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Insectivores (Mammalia) from Rivoli Veronese, a Late Villanyian site in Northeastern Italy

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ABSTRACT – *This paper presents a systematic revision of the insectivores from the microvertebrate faunal assemblage recovered at the Rivoli Veronese site, a karst fissure deposit exposed in a limestone quarry near Verona (Northeastern Italy). This revision has enriched our knowledge of the faunal assemblages of the Italian Peninsula, with the first reported occurrences of Sorex bor, Sorex (Drepanosorex) praeareaneus and a possibly new species of very small sized mole, Talpa sp.. Also Erinaceus sp., Talpa minor, Petenyia hungarica, Beremendia fissidens and Asoriculus gibberodon have been identified. The correlation of the Rivoli Veronese assemblage with Villanyian assemblages of the bioprovinces of Eastern Europe is confirmed by the presence of Sorex bor and Sorex (Drepanosorex) praeareaneus. This species, Asoriculus gibberodon and the two moles may be considered indicative of humid environments with diffuse forest cover.*

RIASSUNTO – [Gli insettivori (Mammalia) di Rivoli Veronese, un sito del Villaniano superiore dell'Italia nord - orientale] – *Viene effettuata una revisione sistematica degli insettivori appartenenti alla associazione a microvertebrati del Villaniano superiore rinvenuta nel deposito della fessura carsica in località Rivoli Veronese (Verona, Italia settentrionale). Questa revisione ha permesso di arricchire le conoscenze delle associazioni faunistiche della penisola italiana con la prima segnalazione di Sorex bor, Sorex (Drepanosorex) praeareaneus e di una probabile nuova forma di talpa di dimensioni molto ridotte, Talpa sp.. Inoltre sono presenti Erinaceus sp., Talpa minor, Petenyia hungarica, Beremendia fissidens e Asoriculus gibberodon. La correlazione della fauna di Rivoli Veronese con faune del Villaniano superiore delle bioprovince dell'Europa centrale è confermata dalla presenza di Sorex bor e di Sorex (Drepanosorex) praeareaneus. Queste specie, Asoriculus gibberodon e le due talpe possono essere considerate degli indicatori di ambienti umidi con diffusa copertura forestale.*

INTRODUCTION

The presence of a well-diversified microvertebrate faunal assemblage at the Rivoli Veronese site, a karst fissure deposit exposed in a limestone quarry near Verona (Northeastern Italy), was first reported by Sala *et al.* (1994), who focused primarily on the arvicolid. The assemblage includes a leporid, *Sciurus*, a flying squirrel, *Muscardinus*, *Eliomys*, a small-sized form of *Glis*, two species of *Apodemus*, and the arvicolid *Ungaromys* sp., *Ellobius*, *Villanyia* cf. *exilis*, a new species of *Dinaromys* (*D. allegranzii*; Sala, 1996), *Mimomys* cf. *pliocenicus*, *Mimomys tornensis* and *Mimomys pitymyoides*. Rivoli Veronese has also yielded fish, amphibian, and abundant reptile remains (Sala *et al.*, 1994). The Rivoli Veronese assemblage is the only well documented Italian late Villanyian assemblage known to date, and clearly had ties with the bioprovinces of Eastern Europe.

This paper presents a systematic revision of the insectivores previously reported by Sala *et al.* (1994) as *Erinaceus*, mole of small size, *Beremendia*, and *Sorex*.

SYSTEMATICS

Though the insectivore assemblage consists of a relatively small number of specimens, it is well diversified and includes, in addition to the hedgehog, two different-sized species of mole and five species of shrew. The faunal list consists of: *Erinaceus* sp., *Talpa minor*, *Talpa* sp., *Sorex bor*, *Sorex (Drepanosorex) praeareaneus*, *Petenyia hungarica*, *Beremendia fissidens* and *Asoriculus gibberodon*.

Family ERINACEIDAE Bonaparte, 1838
Subfamily ERINACEINAE Bonaparte, 1838
Genus ERINACEUS Linnaeus, 1758

ERINACEUS sp.
Pl. 1, fig. 1

Material – A right P⁴.

Description, comparisons and discussion – This premolar (BL = 3.57, LL = 2.95, PE = 2.84, AW = 4.73, PW = 3.61) is smaller than the P⁴ of *Erinaceus*

europaeus Linnaeus, 1758, but its morphology is quite similar, though it displays a lesser degree of posterior emargination and its metastyle is more elongated in a posterior direction. The groove between the protocone and the paracone is narrower and shallower than that of the modern hedgehog.

The fossil Plio-Pleistocene hedgehogs identified in Europe to date are *Erinaceus praeglacialis* Brunner, 1934, of the Early and Middle Pleistocene, and *Erinaceus samsonowiczi* Sulimski, 1959 and *Erinaceus lechei* Kormos, 1934, of the Pliocene. The former species is morphologically similar to but larger than the present-day *Erinaceus europaeus*, whereas the other two are smaller. The dimensions and age of the specimen from Rivoli allow us to rule out *Erinaceus praeglacialis*.

The protocone and hypocone of the upper premolar of the specimen from Weze 1, illustrated by Rzebik-Kowalska (1971), are poorly developed and give the occlusal profile a sub-triangular shape that differs markedly from the trapezoidal form of the P^4 of the modern hedgehog and the Rivoli form. Also, the Polish species displays a small parastyle not present in the Rivoli Veronese specimens or in *Erinaceus europaeus*.

The dimensions and morphology of the *Erinaceus samsonowiczi* premolar from Rebielice Królewskie 1A (Kowalski, 1960) closely resemble those of the Rivoli specimen (BLL=3.50, AW=4.30). Both Rebielice Królewskie 1A and Rivoli hedgehogs resemble *Erinaceus lechei* in size; however, the small number of remains of the latter species, and the fact that Leche (1902) based its description solely on its mandibular characteristics, makes a more satisfactory comparison impossible.

Family TALPIDAE Gray, 1825
Subfamily TALPINA Gray, 1825
Genus TALPA Linnaeus, 1758

At Rivoli Veronese the genus *Talpa* is represented by two species of differing size.

TALPA MINOR Petényi, 1864
Pl. 1, figs. 2-6

Material – Two toothless hemimandibular fragments, an hemimandibular fragment with P_4 - M_2 , 2 P_4 , 1 M_3 , 6 humeri, 2 ulnae, 7 femurs, 4 radii, and 1 sacral vertebra.

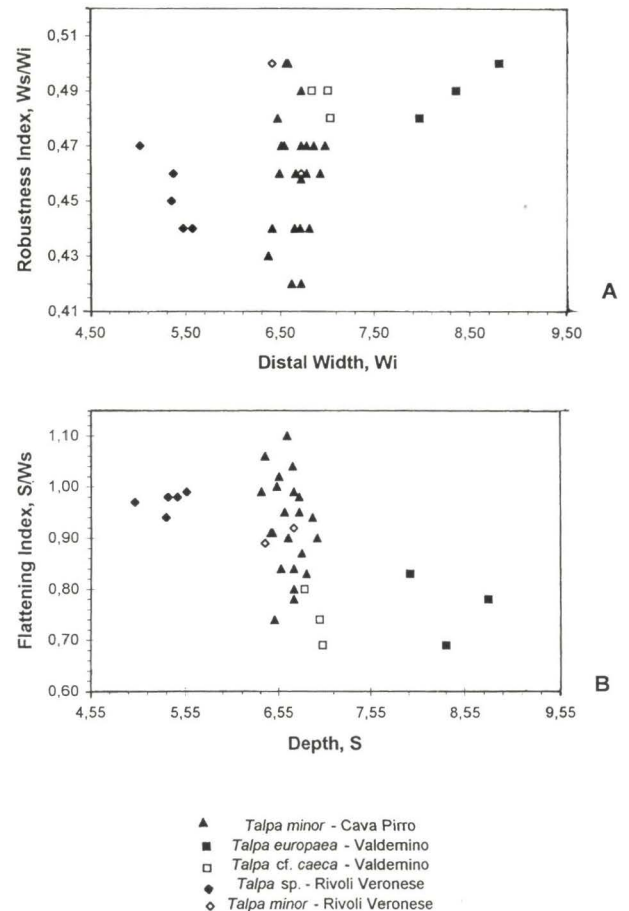
Description – The dimensions of the mandibular fragments and post-cranial skeletal remains, and in particular those of the humeri, are smaller than those of *Talpa europaea* Linnaeus, 1758, falling within the range of variability of the *minor-caeca* group (Text-figs. 1 A,B).

In the mandibles, the distal mental foramen is located either below the first root of the M_1 or at midpoint of the tooth, while the mesial foramen is located under the mesial root of the P_3 . The ascending ramus is almost perpendicular to the horizontal ramus, which displays a uniform thickness below the molar series. The teeth are morphologically similar to those of *Talpa europaea*, though they are slightly more robust. The P_4 presents a more reduced tallonid with a single cusp.

TALPA sp.
Pl. 1, figs. 7-9

Material – One hemimandible with corroded, incomplete M_2 and P_3 , 5 humeri, 2 radii, and a femur fragment.

Description – These specimens show that there was a very small-sized mole at Rivoli Veronese, a form



Text-fig. 1 - A) Scatter of Humerus Robustness Index (W_s/W_i) versus Distal Width (W_i); B) scatter of Humerus Flattening Index (S/W_s) versus Depth (S).

whose dimensions are comparable to those of the smaller-sized specimens from Weze 1 (Sulimski, 1962) (Text-fig. 2).

In addition to being much smaller than the mandibles attributed to *Talpa minor*, the ascending ramus of *Talpa* sp. mandible is inserted at an oblique angle with respect to the horizontal ramus. The post-cranial skeletal elements are somewhat more slender than those of *Talpa minor*, but are similar with regards to the other morphologic characteristics.

Comparisons and discussion – In the Pliocene and Pleistocene of Europe, the genus *Talpa* was present with a number of species that differed mainly in size, while presenting similar morphologies. Making a specific diagnosis is difficult because there are significant variations in size within the individual species, variations in part caused by the sexual dimorphism that characterizes *Talpa*.

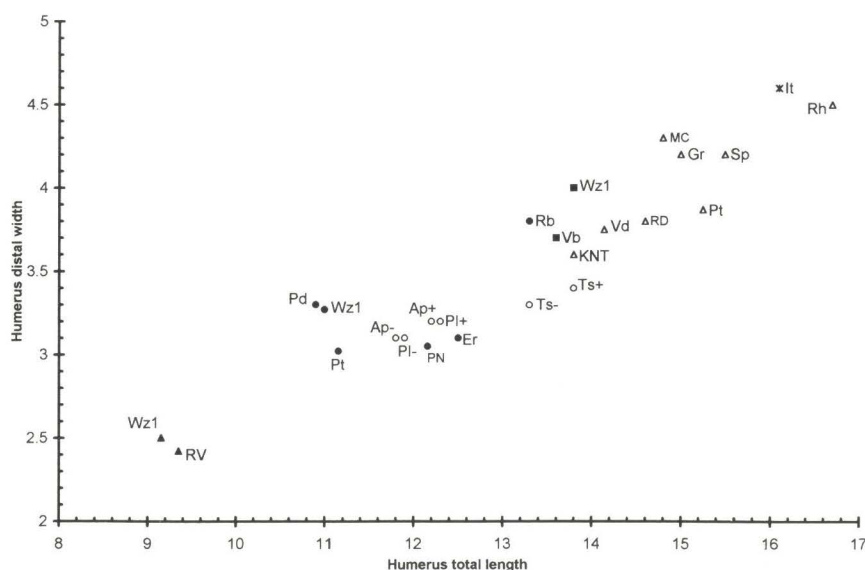
At present this genus is represented by one widely distributed species, *Talpa europaea*, the common mole, and by two smaller forms, *Talpa caeca* Savi, 1822, which inhabits the Apennines, the Central-Western Alps and the Dinarids, and *Talpa occidentalis* Cabrera, 1907, which is limited to Spain. Furthermore, two large-sized moles are known: *Talpa romana* Thomas, 1902, in Southern Italy and *T. stankovici* V. & E. Martino, 1931, in the Balcanic peninsula (Niethammer & Krapp, 1990).

In the Pliocene and Pleistocene *Talpa fossilis* Petényi, 1864, a form slightly smaller than *Talpa europaea*, and *Talpa minor*, which was comparable in size to *Talpa caeca*, were widely distributed. Two other species are recorded in this stratigraphic interval:

Talpa episcopalis Kretzoi, 1956, which was much larger than *Talpa europaea*, and seems to have been limited to Central Europe, and *Talpa stromeri* Brunner, 1950, which was similar in size to *Talpa fossilis*, but it differs from this species for the cusps of its molars bent sharply forward (Kowalski, 1958).

The larger-sized specimens from Rivoli Veronese fall comfortably within the range of variability of *Talpa minor*, and confirm that this form was present in the Italian Peninsula in the late Villanyian. *Talpa minor* has also been found elsewhere in the Italian Peninsula, at Arondelli (MN16a), and in the late early Biharian locality of Cava Pirro (De Giuli *et al.*, 1987; Fanfani, 1995).

The humeri of *Talpa minor* and *Talpa* sp. from Rivoli Veronese are compared with those of *Talpa minor* from Cava Pirro, *Talpa* cf. *caeca* and *Talpa europaea* from the middle Pleistocene locality of Valdemino in Text-figs. 1 A and B. The specimens arrange in three separate clusters according to the width and depth of humerus: the specimens of the Rivoli Veronese *Talpa* sp. are markedly smaller, those of *Talpa europaea* are the biggest, while the specimens of *Talpa minor* and *Talpa caeca* fall within a cluster of intermediate size. The robustness of the different samples (index Ws/Wi , Text-fig. 1A) are similar for *Talpa* sp. and *Talpa minor* while *Talpa caeca* and *Talpa europaea* are characterized by slightly stouter humeri. Text fig 1B, where the index S/Ws expressing the flattening of humerus is plotted against distal width, shows that the humeri of *Talpa europaea* are more flattened with respect to those of the other samples, likely indicating a more advanced digging capability of the latter species.



locality	abb.	species	L	Ws
			mean	mean
Podlesice	Pd	minor	10,9	3,3
Weze 1	Wz1	minor(?)	9,15	2,5
Weze 1	Wz1	fossilis	13,8	4
Weze 1	Wz1	minor	11	3,27
Rebيلية	Rb	minor(?)	13,3	3,8
Rivoli Veronese	RV	sp.	9,35	2,42
Pirro Nord	PN	minor	12,16	3,05
Valdemino	Vd	europaea	14,14	3,75
Petersbuch	Pt	minor	11,15	3,02
Petersbuch	Pt	europaea	15,25	3,87
Sudmer Berg 2	SB2	minor	12,5	3,1
Morovitsa Cave	MC	cf.europaea	14,8	4,3
Varbeshnista	Vb	sp.	13,6	3,7
Tessin	Ts	caeca (m)	13,8	3,4
Tessin	Ts	caeca (f)	13,3	3,3
Appennino	Ap	caeca (m)	12,2	3,2
Appennino	Ap	caeca (f)	11,8	3,1
Pelister	Pl	caeca (m)	12,3	3,2
Pelister	Pl	caeca (f)	11,9	3,1
Kleinalm/Niedere	NK	europaea	13,8	3,6
Ramsau/Dachstein	RD	europaea	14,6	3,8
Rheinland	Rh	europaea	15	4,2
Spagna	Sp	europaea	16,7	4,5
Grecia	Gr	stankovici	15,5	4,2
Italia	It	romana	16,1	4,6

Text-fig. 2 - Distal width versus total length (mean values) of humeri of *talpa* from fossil and recent locality of Europe. (▲) *Talpa* sp.; (●) *Talpa minor*; (■) *Talpa fossilis*; (○) *Talpa caeca* (– and + indicates females and males); (Δ) – *Talpa europaea*; (*) *Talpa romana*, (◆) *Talpa stankovici*.

A form similar in size to the Rivoli Veronese *Talpa* sp. occurs at Weze 1 (see also Text-fig. 2), as is shown by a few humeri that Sumliski (1962) had identified as juvenile remains of *Talpa minor*. Our data suggest that this possibility can be ruled out for the finds from Rivoli Veronese. As a matter of fact the specimens of *Talpa* sp. and *Talpa minor* from Rivoli Veronese have a sharp difference in size. Furthermore, even though the large sample of *Talpa minor* from Cava Pirro reasonably includes individuals of different ages and of both sexes, it forms a compact cluster for what concerning width and depth measurements, suggesting that different ontogenetic stages and sexual dimorphism have a small influence on this parameters. The small size of the mandible from Rivoli Veronese referred to *Talpa* sp. also conforms to the small size of post cranial elements. The Rivoli Veronese material therefore appears to indicate that in Europe, during the late Pliocene, there was, in addition to the widespread *Talpa minor* and *Talpa fossilis*, another extremely small-sized species that could be phylogenetically related to the smaller-sized specimens from Weze 1 (MN15). However, because the number of specimens is small and they are in poor condition, especially the teeth and the mandible, we do not feel it wise to define this new species formally at this time.

Family SORICIDAE Fisher von Waldheim, 1817
Subfamily SORICINAE Fisher von Waldheim, 1817
Tribe SORICINI Fisher von Waldheim, 1817
Genus SOREX Linnaeus, 1758

SOREX BOR Reumer, 1984
Pl. 2, figs. 1-2

Material – One distal hemimandibular fragment, 1 mesial hemimandibular fragment with M_1 and M_2 , 1 mesial hemimandibular fragment without teeth.

Description – The morphology of the condyle, the pigmentation of the teeth and the shape of the molars allow the attribution of the specimens to a mid-to-small-sized species of *Sorex*.

The distal mandibular fragment has a high coro-

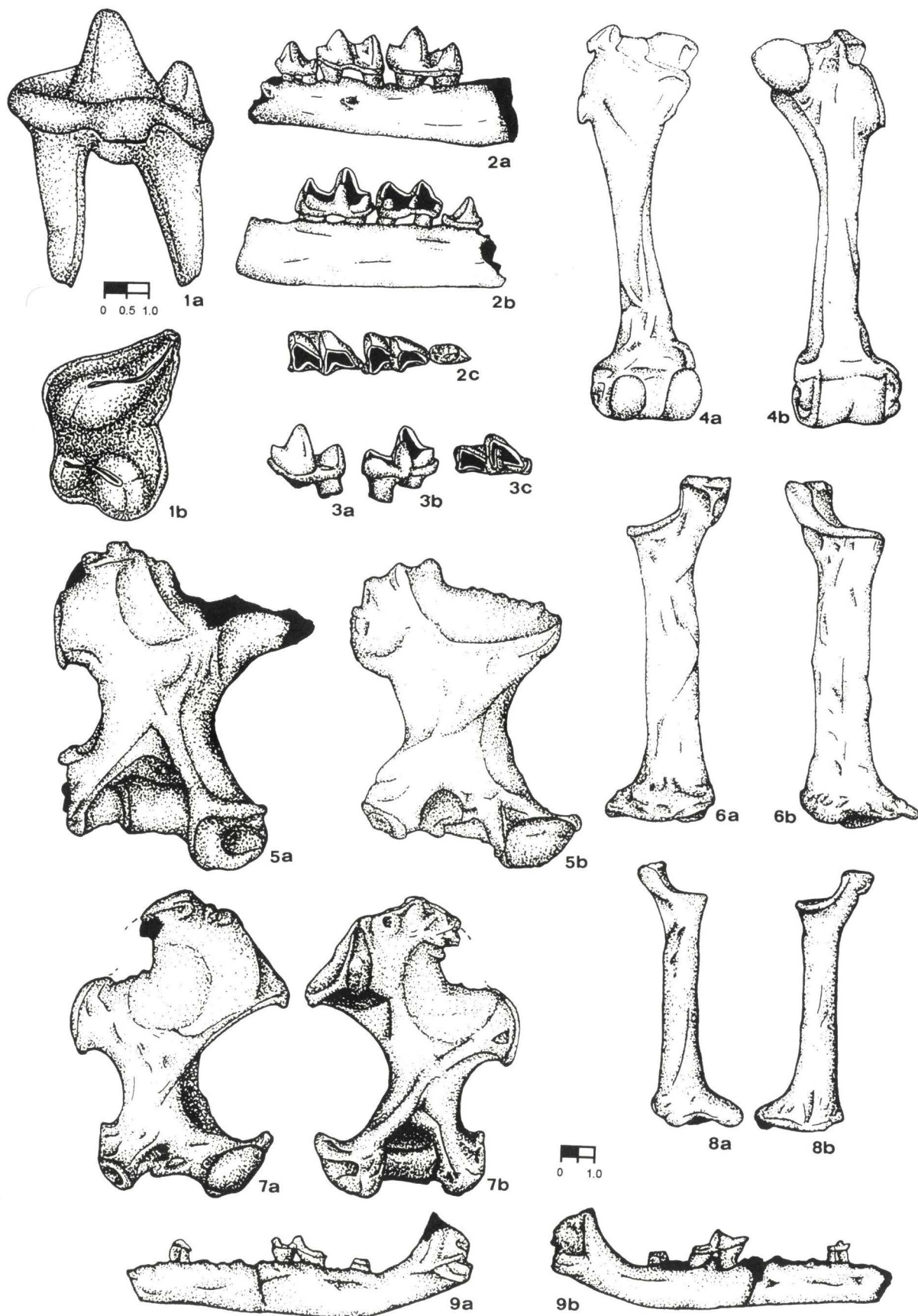
noid process with a slightly concave anterior margin and a straight posterior margin. In the upper part of the external side of the coronoid process there is a faint spicula. The external temporal fossa, which is poorly developed, lacks the longitudinal bar (*sensu* Reumer, 1984) that is often present in many species of *Sorex*. The internal temporal fossa, with a transversal bar, is narrow and set high respect to the molar series. The condyle is fairly slender, and the upper facet is small and cylindrical, while the lower one is broad, and bent down on the lingual side. The interarticular area is broad, and barely depressed on the lingual side. The mandibular ramus is low, and the central part of its lower border is slightly concave. The lower molars display a pale orange pigmentation that reaches approximately half way up the cusps; the entoconid, which is well developed and has an entoconid crest, is separated from the entostylid; the cingula, present on both sides, are pronounced and straight. The trigonid of the M_1 is narrower and more elongate than that of the M_2 .

Comparisons and discussion – For almost all of the stratigraphic interval from the early Ruscinian to the present, the genus *Sorex* has been represented in Europe by species which can be arranged into three different size categories. *Sorex minutissimus* Zimmermann, 1780 and *Sorex minutus* Linnaeus, 1766 are the smaller-sized species, whereas the larger-sized species include, in addition to *Sorex araneus* Linnaeus, 1758 and *Sorex alpinus* Schinz, 1837, several species belonging to the *Drepanosorex* subgenus. Several species are characterized by intermediate dimensions; the most widespread of these are the fossil species *Sorex bor* Reumer, 1984, *Sorex runtonensis* Hinton, 1911, and the extant *Sorex caecutiens* Laxmann, 1788 (Reumer, 1984; Rzebik-Kowalska, 1991).

The *Sorex* remains from Rivoli Veronese fall into the intermediate-sized group. The presence of an ascending ramus that is slightly bent forwards, the poorly developed external temporal fossa lacking a posterior longitudinal bar, the presence of coronoid-spicula, and the faint pigmentation of the teeth distinguish these remains from modern species and from those belonging to the fossil “*runtonensis-kennardi*” group. Among the fossil species, that which most

EXPLANATION OF PLATE 1

- Fig. 1 - *Erinaceus* sp. Right P^4 : 1a) labial view, 1b) occlusal view.
Figs. 2-6 - *Talpa minor*. 2) Left hemimandibular fragment with P_4 - M_2 : 2a) labial view, 2b) lingual view, 2c) occlusal surface of the teeth.
3) Left M_3 : 3a) labial view, 3b) lingual view, 3c) occlusal view.
4) Left femur: 4a) anterior view, 4b) posterior view.
5) Right humerus: 5a) posterior view, 5b) anterior view.
6) Left radius: 6a) internal view, 6b) external view.
Figs. 7-9 - *Talpa* sp. 7) Left humerus: 7a) anterior view, 7b) posterior view.
8) Left radius: 8a) external view, 8b) internal view.
9) Right hemimandible: 9a) labial view, 9b) lingual view.
Scale bar = 1 mm



closely resembles the Rivoli Veronese finds in terms of size and morphology is *Sorex bor*, described by Reumer (1984) in the Hungarian localities of Osztramos 9, 1 and 7, and by Rzebik-Kowalska (1991, 1994) from the Polish localities of Podlesice, Weze 1, Rebielice Królewskie 1A and 2, Kielinki 3B and 3A and Kadzielnia 1. This species was present in Central-Eastern Europe from the Ruscinian to the early Biharian. In some of the localities mentioned above *Sorex bor* is associated with *Sorex minutus*. Even though the two species do present some morphological similarities, *Sorex bor* is distinguishable because of its slightly larger size and the faint coloration of its teeth (Reumer, 1984; Rzebik-Kowalska, 1991, 1994). The *Sorex bor* specimens from Rivoli Veronese represent the first occurrence of this species in the Italian peninsula. Among the early Pleistocene *Sorex* specimens found in Italy, those from the Montagnola Senese (Fondi, 1972; Fanfani, 1995) and Pirro Nord (Fanfani, 1995) seem to resemble the Rivoli shrew in terms of both size and morphology.

Subgenus DREPANOSOREX Kretzoi, 1941

Sorex (DREPANOSOREX) PRAEARANEUS Kormos, 1934
Pl. 2, figs. 3-4

Material – One hemimandible with P_4 - M_3 , 2 hemimandibles with M_1 - M_2 , 1 hemimandible with P_4 , M_1 and M_2 .

Description – These specimens, which are of a size similar to *Sorex araneus*, differ markedly from those attributed to *Sorex bor*. They display several distinctive characteristics, including a sturdy mandible whose ascending ramus is broad and has a flaring apex, a prominent coronoid spicula located at about two thirds of the distance between the condyle and the upper extremity of the coronoid process, and a broad condyle whose upper articular surface is cylindrical, extremely narrow and oblique with respect to the lower surface. The mental foramen is located between the paraconid and the protoconid of M_1 , and the mandibular symphysis is extremely pronounced under the incisor. The teeth are large, but never reach the dimensions of those belonging to *Sorex araneus*, and differ from them in that they display a faint orange pigmentation. The P_4 is bicuspid, with a deep posterolingual basin of the type seen the genus *Sorex*, though in this case the tooth has a more bulbous appearance. The molars are rectangular in outline. M_1 has a very elongated, convex trigonid;

the talloid is broad, with a high entoconid, which is slanted backwards, with a moderately developed entoconid crest. The second molar is smaller, with a shorter trigonid. The basin of the talloid in the M_3 is well developed, with a well formed entoconid. The cingulum is sturdy on the labial side, and in some cases displays a slight waveness in the first molar. It is less sturdy and straight, on the lingual side.

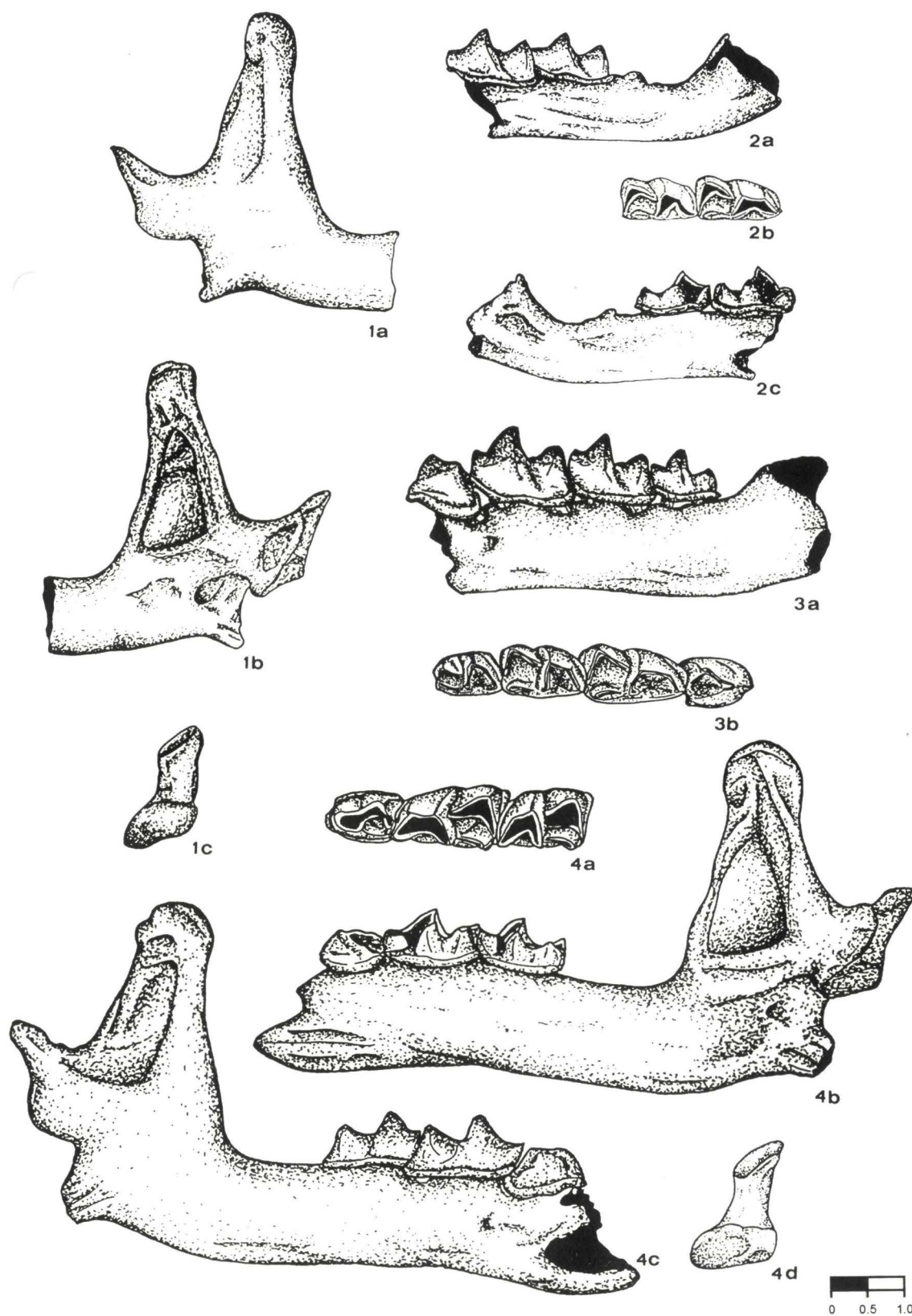
Comparisons and discussion – *Sorex* (*Drepanosorex*) *praeearaneus* is the earliest known European large-sized *Sorex*. The mandible and skull are generally sturdy, and differ from those of the present-day *Sorex*, which are slender and more elongated. The most significant diagnostic characteristic of the subgenus is the exoedaenodonty of the teeth (Reumer, 1984, 1985). In particular, the upper premolars are broad and appear bulbous. This characteristic has been interpreted as an adaptation to a malacophagous diet by Reumer (1985) and Rzebik-Kowalska (1991, 1994), and becomes more pronounced from the late Pliocene to the middle Pleistocene species.

At Rivoli Veronese no upper teeth were found, and it is consequently impossible to evaluate the degree of exoedaenodonty in this population. However, the bulbous shape of the P_4 , the general characteristics of the mandible, the pigmentation of the teeth, and the size of the specimens correspond to those given for the species *Sorex* (*Drepanosorex*) *praeearaneus* by Reumer (1984) and Rzebik-Kowalska (1991). This species has been reported from several European Villanyian and early Biharian localities: Tegelen (Netherlands, Reumer, 1984), Osztramos 3/2, Villany 3 (Hungary, Reumer, 1984), Zamkowa Dolna Cave A, Kielniki 3B, 3A, Kadzielnia 1, Kamyk (Poland, Rzebik-Kowalska, 1991, 1994), Orce 2 (Spain, Augusti *et al.*, 1987) and, in Italy, at Cava Sud, Soave (*Sorex pachyodon*, Pasa, 1947; Reumer, 1984; Rzebik-Kowalska, 1991).

In Italy, except for the occurrences at Rivoli Veronese and Cava Sud, there have not been reported findings of the subgenus *Sorex* (*Drepanosorex*). *Sorex* cf. *araneus* from Loara and S. Agostino Inferiore (Colli Berici; Bartolomei, 1964) could belong to the *Sorex* (*Drepanosorex*) *margaritodon-savini-austriacus* group. Bartolomei describes the specimens as a sturdier *Sorex araneus* (especially with regards to the ascending ramus) with a mental foramen under the M_1 , instead of, as occurs in the present-day species, between P_4 and M_1 .

EXPLANATION OF PLATE 2

- Figs. 1-2 - *Sorex bor*. 1) Right hemimandibular fragment: 1a) labial view, 1b) lingual view, 1c) condyle.
2) Left hemimandibular fragment with M_1 - M_2 : 2a) labial view, 2b) occlusal surface of the teeth, 2c) lingual view.
Figs. 3-4 - *Sorex* (*Drepanosorex*) *praeearaneus*. 3) Left hemimandibular fragment with P_4 - M_3 : 3a) labial view, 3b) occlusal surface of the teeth.
4) Right hemimandible with P_4 - M_2 : 4a) occlusal surface of the teeth, 4b) lingual view, 4c) labial view, 4d) condyle.
Scale bar = 1 mm



Genus PETENYIA Kormos, 1934

PETENYIA HUNGARICA Kormos, 1934

Pl. 3, figs. 1-4

Material – Two left hemimandibular fragments with M_1 - M_3 , a left mascellar with part of the premaxillary and the zygomatic process, with M^1 , M^2 , and P^4 ; two upper incisor fragments.

Description, comparisons and discussion – The dimensions of these fragments fall within the field of variability of *Petenyia hungarica*, as reported by Reumer, 1984, and Rzebik-Kowalska, 1989. The morphologies of the specimens also match those of *Petenyia hungarica*, especially with regards to the diagnostic characteristics: the shape of the ascending ramus; a high coronoid spicula directed towards the upper articulation of the condyle; the correspondence of the condyle's morphology to that of the "Blarina group" (Repenning, 1967); the positions of the mandibular and mental foramina; the marked convexity of the center of the lower border of the horizontal ramus of the mandible; the shape of the upper molars, with a very faint posterior emargination and metalophes; the shape of the alveolus of the last upper antemolar, which indicates that the tooth was small, and in large part hidden under the P^4 ; the very robust cingula; the dark red color of the teeth.

Petenyia hungarica is consistently found in the Pliocene and early Pleistocene insectivore assemblages of many European localities. In Italy the species is present at Arondelli (Berzi *et al.*, 1970), Cava Sud (Pasa, 1947) and Cava Pirro - Cava dell'Erba (Fanfani, 1995; De Giuli *et al.*, 1987).

The morphology of the species remained unchanged throughout its chronological range, and it is consequently easy to identify. It can only be confused with the genus *Alloblarinella* (= *Blarinella*, Thomas, 1911; see Storch, 1995) from which Reumer (1984) suggests it may derive. In their respective studies, Reumer (1984) and Storch (1995) give a list of criteria for distinguishing between the two genera. In our case, the mild coloration of the teeth, the location of the coronoid spicula half-way up the ascending ramus, and the shape of the molars lead us to attribute the specimens to the genus *Petenyia*.

Tribe BEREMENDIINI Reumer, 1984

Genus BEREMENDIA Kormos, 1934

BEREMENDIA FISSIDENS Petényi, 1864

Pl. 3, figs. 5-8

Material – A lower incisor, 3 fragments of premaxillary and mascellar with the P^4 , M^1 and M^2 .

Description, comparison and discussion – On the basis of their dimensions and morphology, the specimens of a large-sized shrew found at Rivoli Veronese can be identified as *Beremendia fissidens*. The most significant characteristics are the morphology of the upper teeth, the number of premolars (A^1 - A^4), the presence of a very deep furrow in the premaxillary bones in correspondence with the premolar series, and, finally, the morphology of the lower incisor. This acuspitate tooth is large, long and knife-shaped; its apex is curved up and strongly colored; on the posterior dorsal margin of the buccal side there is a characteristic thin, prominent cingulum.

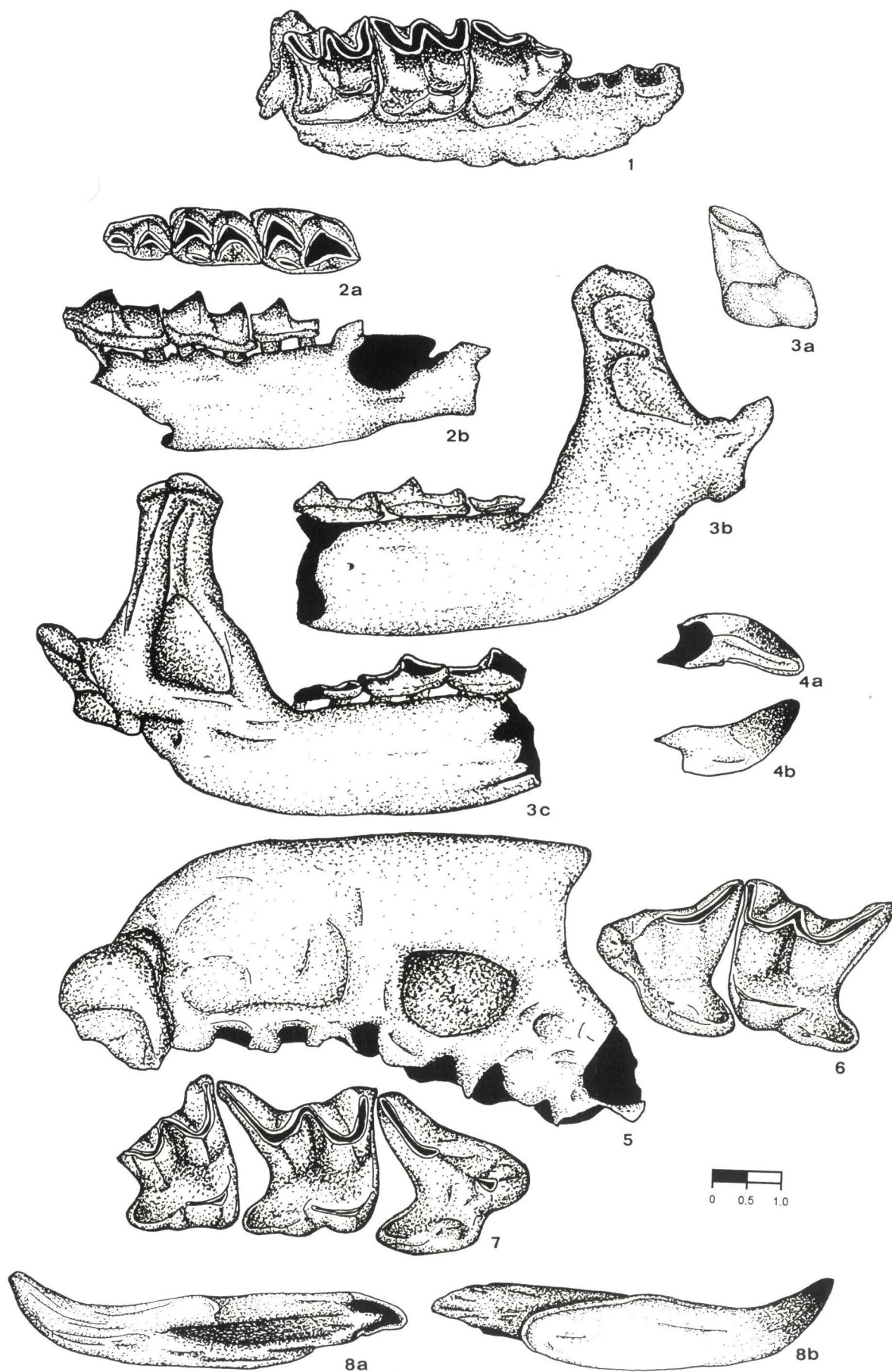
The upper teeth display a fairly marked posterior emargination, and in both the first molar and the P^4 the metastyles project strongly towards the rear. According to Reumer (1984) and Rzebik-Kowalska (1976), the morphology of the P^4 and the upper molars varies considerably within the species, and even within individual fossiliferous localities. Our premolars, in their triangular shape and posterior emargination, closely resemble those found at Osztramos 7 (cf. Reumer, 1984, Plates 33-1 and 33-7). Similar resemblance can be observed in the shapes of the molars and the size of the upper teeth. The M^1 and M^2 from Rivoli Veronese indeed display well developed protocones with inconspicuous metalophes, and hypocones that are low and separated from the protocones by deep furrows. In other localities (Tegelen, Villány 3 and Csarnóta 2) the upper teeth tend to be slightly larger, have a lesser degree of posterior emargination, and the premolar take on a more quadrangular shape, with the protocone closer to the parastyle.

Beremendia fissidens occurs from the Ruscinian to the late Biharian in almost all of Europe, and was commonly associated, until the early Biharian, with *Petenyia hungarica*. In Italy *Beremendia fissidens* has been reported at Arondelli (Berzi *et al.*, 1970), Cava Sud (Pasa, 1947), and Monte Peglia (Van der Meulen, 1973).

EXPLANATION OF PLATE 3

- Figs. 1-4 - *Petenyia hungarica*. 1) Ventral view of the fragment of left premaxillary and maxillary with P^4 - M^2 .
2) Left hemimandibular fragment with M_1 - M_3 : 2a) occlusal surface of the teeth, 2b) labial view.
3) Left hemimandibular with M_1 - M_3 : 3a) condyle, 3b) labial view, 3c) lingual view.
4) Fragment of left I^1 : 4a) lingual view, 4b) labial view.

- Figs. 5-8 - *Beremendia fissidens*. 5) Mesial fragment of cranium. 6) Left P^4 - M^1 . 7) Right P^4 - M^2 . 8) Right I^1 : 8a) lingual view, 8b) labial view.
Scale bar = 1 mm



Tribe NEOMYINI Matschie, 1909
Genus ASORICULUS Kretzoi, 1959

ASORICULUS GIBBERODON (Petényi, 1864)
Pl. 4, figs. 1-4

Material – Nine toothless hemimandibles, 5 hemimandibles with M_1 , 1 hemimandible with a complete molar series, 4 hemimandibles with M_1 and M_2 , 2 hemimandibles with M_2 , 1 mesial mandibular fragment with I , P_4 , M_1 and M_2 , 1 mandibular fragment with M_2 , 5 distalmandibular fragments, 2 isolated lower incisors and one maxillar fragment with P_4 and M_1 .

Description – Most of the soricid remains found at Rivoli Veronese can be attributed to the Neomyini tribe on the basis of the morphology of their condyles. The faint pigmentation of the teeth, which is limited only to the highest cusps, the moderate posterior emargination of the upper molars, the shortness of the incisor and its single small cusp, the lower molars with well developed entoconids and high entoconid crests, the unreduced tallonid of the third molar, and the mental foramen under the tallonid of M_1 are all diagnostic elements for the genus *Asoriculus*.

Comparisons and discussion – Hutterer (1994) pointed out that the European fossil species, previously referred to *Episoriculus* by many authors, actually are not cogenetic with this South-Eastern Asiatic taxon and that the name *Asoriculus* Kretzoi, 1959 is available for them (see also Reumer, 1995).

In Europe, *Asoriculus* was present at least from the late Miocene (*Asoriculus* cf. *gibberodon*, Brisighella, Italy, MN 13, late Messinian, De Giuli *et al.*, 1989, *Asoriculus* sp. Salobreña, Spain, M13, pre-evaporitic phase, Crochet, 1986); and was relatively common in the Pliocene and early Pleistocene from Europe to Turkey (*Asoriculus gibberodon*, cf. Reumer, 1984, Doukas *et al.*, 1995; Rzebik-Kowalska, 1994). Sporadic finds from Romania might indicate it persisted until the middle Pleistocene (cf. Rzebik-Kowalska, 1994). *Asoriculus maghrebiensis* Rzebik-Kowalska, 1988, a large-sized species, occurred in the Maghreb region of Morocco in the late Pliocene and early Pleistocene (Irhoud-Ocre, Rzebik-Kowalska, 1988; Ahl al Oughlam, Geraads, 1995). All the European finds were grouped in the single taxon *Asoriculus gibberodon* by Reumer (1984) and Rzebik-Kowalska (1994), whereas Geraads (1995) assigns the

specimens found at the early Pleistocene locality of Podumci 1 (Kroatia; Malez & Rabeder, 1984), which are larger in size, to *Asoriculus thenii*.

In the Biharian localities of the Italian Peninsula a smaller-sized species, *Asoriculus castellarini* Pasa, 1947, was found by Pasa (1947) at Cava Sud, and by Van der Meulen (1973) at Monte Peglia. This form was also found in the Zabia Cave (Poland) by Rzebik-Kowalska (1994). The inclusion of the species *castellarini* in the *Asoriculus* genus is not accepted by Reumer (1984), who refers it to *Neomys*. The early Biharian specimens from Cava Pirro and Cava Dell'Erba (Gargano), which De Giuli *et al.* (1987) refer to *Asoriculus gibberodon* do actually differ from the Pliocene and early Pleistocene representatives of this species from Central Europe, because they are larger in size (Fanfani, 1995).

The morphology of the ascending ramus and the teeth of the specimens from Rivoli Veronese, as well as their size, allows their positive attribution to *Asoriculus gibberodon*, after the descriptions by Reumer (1984) and Rzebik-Kowalska (1981, 1994, 1995). The first and second molar display hypocones separated by the hypoconal flange (morphotype A of Reumer, 1984). *Asoriculus gibberodon* has also been found in Italy, in the Early Villanyian locality of Cascina Arondelli (Berzi *et al.*, 1970).

PALEOECOLOGICAL CONSIDERATIONS

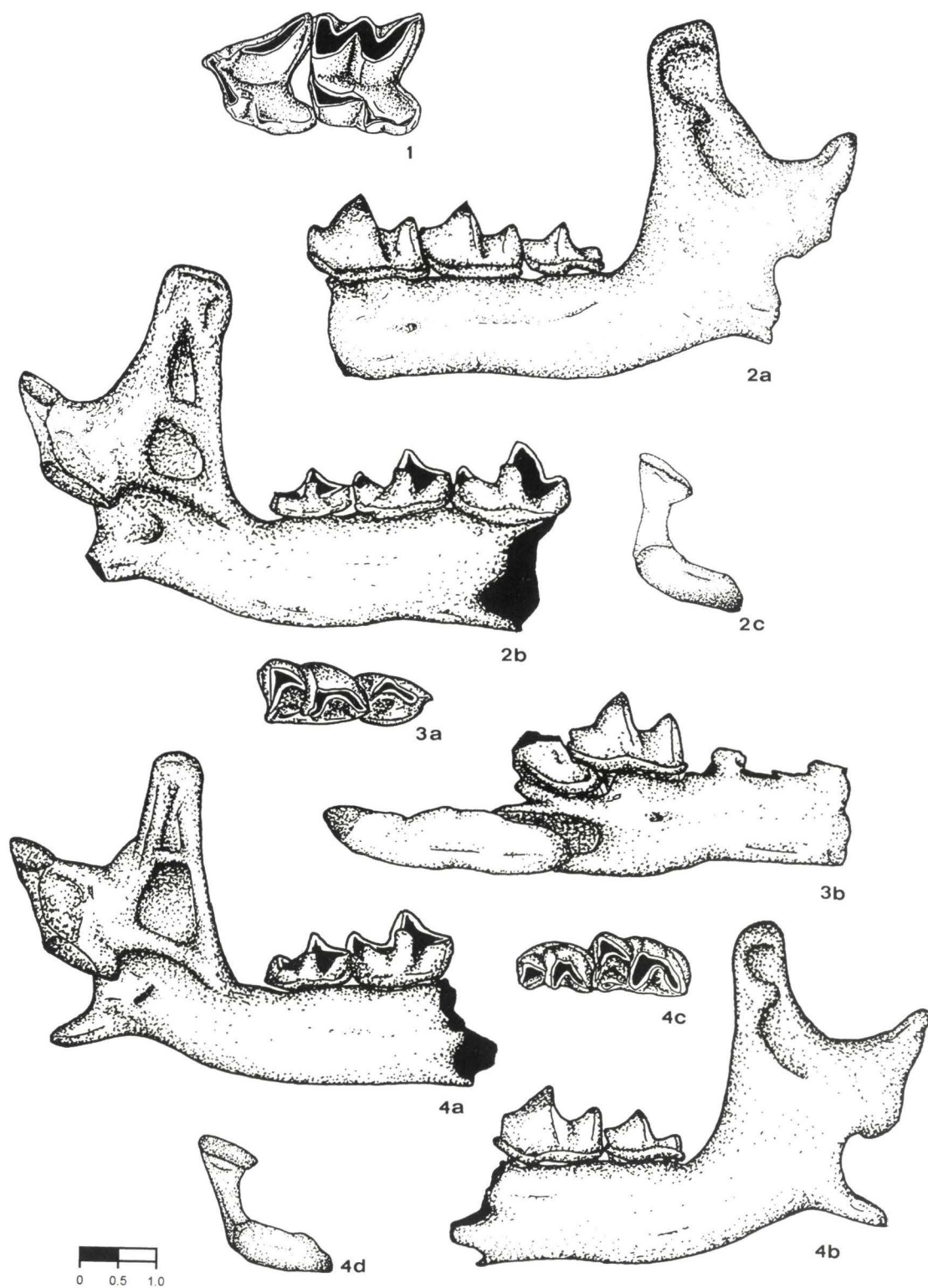
The insectivore assemblage, which is dominated by *Asoriculus* and *Talpa*, displays the broad diversity at the generic level that is typical of Pliocene and early

Pleistocene assemblages, and may be considered indicative of environments with diffuse forest cover. Within this context the abundance of moles is significant, since these insectivores at present prefer environments characterized by soft soils and fairly humid conditions, such as deciduous forests and the meadows surrounding them. According to Reumer (1984) and Rzebik-Kowalska (1995), the presence of *Sorex*, *Drepanosorex* and *Asoriculus* also indicates a humid environment with abundant plant cover. In particular, the abundance of *Asoriculus* would be indicative of a temperate climate, since the genus gradually restricted its range to the Mediterranean regions as the Plio-Pleistocene climatic deterioration progressed (cf. Rzebik-Kowalska, 1995).

The presence of *Erinaceus*, which is considered an opportunist forms, gives no useful paleoecological

EXPLANATION OF PLATE 4

Figs. 1-4 - *Asoriculus gibberodon*. 1) Left P^4-M^1 in occlusal view.
2) Left hemimandible with M_1-M_3 : 2a) labial view, 2b) lingual view, 2c) condyle.
3) Fragment of left hemimandible with I_1 , P_4-M_1 : 3a) occlusal surface of teeth, 3b) labial view,
4) Left hemimandible with M_2-M_3 : 4a) lingual view, 4b) labial view, 4c) occlusal surface of the teeth, 4d) condyle.
Scale bar = 1 mm



information, nor do the fossil genera *Beremendia* and *Petenya*, which have often been found together in assemblages indicative of steppe and forest environments.

The existence of forest biotopes in the region is confirmed by the occurrence of *Muscardinus*, *Glis*, *Sciurus* and a flying squirrel, genera that are found in humid forest environments (Sala *et al.*, 1994). The presence of abundant arvicolids, and especially *Villanyia* and cf. *Ellobius*, in association with leporids, implies there were also open spaces. Therefore the Rivoli Veronese faunal assemblage indicates the terrain was mostly forested, though some of the taxa reveal that there were more open areas.

CONCLUSIONS

The revision of the insectivores from Rivoli Veronese has enriched our knowledge of the faunal assemblages of the Italian Peninsula, with the first reported occurrences of *Sorex bor*, *Sorex (Drepanosorex) praeearaneus* and a possibly new species of mole.

The species *Sorex bor*, *Asoriculus gibberodon*, *Beremendia fissidens*, *Petenya hungarica* and *Talpa minor* have broad chronological distributions and are common elements in many fossiliferous localities dating from the late Ruscinian to the early Biharian. The presence of *Sorex (Drepanosorex) praeearaneus* indicates a date not earlier than the late Villanyian (MN17) and not later than the early Biharian (Rzebik-Kowalska, 1991, 1994).

The insectivore assemblage of Rivoli Veronese indeed resembles that found at Villany 3 (Hungary, Reumer, 1984; Jánossy, 1986), Kadzelnia 1 (Poland, Rzebik-Kowalska, 1995) and Tegelen, localities dating to Zone MN17. The absence of *Crociodura kornfeldi* Kormos, 1934, a form present at Villany 3, suggests that the Rivoli assemblage slightly predates the dispersal of this soricid in Western Europe. It is pos-

sible, however, that the absence of the species could be due to differences in the environmental conditions at the two localities. The rodents present at Villany 3 indeed include several elements with steppe affinities, which would indicate a drier, less forested environment and a climate with more continental characteristics, as one might expect given its geographic location, to the east of Rivoli Veronese.

In addition to *Villanyia*, *Ungaromys* and *Ellobius* (Sala *et al.*, 1994), *Sorex bor* also indicates that the Rivoli Veronese assemblage was related to the bioprovinces of Central-Eastern Europe. The diffusion of *Sorex bor* indeed appeared, before the Rivoli finds, limited to Poland (Rzebik-Kowalska, 1991, 1995) and Hungary (Reumer, 1984). *Sorex (Drepanosorex) praeearaneus*, which occurs in the same regions inhabited by *Sorex bor*, has been also found at Tegelen (late Villanyian, Reumer, 1984) and Orce 2 (early Biharian, Agustí *et al.*, 1987). Its presence at Rivoli Veronese shows that the species already occupied a broad geographic range since the late Pliocene.

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Tab. 1 - DESCRIPTIVE STATISTICS

Explications - min = minimum value; max = maximum value; std = standard deviation; n = number of observations.

Measurements - The scheme of measurement of mandible and dentition is after Reumer (1984), modified. The scheme of measurement for *Talpa* humerus is according to Huchison (1974), simplified.

Mandible - L: Length from point P (= insertion of angular process on the lower margin of horizontal ramus) to mental foramen; H: height of ascending ramus (from point P to the top of the coronoid process); S1, S2, S3: height of the horizontal ramus in correspondence of the distal end of M₁, M₂ and M₃, respectively; TI: height of horizontal ramus from point P to the lower margin of the internal temporal fossa; TM3: distance between point P and the distal end of M₃; AS: height from point P to condyle; SC: height of condilar process; HC: maximum height of condyle; HCM: distance between upper and lower condilar facets on lateral side; LUF, LLF: lengths of upper and lower condilar facets respectively;

Lower dentition - M1-M3: length of the lower molar series; P4, M1, M2, M3: Length of P₄, M₁, M₂ and M₃; SA1, SA2, SA3: width of the trigonid of M₁, M₂ and M₃; SP1, SP2, SP3: width of the talonid of M₁, M₂ and M₃; SP4: width of P₄; LI: length of I₁.

Upper dentition - BL, BL1, BL2: labial length of P₄, M₁ and M₂; LL, LL1, LL2: lingual length of P₄, M₁ and M₂; PE, PE1, PE2: length to the posterior emargination of P₄, M₁, M₂; W: width of P₄; AW1, AW2: width of M₁ and M₂ at the anterior side; PW1, PW2: width of M₁ and M₂ at the posterior side.

Humerus (Talpa) - L: length; LD: length humerus from distal end to deltoid process; LE: length of the humerus from distal end to the lower point of teres

tubercle; LP: length of the humerus from distal end to the lower point of pectoral tubercle; W: width ectoepicondyle to entoepicondyle; WL: width from capitulum to fossa for muscle flexor digitorum ligament; WS: minimum width; ST: distance from pectoral process to head; S: minimum depth. radius (*Talpa*) - LR: length; SR: width. Femur (*Talpa*) - LF: length; SF: width.

<i>A - Talpa minor</i>					
	min	mean	max	std	n
L		9,64			1
S1	2,01	2,06	2,12	0,06	3
S2	2,17	2,23	2,28	0,06	3
S3	2,01	2,03	2,05	0,03	2
M1M3		6,62			1
M1	2,17	2,21	2,25	0,06	2
SA1		1,08			1
SP1		1,35			1
M2	2,38	2,51	2,60	0,12	3
SA2		1,31			1
SP2		1,36			1
M3	1,80	2,09	2,26	0,25	3
SA3		0,99			1
SP3		0,73			1
P4	1,31	1,35	1,38	0,05	2
SP4	0,65	0,65	0,65	0,00	2
LP	3,63	3,95	4,26	0,45	2
WI	6,41	6,57	6,72	0,22	2
WS	3,08	3,29	3,57	0,19	6
S	2,58	2,94	3,16	0,22	6
LR		11,20			1
SR	1,65	1,71	1,80	0,06	4
LF	13,16	13,39	13,75	0,25	4
SF	1,31	1,39	1,45	0,05	6

<i>B - Talpa sp</i>					
	min	mean	max	std	n
L		6,57			1
L2		9,35			1
S1		1,47			1
S2		1,50			1
S3		1,25			1
M1M3		4,64			1
M1		1,74			1
M2		1,50			1
SA2		0,73			1
SP2		0,66			1
M3		1,56			1
L	9,17	9,36	9,54	0,26	2
LD	6,46	6,56	6,66	0,14	2
LE	3,94	4,15	4,36	0,20	4
LP	3,25	3,37	3,57	0,13	5
W		5,63			1
WI	5,02	5,36	5,57	0,21	5
WS	2,36	2,43	2,49	0,05	5
ST		4,03			1
S	2,28	2,36	2,43	0,06	5
LR		8,78			1
SR	1,13	1,27	1,41	0,20	2
SF		1,10			1

<i>C - Sorex bor</i>					
	min	mean	max	std	n
H		3,85			1
S1	0,88	0,91	0,94	0,04	2
S2	0,92	0,94	0,96	0,03	2
S3	0,89	0,90	0,91	0,01	3
TI	1,23	1,36	1,48	0,18	2
AS	0,69	0,77	0,84	0,11	2
SC		2,65			1
HC		1,72			1
HCM		1,21			1
LLF		1,07			1
LUF		0,68			1
M1M3		3,12			1
M1		1,26			1
M2		1,08			1
M3		0,84			1

<i>D - Drepanosorex praeareneus</i>					
	min	mean	max	std	n
L	5,17	5,30	5,43	0,18	2
H	4,39	4,53	4,67	0,20	2
S1	1,26	1,29	1,31	0,03	3
S2	1,14	1,31	1,40	0,12	4
S3	1,18	1,25	1,30	0,05	4
AS	2,96	3,02	3,07	0,08	2
SC	1,13	1,15	1,17	0,03	2
HC	1,72	1,75	1,77	0,04	2
HCM	1,28	1,33	1,38	0,07	2
LLF	1,07	1,15	1,23	0,11	2
LUF	0,83	0,86	0,88	0,04	2
M1M3	3,48	3,63	3,74	0,11	4
M1	1,44	1,55	1,65	0,09	4
SA1	0,69	0,74	0,80	0,05	4
SP1	0,79	0,83	0,92	0,06	4
M2	1,14	1,23	1,31	0,07	4
SA2	0,70	0,75	0,81	0,06	4
SP2	0,63	0,74	0,83	0,08	4
M3	0,94	1,03	1,13	0,10	4
SA3		0,55			1
SP3		0,43			1
P4	1,08	1,09	1,10	0,01	2
SP4	0,67	0,70	0,72	0,04	2

<i>E - Petenyia hungarica</i>					
	min	mean	max	sd	n
S1		1,76			1
S2		1,70			1
S3		1,60			1
SC		1,13			1
HC	1,89	1,94	1,98	0,06	2
HCM	1,17	1,21	1,25	0,06	2
LLF	1,34	1,39	1,44	0,07	2
LUF	0,86	0,88	0,89	0,02	2
SP1		0,87			1
M2		1,23			1
SA2		0,80			1
SP2		0,82			1
BL		1,43			1
LL		1,02			1
PE		0,99			1
W		1,42			1
BL1		1,39			1
LL1		1,42			1
PE1		1,30			1
AW1		1,46			1
PW1		1,57			1
BL2		1,33			1
LL2		1,20			1
PE2		1,13			1
AW2		1,53			1
PW2		1,32			1

<i>F - Beremendia fissidens</i>					
	min	mean	max	std	n
LI		6,44			1
BL	2,18	2,28	2,37	0,13	2
LL	1,26	1,41	1,55	0,21	2
PE	1,12	1,22	1,32	0,14	2
W	1,95	2,03	2,11	0,11	2
BL1	2,14	2,18	2,22	0,06	2
LL1	2,18	2,19	2,20	0,01	2
PE1	1,80	1,81	1,81	0,01	2
AW1	2,15	2,18	2,20	0,04	2
PW1	2,38	2,46	2,53	0,11	2
LL2		1,67			1
PE2		1,32			1
AW2		0,00			1
PW2		2,33			1

<i>G - Asoriculus gibberodon</i>					
	min	mean	max	std	n
L	3,93	4,32	4,50	0,17	10
H	3,71	3,92	4,07	0,11	13
S1	1,18	1,29	1,42	0,07	15
S2	1,12	1,26	1,36	0,06	23
S3	1,02	1,17	1,32	0,09	21
TI	1,32	1,43	1,65	0,09	18
TM3	1,90	1,92	1,93	0,02	2
AS	2,56	2,94	3,14	0,16	15
SC	1,07	1,17	1,32	0,06	15
HC	1,84	2,04	2,21	0,11	17
HCM	1,21	1,38	1,58	0,10	18
LLF	1,20	1,30	1,50	0,07	17
LUF	0,64	0,81	0,91	0,07	17
M1M3	3,45	3,73	3,93	0,15	8
M1	1,33	1,52	1,70	0,09	14
SA1	0,68	0,78	0,85	0,05	13
SP1	0,66	0,84	0,95	0,08	14
M2	1,20	1,38	1,54	0,07	22
SA2	0,56	0,72	0,78	0,06	15
SP2	0,63	0,77	0,81	0,05	15
M3	0,99	1,08	1,17	0,06	14
SA3	0,53	0,57	0,62	0,04	5
SP3	0,41	0,46	0,52	0,05	4
P4	1,05	1,12	1,23	0,08	4
SP4	0,68	0,74	0,80	0,05	4
LI	2,70	2,94	3,18	0,34	2
BL		1,51			1
LL		1,07			1
PE		0,93			1
W		1,51			1
BL1		1,43			1
LL1		1,67			1
PE1		1,30			1
AW1		1,54			1
PW1		1,72			1

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