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# Biochronology of the Pleistocene deposits at Betfia (Bihor, Romania)

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Abstract. The author presents the chronological succession of the mammalian assemblages of six Pleistocene deposits discovered during the last three decades in the karst of Betfia (Bihor, Romania). This succession, covering the entire Biharian (Eburonian to middle of the Cromerian Complex), is based on the composition of mammal associations, on the evolutionary level of the representatives of some arvicolid lineages found in all sites and sometimes on stratigraphical superposition (B-VII). A list of mammal species identified in each site is given and a biochronological sketch is drawn up, pointing out the position of the Betfia faunal sequence in the Pleistocene framework.

Key-words: Biochronology, Pleistocene, karst deposits, Mammalia, Biharian, Betfia, Romania.

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## I. INTRODUCTION

On the southern slope of Somleu Hill, near the village of Betfia (county Bihor), six fossiliferous deposits were discovered between 1966 and 1991. These deposits are fillings of former caves or karstic fissures. Systematic excavations at these sites carried out by the Bucharest Speleological Institute together with the "Tarii Crisurilor" Museum of Oradea brought to light rich vertebrate faunas, in which the rodents are abundant and diversified.

Analysis of the global composition of the mammalian assemblages identified in each site and the determination of the evolutionary level of the representatives of some arvicolid lineages found in all these deposits have enabled us to establish a biochronological succession covering the whole Biharian (Eburonian to middle of the Cromerian Complex; Early Pleistocene to early Middle Pleistocene). Our investigations have therefore considerably widened the chronological framework known from the works published by KORMOS and KRETZOI on the karst deposits of Somleu Hill and have enriched the list of local faunas with numerous mammal species.

In order to identify the extinction phases of the archaic species and the renewal of the fauna through the evolution of autochthonous forms or through migration of allochthonous taxa, some of which are excellent ecological and climatic markers, we outlined the evolution of the local fauna and climate during the whole interval of deposition, which is about one million years.

## II. FOSSILIFEROUS SITES AND CHRONOLOGICAL SUCCESSION OF MAMMAL FAUNAS

The oldest deposit of this region, Betfia-XIII, is a calcareous, slightly cemented breccia with terra-rossa, accumulated in a karstic fissure. It has yielded a rich and varied mammal fauna including chronological markers such as *Mimomys pliocaenicus*, *Lagurus arankae* and *Microtus* (*A.*) *pliocaenicus deucalion*, as well as a number of relict forms, of which we may mention *Prospalax priscus*, *Villanyia exilis*, *Mimomys tornensis*, *M. pitymyoides*, *Ungaromys* and a derived species of *Borsodia*, *B. newtoni*, which develops roots at a very late ontogenetic stage (TERZEA 1973, 1978). Among the large mammals we may mention *Ursus etruscus*, *Canis* cf. *falconeri* and a small sized stenonid horse, attributed to *Equus stenonis senezensis*. (Tables I, II; TERZEA & JURCSÁK 1976).

With regard to the arhizodont arvicolids it is worth noting that *Microtus* (*A.*) *pliocaenicus* in most cases has an undifferentiated enamel band on the anterior and posterior sides of the triangles, though it is sometimes differentiated as in the genus *Mimomys*, while *Lagurus arankae* presents a very primitive dental structure, as shown by the almost constant absence of the "protoconulus" on the upper molars, the large confluence of the distal constitutive elements of $M^3$ and the differentiation in some molars of a basal enamel thickening that reflects the tendency to limitation of crown growth; this limitation is not complete because under this "cingulum" the crown goes on growing, much narrowed and with the enamel cover thinned.

The abundance of *Mimomys* species, which constitute up to 50% of the arvicolid specimens, the persistence of *Mimomys pliocaenicus* and *Borsodia newtoni* and the appearance of the two primitive species of arhizodont arvicolids make it possible to place this fauna at the beginning of the Biharian (Early Pleistocene; Eburonian). The large number of Villanyian survivors justifies such a dating.

It should be pointed out that the B-XIII fauna, which contains some thermophilous forms, such as *Macaca sylvana* cf. *florentina* and a species of flying squirrel, and where the Gliridae, Castoridae and Muridae reach significant frequencies, is subsequent to the first Eburonian cooling, and probably corresponds to a warming phase in the middle of this glacial complex (TERZEA 1984).

In the succession of Plio-Pleistocene faunas in Romania, B-XIII can be situated at a chronological level close to that of the mammalian assemblages of Draganesti-Olt and Izvoru 2 (FERU et al. 1979; RADULESCU & SAMSON 1986). In these localities some forms identical with those of B-XIII have been reported, as well as species of *Mimomys* with a similar degree of evolution. However, the absence of arhizodont arvicolids could point to a somewhat older age for the faunas of these localities.

In a European context, the B-XIII fauna is similar to that of Villány 5. Judging by the absence of Gliridae, the relatively high frequency of *Spermophilus primigenius* and the flourishing of *Allocricetus ehiki*, the V-5 fauna seems to belong to a cooler and more arid phase (KRETZOI 1956). The evolutionary stage of *Microtus pliocaenicus* [$M_1$: Index A/L = 40.3 at B-XIII (N = 73) and 39.9 at V-5 (N = 16; VAN DER MEULEN 1974)] suggests that this phase immediately precedes the interval represented by the B-XIII fauna.

The faunas of Mokrá 1 (FEJFAR & HORÁČEK 1983) and Kadzielnia (KOWALSKI & NADACHOWSKI 1990), in Central Europe, and probably that of Tiligul (REKOVETS, personal communication 1994), a locality situated on the northern coast of the Black Sea, are all of a similar age to B-XIII.

Of a more recent date is the deposit of Betfia-X, accumulated in a small, entirely silted cave near the village of Betfia, opened by quarrying for Cretaceous limestone. It yielded a fauna with *Microtus p. pliocaenicus* and *Lagurus arankae*, which shows a significant turnover relative to B-XIII. Here, most of the relict species are absent, except for *Ungaromys* cf. *nanus* and *Mimomys tornensis*.

# BIOCHRONOLOGY OF THE PLEISTOCENE DEPOSITS AT BETFIA (BIHOR, ROMANIA)

TABLE 1

| Stratigraphical subdivisions | Chronologic Scale/M.Y. | Palaeomagnetic Scale | Chronology in Netherlands | Central and Western Europe (Fejfar & Heinrich 1990) | Sites in Bihor County | Faunal succession at Betfia | | | | Correlations | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Evolution of the main arvicolid lineages | Chronologic markers | Prevailing species and other significant forms | Climatic markers | Mammal ages in C.I.S. (Nikiforova & al. 1991) | Central and Western Europe |
| QUATERNARY | | | | | | | | | | | |
| LOWER PLEISTOCENE | | | | | | | | | | | |
| EBURONIAN | | WAALIAN | MENAPIAN | BAVELIAN | CROMERIAN | | | | | | |
| BIHARIAN | | | | | | | | | | | |
| 1. Mimomys pusillus - Mimomys savini | 0,7 | | | 2. Mimomys savini | Betfia-XIII | Mimomys pliocaenicus | Lagurus transiens<br>Mimomys savini | Cricetus cricetus<br>Clethrionomys glareolus | Ochotona pusilla<br>Spermophilus primigenius<br>Microtus (S) gregaloides | ODESSIAN | Kozi Grzbiet |
| | 0,9 | | | | Chiscău-1 | Mimomys reidi-pusillus | | Clethrionomys glareolus<br>Mimomys savini | Apodemus sylvaticus<br>Praealces latifrons | TIRASPOLIAN | Süssenborn<br>Voigtstedt<br>West Runton |
| | | | | | Subpiatră | Mimomys pusillus pusillus | Microtus agrestis<br>Ursus deningeri<br>Mammuthus cf. trogontherii | Microtus (S) gregaloides<br>Mimomys savini<br>Bison schoetensacki | Lemmus aff. lemmus<br>Marmota cf. marmota | Kolkotova balka | |
| | | | | | B-X<br>B-IX<br>B-V | Mimomys tornensis | | | | Platovo | 0,7 |
| | | | | | B-XI | Ungaromys sp. - U. cf. nanus | | Pliomys episcopalis<br>Clethrionomys gr. glareolus | Apodemus mystacinus<br>Muscardinus dacicus | ?Shamin | ? Villány 6 |
| | | | | | Betfia - VII | Borsodia cf. newtoni - Prolagurus praepannonicus - P. pannonicus | Mimomys pusillus | | | Petropavlovka | |
| | | | | | B-VII/1<br>B-VII/2<br>B-VII/3<br>B-VII/4 | Lagurus arankae - Lagurus transylvanicus - L. transyl.-transiens - L. transiens | Microtus (S.) gregaloides<br>Microtus ratticepoides<br>Microtus nivaloides | Clethrionomys gr. glareolus<br>Lagurus transylvanicus | Lemmus aff. lemmus | | ?Villány 8/9-11 |
| | | | | | Mimomys pusillus blanci | | Microtus (T.) arvalidens<br>Microtus (Ch.) nivalinus | Lagurus transylvanicus<br>Crocidura sp. | Apodemus mystacinus<br>Hystrix sp. | ? | Villány 8/VII<br>Vallonnet |
| | | | | | Mimomys savini | | Microtus h. hintoni<br>Lagurus transylvanicus | Prolagurus pannonicus<br>Canis mosbachensis<br>Gulo schlosseri<br>Homotherium moravicum | | | 1 |
| | | | | | | | | | | TAMANIAN | Holstejn<br>Valerots 2 |
| | | | | | | | Ungaromys nanus<br>Microtus pliocaenicus evolved<br>Prolagurus p. praepannonicus | Glis sackdillingensis<br>Megantereon sp.<br>Canis sp. (? mosbachensis) | Macaca sp.<br>Petauristinae | Morozovka | |
| | | | | | | | Prolagurus praep. primaeus | | Lemmus aff. lemmus | Nogaisk | Mas Rambault<br>Zabia Cave |
| | | | | | | | Microtus p. pliocaenicus | Lagurus arankae<br>Glis sackdillingensis<br>Spalax sp.<br>Apodemus gr. sylvaticus | Glirulus pusillus | ? | |
| | 1,4 | | | | | | | | | Jevakhova | 1,4 |
| | | | | | | | Trogontherium b. boisvilletti<br>Microtus p. deucalion<br>Lagurus arankae<br>Mimomys pliocaenicus | Mimomys reidi-pusillus<br>Mimomys pityomyoides<br>Villanyia exilis<br>Prospalax priscus<br>Canis cf. falconeri<br>Equus stenonis senezensis | Macaca s. florentina<br>Petauristinae | Boshentsa | Kamyk ?Brielle 57-58m |
| | | | | | | | | | | ? Tizdar 1 | |
| | | | | | | | | | | ? Tiligul | Mokra 1<br>Villány 5 |
| | 1,65 | | | | | | | | | | Kadzielnia 1,65 |

Table II

Early Biharian mammal faunas of Betfia

| Taxa \ Localities | B-XIII | B-X | B-XI | B-IX | B-VII/1a | B-VII/1b-e |
|---|---|---|---|---|---|---|
| Chiroptera gen et sp. indet. | ● | ● | ● | ● | ● | ● |
| *Talpa fossilis* PETÉNYI | | sp. | ● | cf. | | ● |
| *Talpa minor* FREUDENBERG | sp. | ● | | | | |
| *Desmana thermalis* KORMOS | ● | | | sp. | | |
| *Erinaceus samsonowiczi* SULIMSKI | cf. | | | | | |
| *Erinaceus* sp. | | | | | | ● |
| *Sorex* gr. *minutus* | ● | | ● | | ● | ● |
| *Sorex praearaneus* KORMOS | | | ? | ● | | |
| *Sorex margaritodon* KORMOS | ● | ● | ● | | | ● |
| *Episoriculus gibberodon* (PETÉNYI) | | ● | ● | | | |
| *Petenyia hungarica* KORMOS | ● | ● | ● | ● | | ● |
| *Beremendia fissidens* (PETÉNYI) | ● | ● | ● | ● | ● | ● |
| *Crocidura kornfeldi* KORMOS | | | | ● | | |
| *Crocidura* sp. | ● | ● | ● | ● | | ● |
| *Macaca sylvana* cf. *florentina* COCCHI | ● | | | ● | | |
| *Prospalax priscus* (NEHRING) | ● | | | | | |
| *Spalax* sp. | | ● | ● | ● | | ● |
| *Sciurus* sp. | ● | ● | ● | | | ● |
| Petauristinae ind. | ● | | | | | ● |
| *Spermophilus primigenius* (KORMOS) | ● | ● | ● | ● | ● | sp. |
| *Marmota* sp. | | | | | ● | ● |
| *Trogontherium b. boisvilletti* LAUGEL | ● | | | | | |
| *Castor* sp. | ● | | | | | |
| *Glis* cf. *minor* KOWALSKI | ● | | | | | |
| *Glis sackdillingensis* (HELLER) | | ● | ● | | ● | ● |
| *Muscardinus dacicus* KORMOS | ● | ● | ● | sp. | | ● |
| *Glirulus pusillus* (HELLER) | | ● | | | | |
| *Eliomys* sp. | ● | | ? | | | ● |
| *Sicista praeloriger* KORMOS | sp. | | ● | sp. | ● | ● |
| *Sminthozapus betfianus* TERZEA | ● | | | | | |
| *Apodemus* gr. *sylvaticus* | ● | ● | ● | sp. | sp. | ● |
| *Parapodemus betfiensis* TERZEA | ● | | | | | |
| *Micromys* sp. | ● | | | | | ? |
| *Epimeriones dacicus* TERZEA | ● | | | | | |
| *Allocricetus bursae* SCHAUB | ● | ● | ● | | | ● |
| *Cricetus cricetus nanus* SCHAUB | | ● | ● | ● | | |
| *Cricetus cricetus praeglacialis* SCHAUB | | | ● | ● | ● | ● |
| *Villanyia exilis* KRETZOI | ● | | | | | |
| *Villanyia paraexilis* TERZEA | ● | | | | | |
| Ungaromys cf. *nanus* KORMOS | sp. | ● | ● | | ● | ● |
| *Mimomys pliocaenicus* MAJOR | ● | | | | | |
| *Mimomys pitymyoides* JÁNOSSY & MEULEN | ● | | | | | |
| *Mimomys* cf. *reidi* HINTON | ● | | | | | |
| *Mimomys pusillus* (MÉHELY) | ● | ● | ● | ● | ● | ● |

Table II ctd.

| Taxa \ Localities | B-XIII | B-X | B-XI | B-IX | B-VII/1a | B-VII/1b-e |
|---|---|---|---|---|---|---|
| *Mimomys tornensis* JÁNOSSY & MEULEN | ● | ● | | ● | ? | ● |
| *Clethrionomys* gr. *glareolus* | | | ● | | | ● |
| *Clethrionomys* sp. | ● | | ● | ● | ● | ● |
| *Pliomys episcopalis* MÉHELY | ● | ● | ● | ● | ● | ● |
| *Pliomys lenki* HELLER | | | ● | | | ● |
| *Borsodia newtoni* (MAJOR) | ● | | | | | |
| *Lagurus arankae* KRETZOI | ● | ● | ● | ● | ● | ● |
| *Prolagurus praepannonicus* TOPACHEVSKI | | | ● | ● | ● | ● |
| *Microtus (A.) pliocaenicus deucalion* KRETZOI | ● | | | | | |
| *Microtus (A.) p. pliocaenicus* (KORMOS) | | ● | ● | ● | ● | ● |
| *Lemmus* aff. *lemmus* LINNAEUS | | | | | ● | |
| *Canis* cf. *falconeri* MAJOR | ● | | | | | |
| *Canis* sp. (?*mosbachensis* SOERGEL) | | | | ● | | ● |
| *Mustela praenivalis* KORMOS | | ? | | ● | ● | ● |
| *Mustela palerminea* (PETÉNYI) | ● | | | ● | | ● |
| *Pannonictis pliocaenica* KORMOS | ● | | | | | |
| *Gulo schlosseri* KORMOS | | | | | ● | ● |
| *Felis (L.)* ? *issiodorensis* CROIZ. & JOB. | | | | | | ● |
| *Panthera* sp. | ● | | | | | ● |
| *Megantereon* sp. | | | | | | ● |
| *Ursus etruscus* CUVIER | ● | | | | | ● |
| *Hypolagus brachygnathus* KORMOS | ● | ● | ● | ● | ● | ● |
| *Lepus* sp. | | ● | ● | | | ● |
| *Ochotona* sp. | ● | | ● | ● | ● | ● |
| *Equus stenonis* cf. *senezensis* PRAT | ● | | | | | *Equus* sp. |
| Cervidae ind. | ● | | | | | ● |

The genus *Prospalax* is replaced by *Spalax*, *Glis minor* by *G. sackdillingensis* and the first occurrence of *Cricetus cricetus nanus* is recorded (TERZEA & JURCSÁK 1968). The genus *Mimomys,* abundant at B-XIII, notably diminishes in frequency and diversity. In contrast, the arhizodont arvicolids are prevalent in the fauna and show a somewhat higher degree of evolution than their counterparts in B-XIII. *Lagurus arankae* has a wide "*Lagurus*-Falte" with a small central anticlinal in more than 50% of the upper cheek teeth, and *Microtus pliocaenicus* already displays a *Microtus*-type of differentiation of the enamel thickness.

Considering these important changes in faunal composition, relative to the fauna of B-XIII, and the primitive and homogeneous morphology of *Microtus pliocaenicus*, we have attributed the mammalian assemblage of B-X to a phase that might be situated in the lower half of the Waalian. The abundance of Muridae and the occurrence of *Glirulus pusillus* are in any case evidence of a temperate phase.

The deposit of Betfia-XI, a clay of terra-rossa type, the filling of a karstic fissure, seems to be of about the same age. Here, a mammalian association resembling in its composition that of B-X has been reported. It differs, however, in the appearance of a new lineage of lagurines, represented by *Prolagurus praepannonicus primaeus,* and by the presence of *Pliomys lenki. Microtus pliocaenicus*, the most abundant species in this fauna, has a wider spectrum of morphotypes and the population of *Lagurus arankae* contains rare specimens with a progressive structure. These

differences in the composition and degree of evolution make it possible to attribute the fauna of B-XI to a phase subsequent to that represented by the fauna of B-X, a phase that could correspond to the final part of the early Waalian and the beginning of the middle Waalian.

The most extensive stratigraphic profile in this karstic region is that of Betfia-VII. It has a height of 8m, and encompasses four complexes of layers. The first three of these represent the filling of a former cave, containing numerous fragments of speleothemes, and the last is made up of loess-like deposits, accumulated in subaerial conditions.

The basal complex (B-VII/1) yielded mammal faunas with evolved *Microtus pliocaenicus* and *Mimomys p. pusillus*. Some species of Villanyian origin, such as *Mimomys tornensis, Ungaromys nanus* and *Megantereon* sp., are reported for the last time in this complex. The lagurines are represented by *Prolagurus p. praepannonicus*, which reaches a remarkable development and by *Lagurus arankae*, which becomes less frequent. Both species are characterized by marked variability and by high percentages of progressive morphotypes. A significant feature of these faunas is the occurrence of some thermophilous forms (Petauristinae) and the abundance of *Glis sackdillingensis*, which becomes the most common species.

In the basal stratum of this sequence, which contains some cracked stones, the first occurrence of *Lemmus* aff. *lemmus* and *Gulo schlosseri* in our area has been reported (TERZEA 1993).

Taking into account, on the one hand the progressive dental structure of *Microtus pliocaenicus* and *Prolagurus praepannonicus*, and on the other the high frequency of Glirids and the emergence of some thermophilous species, we have ascribed the middle and upper parts of this sequence of strata to an interval with a milder climate, corresponding to the late Waalian. The basal stratum, with remains of *Lemmus*, can be referred to a cooling phase, probably contemporaneous with the middle Waalian.

The fauna of Betfia-IX (a fissure-filling breccia with terra-rossa) has a similar composition, and we refer it to a milder phase of the late Waalian. This contains, among the most significant forms, *Macaca* sp., evolved *Microtus pliocaenicus* and *Prolagurus praepannonicus*, *Lagurus arankae* and *Mimomys p. pusillus* (TERZEA 1988).

The second complex of layers of B-VII, formed from an alternation of stalagmitic crusts and clayey-sandy deposits, for which we do not have any cogent paleontological documentation, has been attributed by us, on the basis of stratigraphic superposition, to an interval equivalent to the Menapian.

We must point out, however, that this gap in the documentation is filled by data from the deposit of B-V, which has been investigated by KORMOS, KRETZOI and TERZEA & JURCSÁK. Here, a rich fauna was found characterized by a marked turnover, due both to the presence of immigrants among the large mammals and to accelerating evolutionary changes in the different lineages of rodents (Table III; KORMOS 1914a, b; KRETZOI 1941, 1965; TERZEA & JURCSÁK 1968). It includes the index taxa *Microtus hintoni* and *M. burgondiae*, which arose through cladogenesis from *M. pliocaenicus*, and *Lagurus transylvanicus*, differentiated through gradual evolution from *L. arankae*. The genus *Mimomys* is represented by *M. savini*, the first occurrence of this species in Romania, and by a more evolved subspecies of *M. pusillus*, *M. p. blanci*.

The high frequency of Leporidae, Cricetidae and lagurines, the prevalence of the genus *Microtus* and the scarcity of forest species, lead us to assign this fauna to a dry phase. The evolutionary level of the arvicolids allows us to place it in the late Menapian, slightly before the interval represented by the Chiscau-1 fauna. At the European level, the deposit of B-V seems to be of a somewhat more recent date than that from Valerots-2 (CHALINE et al. 1985) and contemporary with that from Holštejn (MUSIL 1966).

Deposit B-VII/3, formed from three layers of clay with speleothemes, supplied faunas with *Mimomys pusillus* and *M. savini*, in which the rapid diversification of the genus *Microtus* is to be

Table III

Middle and Upper Biharian mammal faunas of Betfia

| Taxa \ Localities | B-V | B-VII/3 | | | B-VII/4 | | |
|---|---|---|---|---|---|---|---|
| | | a | b | c | a | b | c |
| Chiroptera gen. et sp. indet. | ● | ● | ● | ● | | | |
| *Talpa fossilis* PETÉNYI | | ● | | ● | | | |
| *Desmana* sp. | | ● | | | | | |
| *Sorex runtonensis* HINTON | | ● | | ● | | | |
| *Sorex* gr. *minutus* | | ● | | ● | ● | | |
| *Sorex margaritodon* KORMOS | ● | | | ● | | | |
| *Beremendia fissidens* PETÉNYI | ● | ● | ● | ● | ● | | |
| *Crocidura* sp. | | I,II | | ● | | | |
| *Spalax* sp. | ● | | ● | ● | ● | | ● |
| *Sciurus* sp. | ● | | | ● | | | |
| *Spermophilus primigenius* KORMOS | ● | ● | | ● | ● | ● | ● |
| *Marmota* cf. *marmota* LINNAEUS | | | | | ● | | |
| *Hystrix* sp. | | ● | | | | | |
| *Glis sackdillingensis* (HELLER) | | ● | | ● | | | |
| *Muscardinus dacicus* KORMOS | | | | ● | | | |
| *Dryomys* s. *Eliomys* | | ● | | | | | |
| *Sicista praeloriger* KORMOS | ● | ● | | ● | ● | | |
| *Apodemus* gr. *sylvaticus* | ● | ● | ● | ● | ● | ● | ? |
| *Apodemus mystacinus* (DANFORD & ALSTON) | | ● | | ● | | | |
| *Allocricetus bursae* SCHAUB | ● | ● | ● | ● | ● | ● | ● |
| *Cricetus cricetus praeglacialis* SCHAUB | ● | ● | ● | ● | ● | ● | ● |
| *Mimomys pusillus* (MÉHELY) | ● | ● | ● | ● | | | |
| *Mimomys savini* HINTON | ● | ● | ● | ● | ● | ● | ● |
| *Clethrionomys* gr. *glareolus* | ● | ● | ● | ● | ● | ● | ● |
| *Pliomys episcopalis* MÉHELY | ● | ● | ● | ● | ● | ● | sp. |
| *Pliomys lenki* (HELLER) | ● | ● | | ● | ● | | |
| *Lagurus transylvanicus* TERZEA | ● | ● | ● | ● | sp. | sp. | |
| *Lagurus transiens* JÁNOSSY | | | | | | | ● |
| *Prolagurus pannonicus* KORMOS | ● | ● | | | | | |
| *Microtus hintoni* (KRETZOI) | ● | | | | | | |
| *Microtus burgondiae* CHALINE | ● | | | | | | |
| *Microtus* (*Terricola*) *arvalidens* (KRETZOI) | | ● | ● | ● | ● | ● | |
| *Microtus* (*Stenocranius*) *gregaloides* HINTON | | | ● | ● | ● | | ● |
| *Microtus* (*Chionomys*) *nivalinus* HINTON | | ● | ● | ● | ● | | ● |
| *Microtus* (*M.*) *nivaloides* MAJOR (*M. arvalinus* HINTON) | | | ● | ● | ● | ● | ● |
| *Microtus* (*M.*) *ratticepoides* HINTON | | | ● | ● | ● | | |
| *Microtus* (*M.*) *agrestis* LINNAEUS | | | | | ● | | ? |
| *Lemmus* aff. *lemmus* LINNAEUS | | | ● | | ● | | |
| *Canis mosbachensis* SOERGEL | ● | ● | | ● | ● | | |
| *Cynalopex praecorsac* (KORMOS) | ● | | | | | | |
| *Vulpes* (s. l.) sp. | ● | ● | | ● | ● | | |
| *Mustela praenivalis* KORMOS | | ● | | ● | | | |
| *Mustela palerminea* (PETÉNYI) | ● | ● | | ● | sp. | | |
| *Putorius* cf. *stromeri* KORMOS | ● | | | | | | |

Table III ctd.

Middle and Upper Biharian mammal faunas of Betfia

| Taxa \ Localities | B-V | B-VII/3 | | | B-VII/4 | | |
|---|---|---|---|---|---|---|---|
| | | a | b | c | a | b | c |
| *Martes vetus* KRETZOI | ● | | | | | | |
| *Gulo schlosseri* KORMOS | ● | | ● | | ● | | |
| *Meles meles atavus* KORMOS | ● | | | | | | |
| *Felis* sp. | ● | | | | | | |
| *Felis* (*Lynx*) cf. *issiodorensis* CROIZ. & JOB. | ● | | | | | | |
| *Homotherium moravicum* WOLDRICH | ● | | | | | | |
| ? *Crocuta* sp. | ● | | | ● | ● | | |
| *Ursus mediterraneus* MAJOR | ● | | | | | | |
| *Ursus gombaszögensis* KRETZOI | ● | | | | | | |
| *Ursus* cf. *deningeri* REICHENAU | | | | | ● | | sp. |
| *Hypolagus brachygnathus* KORMOS | ● | ● | | | | | |
| *Lepus* sp. | ● | ● | ● | ● | ● | ? | ● |
| *Ochotona* sp. | ● | | ● | | ● | | ● |
| *Dicerorhinus etruscus* ssp. | ● | ● | | ● | | | |
| *Equus* sp. (? *mosbachensis* REICHENAU) | ● | | | | ● | | |
| *Capreolus süssenbornensis* KAHLKE | ● | | | | | | |
| *Praealces latifrons* (JOHNSON) | ● | | ? | ● | ● | ● | |
| *Praemegaceros* sp. | ● | | | ● | ? | | ? |
| Cervidae ind. | | ● | | | | | |
| *Bison schoetensacki* FREUDENBERG | ● | | | ● | ● | | |
| Bovidae ind. | | | | ● | | | |
| *Mammuthus* cf. *meridionalis* NESTI | | ● | | | | | |
| *Mammuthus* cf. *trogontherii* POHLIG | | | | | ● | | |

seen in parallel with the gradual decline of the lagurines. The oldest of them (B-VII/3a), consists of 35 species, among which *Lagurus transylvanicus* is dominant. It is noteworthy for the high frequency of *Microtus* (*Terricola*) *arvalidens*, represented by a primitive form (with some allophaiomyian and *praearvalidens* morphotypes), the extreme scarcity of *Microtus nivalinus*, the low frequency of sylvan species and the emergence of two Mediterranean immigrants: *Apodemus mystacinus* and *Hystrix* sp. (TERZEA 1992). In its composition it evokes a steppe environment with isolated enclaves of forest in a warm and dry climate of Mediterranean aspect. On the basis of the evolutionary level of the arvicolids, it can be placed immediately after the mammalian assemblages of B-V and Chiscau-1. The subsequent fauna (B-VII/3b) is characterised by the decreasing frequency of lagurines, the disappearance of thermophilous species and the occurrence of *Lemmus* aff. *lemmus*. This fauna indicates a phase of climatic deterioration, a fact also suggested by the presence of *Microtus (Stenocranius) gregaloides* and *M. ratticepoides*, the first occurrences of these species in our area. The last fauna (B-VII/3c), distinguished by a marked diversity and by an abundance of forest species, among which *Pliomys episcopalis* and *Clethrionomys* gr. *glareolus* attain the highest frequencies, belongs to a temperate phase with some continental features.

The persistence of *Mimomys pusillus* and the primitive and variable dental structure of the *Microtus* populations identified in the successive strata allow the placement of this sequence in a chronological interval prior to the Cromerian stage, and therefore in the Bavelian (ZAGWIJN 1985). We correlate these two mild climatic fluctuations with the Bavel Interglacial and, respectively, with Leerdam, and the cool and wet interval, which is interposed between them, with the Linge

Glacial. In KRETZOI's (1962) biozonation, B-VII/3 may correspond to the Nagyharsányhegy-Phase.

Deposit B-VII/4, consisting of two layers of loess separated by a fossil soil, yielded typical Cromerian faunas with evolved *Mimomys savini*. The subgenera *Microtus* and *Stenocranius* are well represented and have a tendency towards equal frequencies, and the subgenus *Terricola* is obviously in decline. The Lagurines become ever more scarce, while *Clethrionomys* is still significantly represented. The oldest of these faunas, of a remarkable diversity, is distinguished by the prevalence of the species *Mimomys savini* and *Microtus gregaloides*, the high frequency of *Bison schoetensacki* and the first emergence of *Microtus agrestis*, *Ursus deningeri* and *Mammuthus trogontherii*. At this chronological level the last expansion of the genus *Lemmus* into Romania took place (TERZEA 1972). Of the relatively poor faunas of the two overlying strata, the first is characterised by the predominance of sylvan species, with *Clethrionomys glareolus* being relatively abundant, and the second by the first appearance of *Lagurus transiens* and a large number of open land dwellers.

Taking into account, both the presence of *Mimomys savini* in this sequence of strata, and the fact that its successive populations, although characterized by a marked hypsodonty, do not yet display a tendency to reduction of the molar roots*, we consider it possible to correlate the two loess strata with Glacials A and B of the Cromerian Complex and the intercalated fossil soil with the Cromerian II. In the biochronology of Central Europe the faunal succession at B-VII/4 may be placed in the late Biharian, corresponding to the Templomhegy stage. The evolutionary level of *Mimomys savini* suggests close chronological relationships with the faunas of Voigtstedt and Süssenborn. Arguments based on degree of evolution, especially of the genera *Microtus* and *Lagurus*, also allow the correlation of the B-VII/4 sequence with the Platovian and Kolkotovian (lower part) horizons of the Tiraspolian stage of eastern Europe (NIKIFOROVA & ALEXANDROVA 1991).

## III. CONCLUDING REMARKS

The faunas from the karstic deposits at Betfia form a continuous chronological succession covering the whole Biharian except for the final part. This succession starts with the mammalian assemblage of B-XIII, containing numerous relict species in association with *Microtus* (*A.*) *pliocaenicus deucalion* and *Lagurus arankae*. This fauna goes back as far as the beginning of the Biharian (Early Pleistocene; Eburonian) and represents the "*Microtus pliocaenicus deucalion*-biozone".

The somewhat more recent faunas of B-X, B-XI, B-IX and B-VII/1, characterised by the progressive loss of archaic species and the flourishing of *Microtus p. pliocaenicus* and *Lagurus arankae*, represent successive intervals of the "*Microtus p. pliocaenicus*-biozone" (Betfia-Phase, Zone 1; KRETZOI 1962). From a climatic point of view they correspond to the Waalian and define two temperate – warm phases separated by a cool spell marked by the first immigration of *Lemmus* into this area.

The rich fauna of B-V, characterised by considerable turnover, may be assigned to the "*Microtus hintoni*-biozone". At this chronological level, considered by us equivalent to the late Menapian, *Mimomys savini* occurs for the first time in Romania.

The small faunal suite at B-VII/3, distinguished by the association *Mimomys savini*-evolved *M. pusillus* and corresponding to an alternation of two mild phases separated by a cool interval, is

*In B-VII/4 there are no specimens that show transitional features between *Mimomys* and *Arvicola*, as reported at Kozi Grzbiet (NADACHOWSKI 1990).

attributed to the Nagyharsányhegy Phase. In the pollen chronology of western Europe it may be placed in the Bavelian Stage.

Finally, the faunal sequence of B-VII/4, which ends the biochronological succession in this area, is characterised by the presence of *Mimomys savini* in association with advanced species of *Microtus* (*M. agrestis*) and also by the first occurrence of *Lagurus transiens* and *Mammuthus trogontherii*. It dates from the late Biharian, corresponding to the Templomhegy Stage.

To conclude, we should like to express our agreement with the opinion of FEJFAR & HEINRICH (1990), according to which the Biharian mammal age ends when the last representatives of the genus *Mimomys* disappear. An argument in support of this opinion is the fact that in the reference sites at Betfia, from which the name Biharian is derived, deposits with *Arvicola* were not found.

With reference to the composition of the mammalian assemblages some significant chronological differences are worth mentioning, namely:

The fauna of B-XIII, marking the beginning of the Pleistocene, is dominated by species of *Mimomys*, while at all other sites of Betfia arhizodont arvicolids predominate.

A remarkable feature of the local faunas is the abundance of lagurines, which reach high frequencies throughout the Early Pleistocene except the final part, equalling and sometimes even exceeding *Microtus* in importance. After a final peak at the beginning of the Bavelian (B-VII/3a) this group decreases in frequency and during the Cromerian Stage it becomes quite rare.

Simultaneously with the decline of lagurines a rapid diversification of the genus *Microtus* takes place, as well as a resurgence of rhizodont arvicolids. The latter successively attain peak frequencies by *Clethrionomys* in the middle Bavelian (B-VII/3b), *Pliomys episcopalis* and *Clethrionomys* gr. *glareolus* in the Late Bavelian (B-VII/3c), and *Mimomys savini* at the beginning of the Cromerian stage (B-VII/4a).

To the above remarks it should be also added that the boreal (*Lemmus* aff. *lemmus*) and Mediterranean (*Macaca* sp., *Hystrix* sp., *Apodemus mystacinus*) elements occur alternatively in the faunas of Betfia, as short time immigrants, probably only during the phases of their maximal expansions. Usually represented by sparse remains, they have, however, a value in facilitating the identification of climatic fluctuations, thus allowing the establishment of a fine biochronology.

## REFERENCES

CHALINE J. RENAULT-MISKOVSKY J., BROCHET G., CLEMENT-DELS C., JAMMOT D., MOURER-CHAUVIRE C., OMNES J., RAGE J. C. 1985. L'aven des Valerots (Nuits-Saint-Georges, Côte-d'Or) site de référence du Pléistocène inférieur. Revue de Géologie Dynamique et de Géographie Physique, **26**: 108-118.

FEJFAR O., HEINRICH W.-D. 1990. Proposed biostratigraphical division of the European continental Neogene and Quaternary based on muroid rodents (Rodentia, Mammalia). International Symposium on the Evolution, Phylogeny and Biostratigraphy of Arvicolids, Praha, pp. 115-124.

FEJFAR O., HORÁČEK I. 1983. Zur Entwicklung der Kleinsäugerfaunen im Villanyium und Alt-Biharium auf dem Gebiet der ČSSR. Schriftenreihe für geologische Wissenschaften, **19/20**: 111-207.

FERU M., RADULESCO C., SAMSON P. 1979. Biostratigraphie (Micromammifères) des dépôts pliopléistocènes du domaine gétique de la Dépression Valaque. Travaux de l'Institut de Spéologie "E. Racovitza", **18**: 141-169.

KORMOS T. 1914a. Über die Resultate meiner Ausgrabungen im Jahre 1913; Die Fauna des Somlyó-Berges nächst Püspök-fürdö. Jahresbericht der K. ungarischen geologischen Anstalt **1913**: 559-567.

KORMOS T. 1914b. Drei neue Raubtiere aus den Praeglazial-Schichten des Somlyóhegy bei Püspökfürdö. Mitteilungen aus dem Jahrbuch des K. ungarischen geologischen Anstalt, **22**: 224-247.

KOWALSKI K., NADACHOWSKI A. 1990. Review of fossil arvicolid faunas of Poland. International Symposium on the Evolution, Phylogeny and Biostratigraphy of Arvicolids, Praha, pp. 297-304.

KRETZOI M. 1941. Die unterpleistozäne Säugetierfauna von Betfia bei Nagyvárad. Földtani Közlöny, **71**: 308-355.

KRETZOI M. 1956. Die altpleistozänen Wirbeltierfaunen des Villányer Gerbiges. Geologica Hungarica, Series Palaeontologica, **27**: 187-191.

KRETZOI M. 1962. Fauna und Faunenhorizont von Csárnota. Földtani Intézet Evi Jelentése, **1959**: 297-395.

KRETZOI M. 1965. Die Nager und Lagomorphen von Voigtstedt in Thüringen und ihre chronologische Aussage. Paläontologische Abhandlungen, Abt. A, **2**: 585-660.

MEULEN A. J. VAN DER. 1974. On *Microtus* (*Allophaiomys*) *deucalion* (KRETZOI, 1969) (Arvicolidae, Rodentia), from the Upper Villanyian (Lower Pleistocene) of Villány-5, S. Hungary. Proceedings Koninklijke Nederlandse Akademie van Wetenschappen, Series B, **77**: 259-266.

MUSIL R. 1966. Holštejn, eine neue altpleistozäne Lokalität in Mähren. Acta Musei Moraviensis, **51**: 133-168.

NADACHOWSKI A. 1990. Review of fossil Rodentia from Poland (Mammalia). Senckenbergiana biologica. **70**(4/6): 229-250.

NIKIFOROVA K. V., ALEXANDROVA L. P. 1991. [Late Pliocene and Anthropogene stratigraphy, chronology and correlation of the events of Europe and North America connected with the changes in the geosphere and biosphere.] [In:] Pliocene and Anthropogene Palaeogeography and Biostratigraphy. Moscow, pp. 99-123. (In Russian).

RADULESCU C., SAMSON P. 1986. Les mammifères du Pléistocène inférieur d'Izvoru (Dép. d'Olt, Roumanie). Quartärpaläontologie, **6**: 157-171.

TERZEA E. 1972. Sur la présence du genre *Lemmus* (Rodentia, Mammalia) dans le Pléistocène de la Roumanie. Folia Quaternaria, **40**: 57-65.

TERZEA E. 1973. A propos d'une faune villafranchienne finale de Betfia (Bihor, Roumanie). Travaux de l'Institut de Spéologie "E. Racovitza", **12**: 229-242.

TERZEA E. 1978. *Epimeriones dacicus* n.sp. (Rodentia, Mammalia) du Villafranchien supérieur de Roumanie. Travaux de l'Institut de Spéologie "E. Racovitza", **17**: 135-138.

TERZEA E. 1984. Mammifères rares du Pléistocène inférieur de Betfia-XIII (Bihor, Roumanie). Travaux de l'Institut de Spéologie "E. Racovitza", **23**: 49-56.

TERZEA E. 1988. La faune de Vertébrés du Pléistocène inférieur de Betfia-IX (dép. de Bihor, Roumanie). Travaux de l'Institut de Spéologie "E. Racovitza", **27**: 79-86.

TERZEA E. 1992. *Apodemus mystacinus* (DANFORD & ALSTON) (Rodentia, Mammalia) dans le Pléistocène inférieur final de Betfia-VII (Bihor, Roumanie). Travaux de l'Institut de Spéologie "E. Racovitza", **31**: 83-94.

TERZEA E. 1993. Événements évolutifs et de dispersion chez les Rongeurs au Quaternaire de Roumanie. Travaux de l'Institut de Spéologie "E. Racovitza", **32**: 107-118.

TERZEA E., JURCSÁK T. 1968. Bemerkungen über die mittelpleistozänen Faunen von Betfia. Berichte der Deutsche Gesellschaft für Geologische Wissenschaften, Serie A, Geologie und Paläontologie, **13**: 381-391.

TERZEA E., JURCSÁK T. 1976. Faune de Mammifères de Betfia-XIII et son ge géologique. Travaux de l'Institut de Spéologie "E. Racovitza", **15**: 195-205.

ZAGWIJN W. H. 1985. An outline of the Quaternary stratigraphy of the Netherlands. Geologie en Mijnbouw, **64**: 17-24.