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The Arvicolids from Arondelli-Triversa: a new look

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ABSTRACT – Based on new evidence from the arvicolid record, the Arondelli local fauna of northern Italy is correlated with similar occurrences in Central Europe (Hajnáčka, Wölfersheim, Hambach, Gundersheim), Russia (Uryv 1) and Anatolia (Kadiözü, Ziyaret, Yenice-1). The similarity with the Hambach fauna in the normally polarized Reuver clay establishes the correlation with the Gauss magnetic chron.

RIASSUNTO – [Nuove osservazioni sugli arvicolidi di Arondelli-Triversa] – Un nuovo esame degli arvicolidi provenienti da Arondelli (nei pressi di Villafranca d'Asti, in Piemonte) consente di correlare la fauna locale di Arondelli con associazioni confrontabili dell'Europa centrale (Hajnáčka, Wölfersheim, Hambach, Gundersheim), Russia (Uryv 1) e Anatolia (Kadiözü, Ziyaret, Yenice-1). La somiglianza degli arvicolidi di Arondelli con quelli di Hambach, permette una correlazione con il magnetocrono Gauss.

INTRODUCTION

According to the Hungarian paleontologist M. Kretzoi, arvicolids belong to a group of small mammals that reflect in a most sensitive way the environmental and climatic changes during the last 4-5 million years. Having very wide geographic distribution combined with high rate of morphological changes, arvicolids are «the foraminifers of the terrestrial biostratigraphy» and represent a very good tool for dating of the youngest history of the continental biosphere (Kretzoi, 1956; Fejfar *et al.*, 1998). In addition, «it is also important to remember that the microtine rodents are the most rapidly evolving mammals yet known and, for this reason, many of the problems of their classification, and of the nature of their populations, are unique. This uniqueness makes their history much more sensitive to time and their biochronology much more precise. In no other mammalian type has there been found so many isolate populations with individual variation covering the morphotype span from the most recent ancestor to the direct descendant. It is rare that one can positively identify a species from one or a few fossil individuals: a sample of at least thirty individuals of the population is considered the approximate minimum for a positive identification» (Repenning, in press).

Here, I take a new look at the important record of arvicolids in the type section of the Villafranchian in Piedmont, northern Italy, collected in a productive level in the quarry of Arondelli, a site along the river Triversa (Michaux, 1970).

THE ARVICOLIDS FROM ARONDELLI-TRIVERSA

The arvicolid remains in the Arondelli local fauna were collected by D. E. Savage and party in

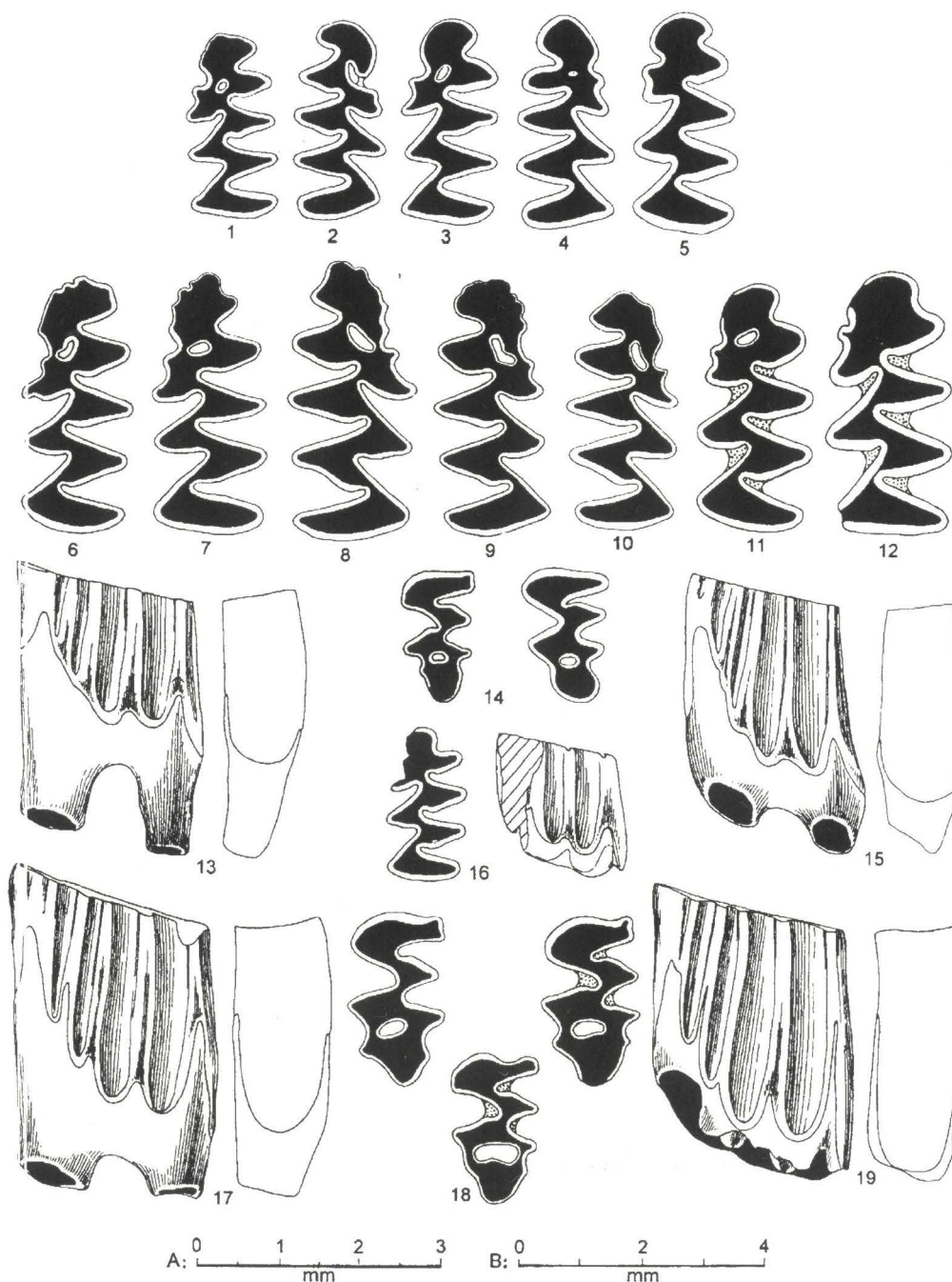
September 1965 at the Arondelli farm near Villafranca d'Asti (Berzi *et al.*, 1967).

Part of the matrix collected was washed and picked at the University of California, Berkeley by E. Lindsay and J. H. Hutchison. Michaux (1970) described the Italian collection and assigned the arvicolid material to two forms. The larger, more common one (*Mimomys polonicus*) was more progressive and the smaller, rather rare one (*Mimomys gracilis*) had archaic features. In the larger species, Michaux correctly noted an undulated crown base, the «linea sinuosa» sensu Rabeder (1981). The second, smaller form was based upon a deeply worn molar which did not display the crown base. Michaux observed in both forms a further important feature: cementum layers in the synclines. Concerning the larger form *Mimomys polonicus*, Michaux also noted similarity with the early Villafranchian arvicolid *Mimomys hajnackensis* from Hajnáčka; but he considered this species synonymous with *Mimomys polonicus*.

In 1976 I had the opportunity to study the Arondelli collection kept in the Museum of Paleontology at Berkeley, and in 2000 I obtained further arvicolid material from Berkeley for detailed study. This new evidence permits reconsideration of the Arondelli arvicolid assemblage and its position in the European late Pliocene, as presented here.

The Arondelli local fauna contains the following taxa of arvicolids (Text-figs. 1 and 4):

- 1 - *Mimomys hassiacus* (Text-figs. 1 and 4) – This species was first described by Heller (1936) from the karst fissure fillings at Gundersheim 1. Revision of the fauna (Fejfar & Storch, 1990, figs. 18-26) revealed that all molars of *Mimomys hassiacus* display cementum present in the reentrants and that they differ significantly from both



Text-fig. 1 - The topotypic material of arvicolids from the Arondelli Local Fauna in the quarry of Arondelli at Villafranchian d'Asti, UCMP, locality nr. V66132. (Specimens 1-10; 13-17, 19, are from the personal reference collection of Ch. A. Repenning, UCMP #6701a-l. Specimens 11, 12 and 18 belongs to UCMP; 11 and 12: #77608; 18: #77607).

- 1-5, 13-15 - *Mimomys stehlini* (1, 3 and 5, left m_1 in occlusal view; 2 and 4, right m_1 in occlusal view; 13 and 15, right m_1 in buccal and posterior views; 14, two left m_3 in occlusal view)
 6-12, 17-19 - *Mimomys hassiacus* (6, 7, 11 and 12, left m_1 in occlusal view; 8, 9 and 10, right m_1 in occlusal view; 17 and 19 right m_1 in buccal and posterior views; 18, three left m_3 in occlusal view)
 16 - *Germanomys cf. weileri*: left m_1 in occlusal and buccal views.

Note the less progressive buccal linea sinuosa in *Mimomys stehlini* (13, 15), and the outer cementum in the reentrants that is secondarily removed and visible in some specimens of *M. hassiacus* (11, 12, 18, 19). Scale A: occlusal views; scale B: buccal views. Abbreviations: UCMP - University of California, Berkeley, Museum of Paleontology; CAR - reference collection of Ch.A. Repenning; UFIP - University of Florence, Museo di Storia Naturale (Sezione Geologia e Paleontologia); OF - reference collection of O. Fejfar; NHMBO - Naturhistorische Museum Basel, Osteologie; SMF - Senckenberg Museum, Frankfurt a.M.; GIB - Geological Institute, Budapest; SMB - Slovakian National Museum, Bratislava; ULMP - University of Lyon, Museum of Paleontology; UUPC - University of Utrecht, Paleontological collections.

Mimomys polonicus and *M. pliocaenicus* in having a more primitive basal enamel margin (the «*linea sinuosa*»).

- 2 - *Mimomys stehlini* (Text-fig. 1) – This is the smaller *Mimomys* species, recorded first in San Giusto at Empoli. Compared with the previous larger species, this taxon is relatively more primitive in the less complete alternation of enamel reentrants and more confluent dentine triangles. The presence of cementum in the reentrants is irregular; the shape of the *linea sinuosa* is very similar to *Mimomys hassiacus*.
- 3 - *Germanomys* cf. *weileri* (Text-fig. 1) – *Germanomys*, first described from the karst fillings at Gundersheim (Heller, 1936), is a representative of a typical conservative branch of arvicolines during the Late Ruscinian - Early Villányian, MN 15b - MN 16b (e.g., in the sites: Ivanovce, Weze, Gundersheim 1, Rebielice Królewskie, Hajnáčka and Ostrámos 7). During this time span no significant changes in its primitive morphology can be observed. Typical features of *Germanomys* are as follows: 1) thick enamel with simple indifferentiated microstructure of radial type; 2) confluent dentine triangles (confluency increasing with wear); 3) nearly straight basal enamel margin, low (mesodont) type of hypsodonty, 4) the irregular undulation of the relatively thinner enamel on the mesial border of the anteroconid does not show the *Mimomys*-like details; the rare *insula*-islet in the anteroconid complex (ACC) is not homologous with that in *Mimomys* but is derived from a sagittal syncline on the mesial border.

CHARACTERISTICS OF THE GENUS *MIMOMYS* FORSYTH MAJOR, 1902 IN THE EUROPEAN LATE PLIOCENE

During the late Ruscinian zone MN 15 the genus *Mimomys* is not yet diversified: only one size of the initial, closely related species occurs in limnic/paludal environments. Subsequent species - derived from the local genus *Promimomys* of the preceding early Ruscinian zone MN 14 - are known in western Europe: in the early subzone MN 15a (*Mimomys vandermeuleni* and *M. davakosi*) and in the late subzone MN 15b (*M. gracilis*). At the beginning of the early Villányian mammal stage in zone MN 16a appear for the first time two species of *Mimomys* of different size: 1. the larger form, *Mimomys hassiacus* (Text-fig. 2), is most probably an immigrant from the east and its features are progressive; 2. the smaller species *Mimomys gracilis* persists from the preceding zone and its features are primitive (Text-fig. 3). Thus, the first appearance of the «modern» *Mimomys hassiacus* represents not only a marker for the base of MN 16 but is also a good index fossil for the whole zone MN 16. *Mimomys hassiacus*, first recorded in the fissure fills of Gundersheim 1 (Heller, 1936), appeared later

to be synonymous with *Mimomys hajnachensis* after the original fossils of Heller (1936) were available for comparison. Recently, *Mimomys hassiacus* is best recorded in the lignites/clays of the Lower Rhine Basin/Embayment – in the “classic” fauna of Wölfersheim – and in two other similar faunas from Hambach and Frechen. All three sites represent limnic/paludal environments in one stratigraphical level, in contrast to the type locality Gundersheim which apparently may contain a faunal mixture of assemblages: MN 15b - MN 17.

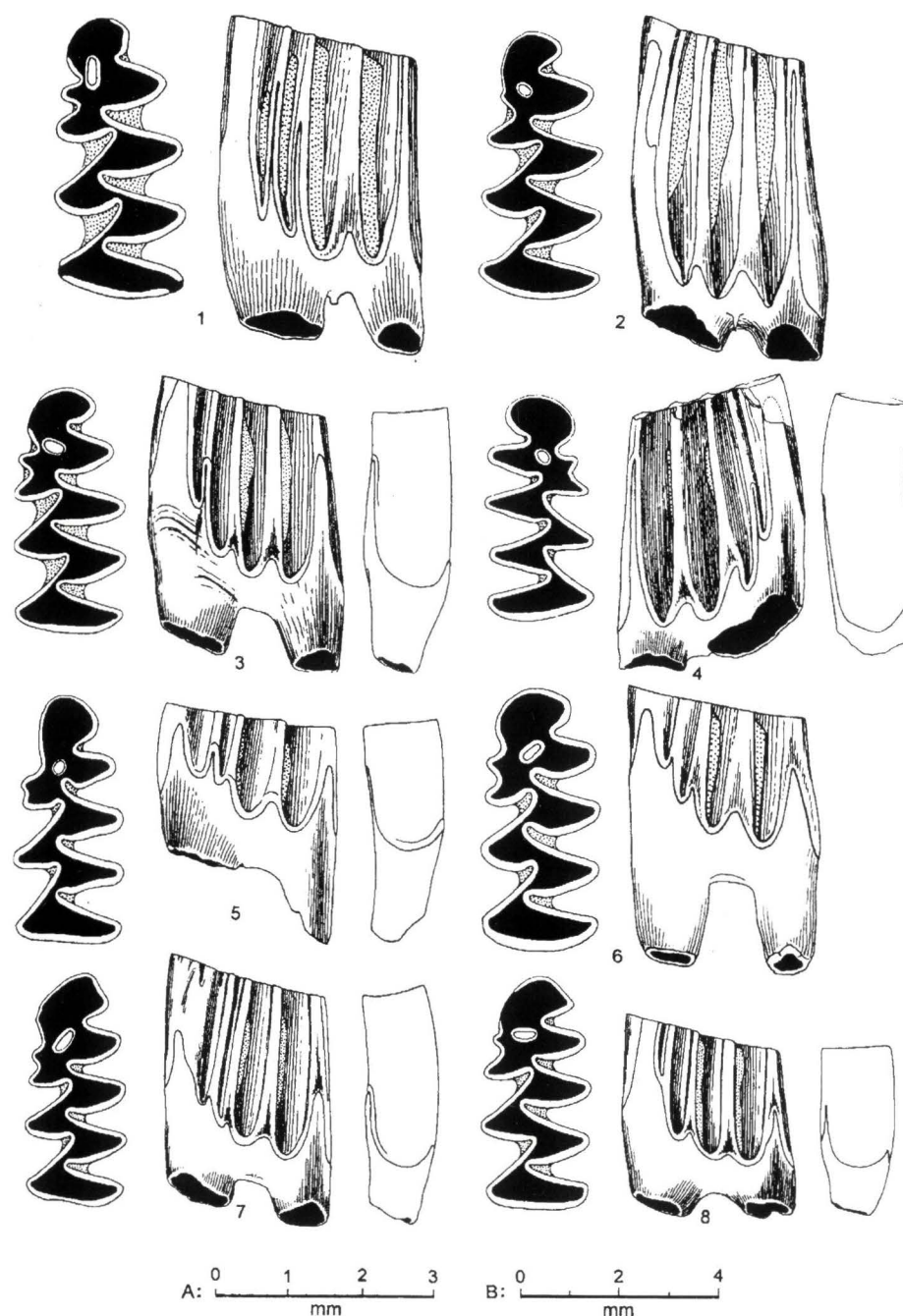
In contrast to the initial species of the genus *Mimomys* of the Ruscinian mammal stage: zones MN 15a (*M. antiquus*, *M. davakosi* and *M. vandermeuleni*) and MN 15b (*Mimomys gracilis*), the following features are typical for the MN 16a arvicolids (for details: Rabeder, 1981; Fejfar & Heinrich, 1983; Fejfar & Repenning, 1998):

- 1 - cementum in the reentrants of the molars (synclines);
- 2 - the enamel crown base (the *linea sinuosa*) in buccal view of the lower first molar shows distinct high elevations, mainly: *hyposinuid* on the hypoconid prism; and *anterosinuid* on the buccal side of the anteroconid complex (ACC). In those places appear the very first interruption of the enamel wall of the occlusal surface in adult specimens;
- 3 - the thickness and Schmelzmuster of the prismatic enamel walls is differentiated. The leading edges (anterior in lower molars, posterior in upper molars) are thinner than the corresponding trailing edges and display two enamel layers: outer radial and inner lamellar. The trailing edges (posterior in the lower molars, and anterior in the upper molars) are thicker than the leading edges and show an outer tangential layer and the inner thicker radial enamel (von Koenigswald, 1980; Fejfar & Heinrich, 1982; Mörs *et al.*, 1998).

All features listed here can be explained as direct results of the environmental changes during the late Pliocene Villányian mammal stage (Fejfar & Heinrich, 1982).

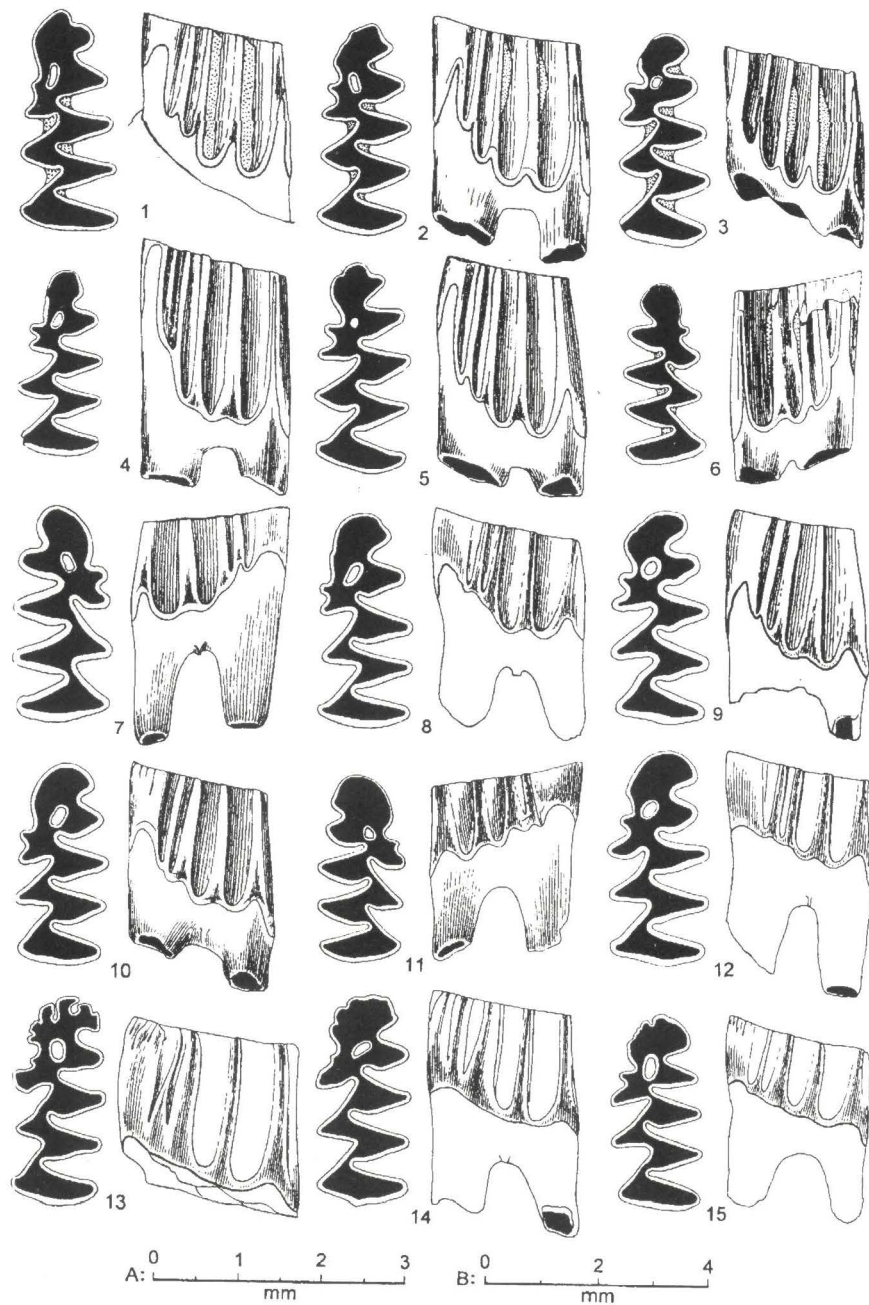
IMPORTANT SITES OF ARVICOLIDS IN THE LATE PLIOCENE MN 16A SITES OF EUROPE

Research on arvicolids in the early Villányian zone MN 16a has noticeably progressed in recent years. Among the new stratified sites, three areas are very important: 1) The Russian locality Uryv 1 in the deposits of the river Ob (Agadzhanian, 1976), 2) The sites in the “Reuver” clay associated with lignites/brown coal: Wölfersheim, Hambach and Frechen (Mörs *et al.*, 1998), and 3) Some new sites in the Pliocene of Turkey/Anatolia (Ünay & Bruijn, 1998). Comments on the arvicolid record from some of the early Villányian zone MN 16 localities listed in Tables 1 and 2 follow:



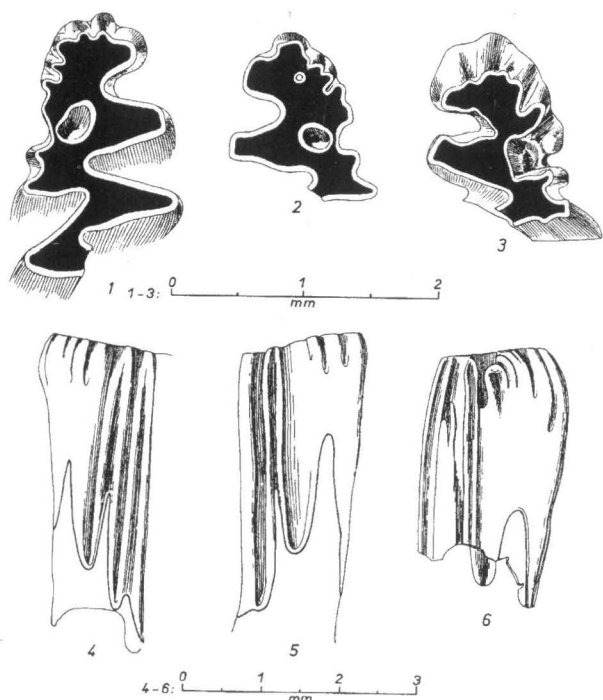
Text-fig. 2 - The European record of the large species of *Mimomys* (*Mimomys*) in the late Ruscinian (MN 15b) and Villányian (MN 16a,b – MN 17). Note the gradually increasing elevations of the linea sinuosa in the buccal views. Scale A: occlusal views; scale B: buccal views. See figure 1 for Abbreviations.

- 1- *Mimomys pliocaenicus*, left m_1 in occlusal and buccal views from the type locality Castelfranco di Sopra, Upper Valdarno, Italy (UFIP);
- 2- *Mimomys ostramosensis*, left m_1 in occlusal and buccal views, topotype from the type locality Ostramos-3, North Hungary (OF);
- 3- *Mimomys polonicus*, left m_1 in occlusal, buccal and posterior views, topotype from the type locality Rembielice Królowskie, Southern Poland (OF);
- 4- *Mimomys polonicus*, right m_1 in occlusal, buccal and posterior views, from the volcanic tuffs at Les Étouaires, Auvergne, France (NHMBO);
- 5- *Mimomys hassiacus*, left m_1 in occlusal, buccal and posterior views, topotype from Gundersheim-Heller, 1936, part 1 (SMF);
- 6- *Mimomys hassiacus*, left m_1 in occlusal and buccal views, from Wölferstheim, Rheinhessen, Germany (SMF);
- 7- *Mimomys hassiacus*, left m_1 in occlusal, buccal and posterior views, from Beremend 3, South Hungary, GIB, coll. Petényi;
- 8- *Mimomys hassiacus*, left m_1 in occlusal, buccal and posterior views, from Hajnáčka at Filakovo, Southern Slovakia (type of «*Mimomys hajnackensis* Fejfar, 1961») (SMB).



Text-fig. 3 - The European record of the smaller species of *Mimomys* from the Ruscinian (MN 15) and the early Villányian (MN 16a). Left (1-5, 8-10, 12-15) and right (5, 7, 11) m_1 in occlusal and labial views. Note the gradually increasing elevations of the linea sinuosa in the buccal views. Scale A: occlusal views; scale B: buccal views. See figure 1 for Abbreviations.

- 1 - *Mimomys stehlini*, holotype of S. Schaub, 1931, from San Giusto at Empoli, North Italy (NMBO).
- 2 - *Mimomys stehlini* from Beremend 3, South Hungary, GIB, coll. Petényi.
- 3 - *Mimomys stehlini* from Hajnáčka bei Fidakovo (the type of «*Mimomys pliocaenicus minor* Fejfar, 1961», SMB).
- 4, 5 - *Mimomys stehlini* from Ostrámos 7, NE Hungary (OF).
- 6 - *Mimomys stehlini* from Les Étouaires, Auvergne, France (NHMBO).
- 7 - *Mimomys gracilis* from Weze, Southern Poland (OF).
- 8 - *Mimomys gracilis* from Escorihuela B, Teruel basin, Western Spain (ULMP).
- 9 - *Mimomys stehlini* from Wölfersheim, Rheinhessen, Germany (SMF).
- 10 - *Mimomys gracilis* from Ivanovce A, Western Slovakia (SMB).
- 11 - *Mimomys gracilis* from Serrat d'en Vacquer, Rousillon (the type locality of the Ruscinian), Southern France (CA).
- 12 - *Mimomys davakosi* from Gundersheim, Rheinhessen, Germany; material of Tobien (not yet published) (SMF).
- 13 - *Mimomys vandermeuleni* from La Gloria 2, Teruel basin, Western Spain (ULMP).
- 14 - *Mimomys vandermeuleni* from the lignites near Ptolemais, Ptolemais 3, Macedonia, Greece (UUPC).
- 15 - *Mimomys davakosi* from Villalba Alta, Teruel basin, Western Spain (ULMP).



Text-fig. 4 - Examples of the anterior part of the juvenile less-worn lower m_1 (ACC - anteroconid complex) of the large *Mimomys hassiacus* from the Arondelli local fauna. 1 and 4 left, 2, 3, 5 and 6 right, in occlusal (1-3) and buccal (4-6) views. Note the undulated anterior margin of the ACC, and the wide and high/deep islet (6) produced early in wear by the dammed buccal syncline.

- 1 - *Gundersheim* (Rheinhessen district, Germany). The type locality of *Mimomys hassiacus* Heller 1936. Revision of the old collections and studies of the recent ones show that the karst fillings in the three local limestone quarries at Gundersheim represent different faunal units; fossil material was collected in at least 5 fossiliferous karstic fillings (in addition to about 20 sterile fissures investigated): 1. Gundersheim «Findling» and undescribed material formerly in the possession of H. TOBIEN: MN 15b; 2. Gundersheim part 1 of Heller (1936): MN 16a; 3. Gundersheim part two of Heller (1936): MN 17 (Fejfar & Storch, 1990, Storch & Fejfar, 1990).
- 2 - *Wölfersheim* (Horloff basin, Frankfurt a.M.). In the year 1949, in the lignite mine «Römerstraße» at Wölfersheim (Horloff basin, in the volcanic region of Vogelsberg), an abundant mammalian fauna of about 47 taxa was discovered (Tobien, 1953). Detailed study of the more than 1000 isolated molars of arvicolids in the original collection now housed in the Senckenberg Museum in Frankfurt, Germany yielded the following taxa of rodents: *Mimomys hassiacus*, *Mimomys gracilis*, *Dolomys occitanus*, *Germanomys* cf. *weileri*,

Baranomys cf. *longidens*, *Baranomys kowalskii* and *Trilophomys vandeweerdii*. Further extensive comparisons produced records of two new forms with rooted molars which represent the subfamily Lemminae: *Tobienia kretzoi* and *Lemmini* nov. gen., nov. sp. (Fejfar & Repenning, 1998).

- 3 - *Hajnácka* (south Slovakia). Remains of large mammals were known since about 1850; in 1957-1961 extensive material was collected by the Geological Survey of Czechoslovakia in a fill of a maar-like crater. The layers of volcanic ashes and limnic/paludal tuffites were washed on a large scale to obtain micromammals. Since 1995, new research is being done in the volcanics of Hajnácka by M. Sabol of the University of Bratislava, Slovakia. The following taxa of rodents were identified: *Mimomys hassiacus*, *Mimomys stehlini*, *Germanomys* cf. *weileri* and *Baranomys* sp. (Fejfar, 1964; Fejfar & Heinrich, 1983; 1985).
- 4 - *Uryv 1* (Don river, Russia). From fluvial sands on the right bank of the river Don south of Voronezh, Russia, Agadzhanyan (1976) reports: *Propliomys* aff. *ucrainicus*, *Mimomys* cf. *hassiacus*, *Mimomys stehlini*, *Villanyia veterior*.
- 5 - *Arondelli-Triversa* (Italy). From the productive level in the quarry of Arondelli, a site along the river Triversa in Piedmont (Michaux, 1970) were collected the arvicolids described in this paper, *Mimomys hassiacus*, *Mimomys stehlini*, and *Germanomys* cf. *weileri*.
- 6 - *Arcille* (Italy). Remains of *Mimomys hassiacus* were found in the peaty clays near Grosseto, in southern Tuscany. The fossiliferous layers (early Villanyian, MN 16a) belong to the youngest level of the faunal succession of the Neogene basin of Baccinello (Hürzeler & Engesser, 1976; Engesser, 1989; Masini & Torre, 1990).
- 7 - *Les Étouaires* (France). The arvicolids from the consolidated tuffites of this Villafranchian locality of Auvergne are kept in the Naturhistorisches Museum of Basel: *Mimomys polonicus*, *Mimomys stehlini* (Fejfar et al., 1998).
- 8 - *Hambach* (Lower Rhine Basin, Germany). Arvicolids were collected in an open brown coal pit in a channel fill in the upper part of the Reuver clay: *Mimomys* (*Mimomys*) *hassiacus*, *Germanomys weileri* (Mörs et al., 1998).
- 9 - *Frechen* (Lower Rhine Basin, Germany). Arvicolids were found in a open cast lignite mine in the Reuver series (unit 11): *Mimomys hassiacus*, *Germanomys weileri* (van Kolfschoten et al., 1998).

The localities 10 - 13 of Anatolia/Turkey were published by Ünay & Bruijn (1998); the species of arvicolids and their stratigraphical positions in Tables 1 and 2 are my interpretation:

- 10 - *Kadiözü*, massive lacustrine claystones, Çerke basin, North Anatolia: *Mimomys* cf. *hassiacus*;

Localities	MN Zones	<i>Mimomys</i> Species
Tegelen $\square$ Saint Vallier $\square$, Ostramos 3* $\odot$ Catelfranco di Sopra* $\square$ Gundersheim (Heller, part 2) $\star$	MN 17	<i>Mimomys pliocaenicus</i> , <i>Mimomys tigliensis</i> <i>Mimomys ostramosensis</i> * <i>Mimomys pliocaenicus</i> * <i>Mimomys pitymyoides</i> , <i>Mimomys reidi</i> , <i>Mimomys tornensis</i>
Rembielice Królewskie* $\star$ Ostramos 7 $\star$, Les Étouaires $\odot$	MN 16b	<i>Mimomys polonicus</i> *, <i>M. pitymyoides</i> , <i>M. reidi</i> , <i>M. tornensis</i> <i>Mimomys polonicus</i> , <i>Mimomys stehlini</i>
San Giusto* $\square$, Arcille $\square$ Uryv 1 $\square$, Akkulaevo $\square$ Hajnácka $\odot$, Beremend $\star$ Arondelli local fauna ¹⁾ $\square$ Gundersheim*(Heller, part 1) $\star$ Wölfersheim $\square$, Hambach $\square$, Frechen $\square$	MN 16a	<i>Mimomys hassiacus</i> , <i>Mimomys stehlini</i> * <i>Mimomys hassiacus</i> , <i>Mimomys stehlini</i> <i>Mimomys hassiacus</i> , <i>Mimomys stehlini</i> <i>Mimomys hassiacus</i> , <i>Mimomys stehlini</i> <i>Mimomys hassiacus</i> *, <i>Mimomys stehlini</i> <i>Mimomys hassiacus</i> , <i>Mimomys gracilis</i>
Weze $\star$, Csarnóta 2 $\star$, Ivanovce $\star$ Gundersheim («Findl.», Tobien) $\star$	MN 15b	<i>Mimomys gracilis</i> * <i>Mimomys gracilis</i>
Serrat d'en Vacquer $\square$ ²⁾ Ptolemais 3* $\square$ Villalba Alta 1 $\square$, Arquillo 3 $\square$ Villalba Alta Rio 2a*, 2b1-3 $\square$, La Gloria 2 $\square$	MN 15a	<i>Mimomys davakosi</i> <i>Mimomys davakosi</i> * <i>Mimomys davakosi</i> <i>Mimomys vandermeuleni</i> * <i>Mimomys vandermeuleni</i>

Tab. 1 - Occurrence of the species of *Mimomys* in the important late Pliocene sites.

Notes: $\star$ = karstic fillings (caves), $\odot$ = volcanic pyroclastics, $\square$ = limnic/fluviatil/eolic, * = type localities and species. ¹⁾ Type of the Villafranchian mammal age; ²⁾ Type of the Ruscinian mammal age.

- 11 - *Sivricek*, green lacustrine with lignites, Çerke basin, North Anatolia: *Mimomys* cf. *hassiacus*;
- 12 - *Ziyaret*, grey siltstones, Mus Basin, East Anatolia: *Mimomys* cf. *hassiacus*;
- 13 - *Pecekik 0, 1, 2*, grey mudstones with lignites, Pasinler Basin, North-east Anatolia: *Mimomys* cf. *ostramosensis*, *Borsodia* cf. *petenyi*, *Clethrionomys* sp.

THE INTERVAL OF THE VILLANYIAN LAND MAMMAL AGE

The concept of the Villanyian land mammal age is based on a sequence of large and small mammals collected from karst infillings near Villány, southern Hungary. The type locality for the concept is the locality Villány-3 (Kretzoi, 1941, 1956; Fejfar & Heinrich, 1983). The concept of the Villafranchian land mammal age is based on the well-established record of large and small mammals collected from stratified fluvio-limnic deposits near Villafranca d'Asti in the Piedmont Province of north Italy (Pareto, 1865). Both Villanyian and Villafranchian have been utilized as biochronologic units for the late Pliocene, and both are applicable to large and small mammal evolution. At the present time there is no conceivable means to distinguish difference or equivalence in the earliest or la-

test limits of either Villanyian or Villafranchian. In general, the Villanyian land mammal age has been applied more widely in eastern Europe whereas Villafranchian has been applied more widely in western Europe. Azzaroli (1977) recognized six faunal phases/divisions of Villafranchian: Triversa, Montopoli, Saint Vallier, Olivola, Tasso and Farneta. The first one, the «Triversa fauna» (= Arondelli local fauna), became the Type of the Villafranchian land mammal age. The first three phases (Triversa, Montopoli and Saint Vallier) belong to the late Pliocene, the last three (Olivola, Tasso and Farneta) are in the early Pleistocene.

On the basis of the arvicolid succession (Kretzoi, 1956; Fejfar & Heinrich, 1983) we can state that:

- (a) the six "stages" of the Villafranchian identified by Azzaroli (1977) and followed by most other workers in central Europe approximate, more or less, the combined intervals of the mammal stages Villanyian and Biharian; this does not mean, however, that they should be considered strictly identical or equivalent; and
- (b) most probably, the Villanyian interval closely approximates the early and middle Villafranchian (i.e., up to the Wolf event of Azzaroli, 1983), whereas the Biharian interval approximates the late Villafranchian (i.e., the Tasso and Farneta faunal units of Azzaroli, 1977).

Land Mammal Ages	Rodent Superzones	MN Zones	Arvicolids	Localities
VILLANYIAN	<i>Borsodia Villanyia</i>	MN 17	<i>Borsodia</i> , <i>Lagurodon</i> <i>Villanyia exilis</i> , <i>Ungaromys</i> <i>Mimomys pliocaenicus</i> <i>Mimomys pitymyoides</i> , <i>M. reidi</i> , <i>M. tornensis</i> , <i>M. hordijki</i> , <i>M. tigliensis</i>	Plešivec, Kolinany 1,2, Tegelen, Gundersheim (HELLER 2), Schernfeld, Castelfranco di Sopra Schambach, Deinsdorf Saint Vallier, Senèze
		MN16b	<i>Ungaromys</i> , <i>Villanyia veterior</i> <i>Mimomys polonicus</i> <i>Mimomys pitymyoides</i> , <i>M. reidi</i> , <i>M. tornensis</i> , <i>Borsodia hungarica</i>	Rembielice Królewskie Livencovka 4, Uryv 2, Havutculu Novaya Etulia 2, Pekecik-1 Chagny 2, Les Étouaires, Ostramos 7
		MN16a	<i>Germanomys</i> , <i>Borsodia</i> <i>Ungaromys</i> , <i>Villanyia</i> <i>M.hassiacus</i> + <i>M.stehlini</i> <i>Propliomys ucrainicus</i> <i>Dolomys nehringi</i> <i>M.hassiacus</i> + <i>M.gracilis</i>	Uryv 1, Akkulaevo, Livencovka 5, Kotlovina, Kryzhanovka, Sivrice San Giusto, Arcille, Viale, Seynes Hajnácka, Beremend 1-3, 5; Barault C. Arondelli l.f., Tourkobounia 1, Moreda Wölferheim, Hambach, Frechen Gundersheim (HELLER 1, Findling) Kadiözü, Ziyaret, Yenice-1
RUSCINIAN	<i>Trilophomys Ruscinomys</i>	MN15b	<i>Mimomys gracilis</i> <i>Propliomys hungaricus</i> <i>Dolomys milleri</i>	Ivanovce A, Weze, Gundersheim (TOBIEN) Malusteni, Beresti Csarnóta 2, Ostramos 9, 13 Ortalica, Sürsürü,
		MN15a	<i>Germanomys helleri</i> <i>Mimomys vandermeuleni</i> , <i>M. davakosi</i> , <i>Dolomys occitanus</i>	Escorihuela A, Ptolemais 3, Sète Serrat d'en Vacquer, Çalta Villalba Alta Rio (VAR*), La Gloria 2 Tozaklar, Zirnak, Tasova
		MN14b	<i>Promimomys cor</i>	Ptolemais 1, Kardina, Vendargues, Terrats, Gloria 4, Celadas 9,12, Grebeniki, Musait, Budei, Hacısam
		MN14a	<i>Promimomys insuliferus</i>	Podlesice, Antipovka, Chugunovka, Novaya Andriashevka, Asagi Page

Tab. 2 - Stratigraphical position of the sites related to the Arondelli local fauna.

SUMMARY

Among the new stratified sites mentioned here, the following localities are very important for the correlation of the Arondelli local fauna:

- 1 - Wölferheim: marl with sandy lenses underlying the lignite seam,
- 2 - Hambach fauna in the Reuver clay associated with lignites/brown coal,
- 3 - Uryv 1: the Russian locality in the Late Pliocene deposits of the river Ob: fluvial sands below a lignite seam,
- 4 - Kadiözü, Ziyaret, Sivrice: the new sites in the Pliocene of Turkey/Anatolia.

All sites mentioned are associated with lignites, and contain the same slightly progressive large species

Mimomys hassiacus, often together with the smaller form *Mimomys stehlini*, and displaying for the first time cementum in the synclines, with moderately undulated crown base and with differentiated Schmelzmuster of the enamel. *Mimomys stehlini* is here considered to be a descendant of *Mimomys gracilis*; as proven by the Russian site Uryv 1, the larger *Mimomys hassiacus* is most probably an immigrant from the east. Also, the polymorphous character of the smaller *Mimomys* mentioned from this site by Agadzhanyan (1976) indicates the much brighter composition of the future MN 17 arvicolid faunas. The arvicolid level of Hambach in the normally polarized Reuver Clay supports Scenario 1 of Lindsay *et al.* (1997); namely, that the «Arondelli fauna should occur in or close to the base of the Gauss magnetic

chron». The evidence of the Russian Uryv 1 fauna and the Anatolian sites with occurrence of *Mimomys hassiacus* documents the wide geographic distribution of this index species, indicating the start of the Villafranchian and Villanyian mammal stages.

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