It is possible to distinguish this species from *S. antinorii* by a few characters mainly observed in the skull and in the upper tooth-row. The mandible of the Italian shrew is characterised by the presence of an extension of the lower side of the upper facet of the mandibular condyle. Moreover the lower incisor cusps are lower in *S. samniticus* and the continuous pigmented area in antemolars and molars is interrupted between the first and second antemolar. This character is present also in *S. alpinus* but this last species lacks the typical morphology of the mandibular condyle. Each single character is insufficient to distinguish *S. samniticus* from *S. antinorii* because of its large variability but all together allow us to ascribe this mandible to the Italian shrew (Graf et al., 1979; Lapini et al., 2001; Nappi, 2001; Breda, 2002).

S. samniticus has been erected by Altobello in 1926 but for a long time it was considered a synonym or a subspecies of *S. araneus* and has been recognized again as a valid species by Graf et al. (1979). Allozymic, morphologic and morphometric studies indicate that *S. samniticus* is genetically well differentiated from *S. antinorii* and *S. arunchi*, displaying a high mean value of genetic distance in comparison with the other two species (Lapini et al., 2001). These data suggest that a divergence between *S. antinorii* and *S. samniticus* occurred a long time ago (? Middle Pleistocene). Till now in the palaeontological analyses no distinction has been made between *S. antinorii* and *S. samniticus*, being the two considered conspecifics (see Kotsakis et al., 2003). In some recent papers attribution has been made to *S. araneus-samniticus* group. As we know this is the first attribution of fossil material to *S. samniticus*. A general review of the fossil material collected in Italy, previously assigned to *S. araneus*, is now necessary to separate *S. samniticus* from *S. antinorii*.

S. samniticus, an Italian endemic species, is present in the Italian peninsula from the Po plain south to Calabria (Nappi & Contoli, 2008). It lives along rivers in mountain areas. In a locality of Abruzzi it is syntopic with *S. antinorii* (Hausser, 1990; Mitchell-Jones et al., 1999).

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