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Biochronological implications of the arvicolids (Mammalia: Rodentia) from the Pliocene and Pleistocene faunas of Neuleiningen (Rheinland-Pfalz, southwest Germany)

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Abstract. Several fissures north of Neuleiningen have yielded rich small mammal associations. The arvicolids are identified as: *Ungaromys dehmi*, *Clethrionomys kretzoii*, *C. hintonianus*, *Pliomys episcopalis*, *Mimomys pitymyoides*, *M. pusillus*, *M. tornensis*, *M. ostramosensis*, *M. savini*, *Borsodia* cf. *newtoni*, *Microtus* ex gr. *pliocaenicus/deucalion*, *M.* ex gr. *hintoni/thenii*, and *Lemmus* cf. *kowalskii*. Among the Biharian (*sensu* FEJFAR & HEINRICH 1980, 1989) faunas from Neuleiningen, those of NL 5 and 15 are somewhat younger than NL 2, 3 and 13 because of the occurrence of more advanced *Mimomys* and *Microtus* species. The associations of NL 7, 9 and 14 on the one hand and NL 4 and 11 on the other belong to different levels of the uppermost Villányian (*sensu* FEJFAR & HEINRICH 1980, 1989). The validity of this biochronological sequence of the Neuleiningen faunas and correlations with other European faunas are supported by quantitative data on the crown height of the rooted forms and the A/L-Index of the rootless taxa.

Key words: Pliocene, Pleistocene, Arvicolidae, Biochronology, Neuleiningen.

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I. INTRODUCTION

The locality of Neuleiningen is situated in the southern part of the Mainz Basin (southwest Germany, Fig. 1), 1,5 km north of the village of Neuleiningen (Mbl. Grünstadt-West, R 34 37 150 - 370 H 54 90 500 - 620, see HEIDTKE 1979 and ROTHAUSEN & SONNE 1984). This is an area with numerous fossil sites of land mammals from different stratigraphic levels of the Cenozoic (TOBIEN 1980).

The fossils originate from several fissures in a quarry of Lower Miocene limestone and were embedded in brownish residual clays with sandy and small pebble components and Aquitanian limestone fragments (TOBIEN 1980). Out of 15 investigated fissures 11 were fossiliferous. Most of the fossils were of small mammals, but remains of larger mammals and molluscs were also found.

The material was collected by F. MALEC and U. HEIDTKE in the 1970's. MALEC & TOBIEN (1976) reported preliminary results of their small mammal investigations of fissure number 11.

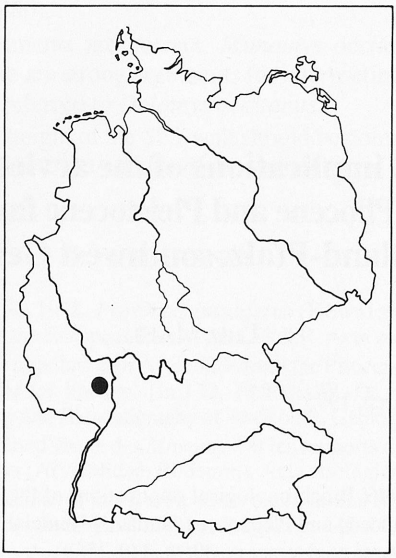

Fig. 1. Geographic position of the locality Neuleiningen.

Through a later misunderstanding the taxa recorded from there were cited as belonging to NL 15 (TOBIEN 1980; KOENIGSWALD & TOBIEN 1990). This must be corrected, because fissure 15 contained a quite different fauna from that of fissure 11. Large mammals from this locality were described by HEIDTKE (1979). A further contribution dealt with the carnivores of fissures 6 and 11 (DE BEAUMONT 1980).

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II. THE RECORDED SPECIES

An overview of the recorded small mammals, in particular the arvicolids, is given in Table I. The material collected by MALEC is indicated with M and that from HEIDTKE with H. According to HEIDTKE (1979), his material is labeled with the locality numbers that were introduced by MALEC & TOBIEN (1976).

III. BIOCHRONOLOGICAL POSITION

According to current knowledge of small mammal assemblages from Europe the species composition of each fauna from Neuleiningen has its analogues in other localities and there seems therefore not to be any mixing. This is also in agreement with the metrical analyses, which show

Table I

Recorded small mammal taxa from Neuleiningen NL 1 - NL 15 = Number of the fissure. Collectors: M = MALEC; H = HEIDTKE

Fissure	NL 1	NL 2	NL 3	NL 4	NL 5	NL 6	NL 7	NL 8	NL 9	NL 10	NL 11	NL 12	NL 13	NL 14	NL 15
collector		H	H	M	H		M		M		M	M	M	M	M, H
Insectivora															
Erinaceidae															
Talpidae															
Soricidae															
Chiroptera															
Lagomorpha															
Rodentia															
Sciuridae															
Zapodidae															
Myoxidae															
Muridae															
Cricetidae															
Arvicolidae															
Ungaromys dehmi		4					15				8				
Clethrionomys kretzoii				4			1				37				
Clethrionomys hintonianus					9										16
Pliomys episcopalis					2										6
Mimomys pitymyoides		74	1	489			98		52		191	1	6	51	
Mimomys pusillus					6										13
Mimomys savini					20										33
Mimomys ostramosensis		1		9			1				15		1	8	
Mimomys tornensis		4		61			3		2		75		9	42	
Borsodia* cf. *newtoni				224			1				1			1	
Microtus* ex gr *plioc.-deuc.		2	2										5		
Microtus* ex gr *hint.-thenii					170										261
Lemmus* cf. *kowalskii				1	1						1	1			

homogenous series (M_1-length). On the basis of species composition the Neuleiningen faunas can therefore be referred to different biochronological levels.

The whole spectrum consists of faunal elements of Villányian and Biharian age [*sensu* FEJFAR & HEINRICH (1980, 1989)]. These authors define the beginning of the Biharian as the first appearance of *Microtus*.

In addition to *Microtus*, the faunas of NL 5 and 15 contain such typical Biharian elements as *Pliomys episcopalis* MÉHELY, 1914, *Mimomys savini* HINTON, 1910, and *Mimomys pusillus* (MÉHELY, 1914). Because of the presence of the latter species they are referred to the *Mimomys savini/Mimomys pusillus* Zone.

From a lower stratigraphic level, but also of Biharian age, are the faunas of NL 2, 3 and 13. In these faunas the primitive *Microtus deucalion* (KRETZOI, 1969) is found in association with *Ungaromys dehmi* CARLS & RABEDER, 1988, *Mimomys ostramosensis* JÁNOSSY & VAN DER MEULEN, 1975, *Mimomys pitymyoides* JÁNOSSY & VAN DER MEULEN, 1975, and *Mimomys tornensis* JÁNOSSY & VAN DER MEULEN, 1975. These are species which did not persist to the level of NL 5 and 15.

With the exception of *Microtus*, the last mentioned species also occur in the remaining faunas. It is assumed that *Microtus* is absent in the assemblages of NL 4, 11, 7, and 14 because they are

older than the FAD of this stratigraphical marker. For this reason those faunas are referred to the Villányian stage, and in particular to the *Mimomys pliocaenicus* Zone (Fig. 2).

My B.P.	MQ/ MN	Mammal Ages	Rodent Superzones	Rodent Zones	
0.0	MQ 2	Toringian	*Arvicola/ Microtus*	*Arvicola terrestris*	
0.2				*Arvicola cantiana*	
0.4					
0.6	MQ 1	**Biharian**	*Microtus/ Mimomys*	*Mimomys savini*	
0.8				***Mimomys savini-Mimomys pusillus***	NL 5, 15
1.0					
1.2					NL 2, 3, 13
1.4					
1.6					
1.8	MN 17	**Villányian**	*Borsodia/ Villanyia*	***Mimomys pliocaenicus***	NL 4, 7, 9, 11, 14
2.0					
2.2	MN 16b			*Mimomys polonicus*	
2.4					
2.6	MN 16a			*Mimomys hajnackensis*	
2.8					
3.0	MN 15b	Ruscinian	*Trilophomys/ Ruscinomys*	*Mimomys occitanus*	
3.2	MN 15a				

Fig. 2. Biochronological subdivision of the Quaternary and late Pliocene (after FEJFAR & HEINRICH 1980, 1989, slightly modified).

That *Microtus* is really absent in NL 4, 11, 7, and 14 because of the greater age of these assemblages can be validated by quantitative data.

One of the most useful methods for estimating the evolutionary level of rhizodont arvicolids is the degree of hypsodonty as indicated by the height of the linea sinuosa (RABEDER 1981). To document this quantitatively for M_1, CHALINE (1974) introduced the E-value and RABEDER (1981) the HH-index. Comparison of the different methods shows that in the same sample the relation of the height of the hyposinuid (after RABEDER 1981) to the length of the M_1 at the level of the top of the hyposinuid (Hsd/Lg in Figs. 3, 4) is easier to handle, and more frequently available, than data required in other methods.

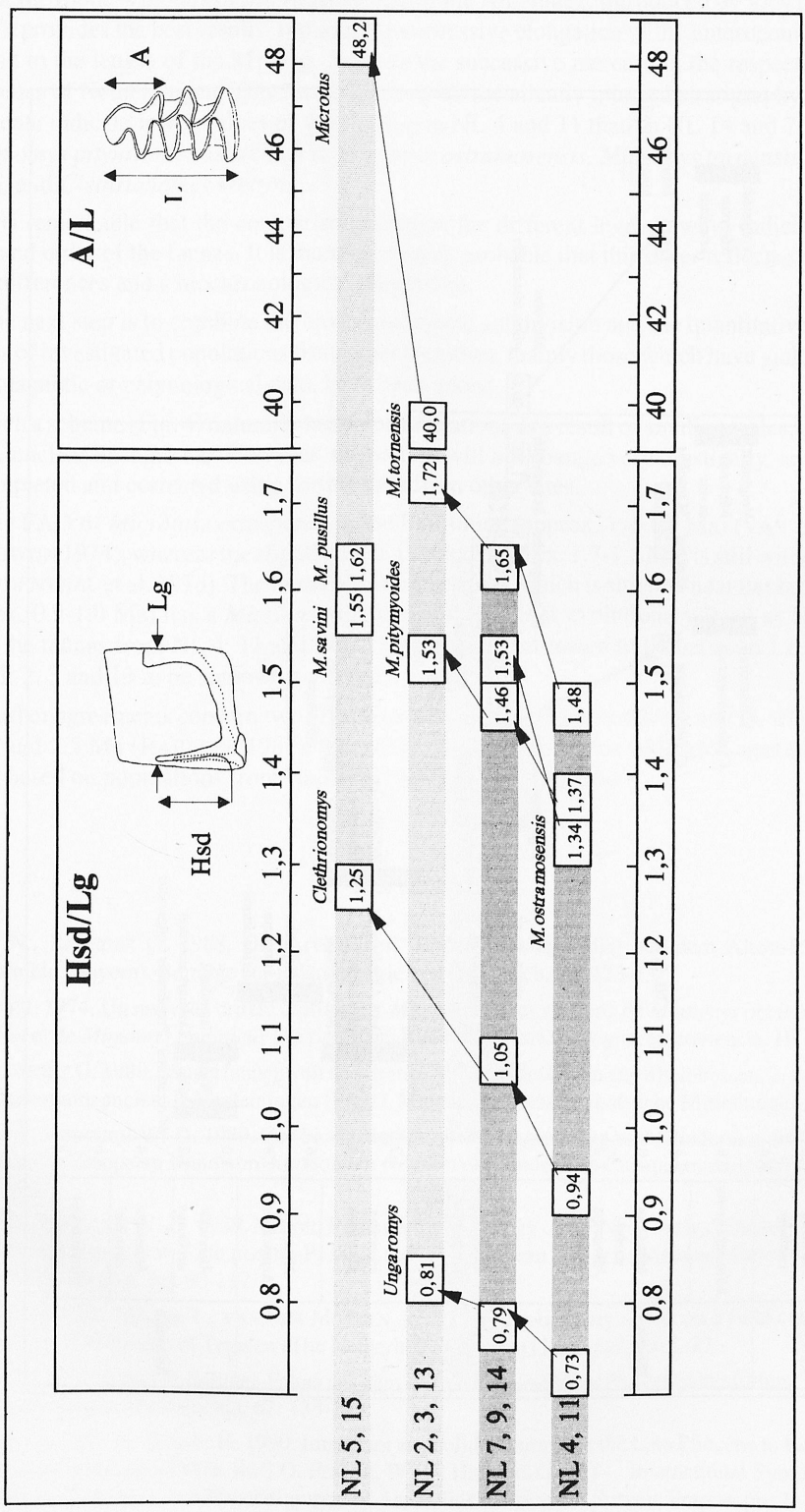
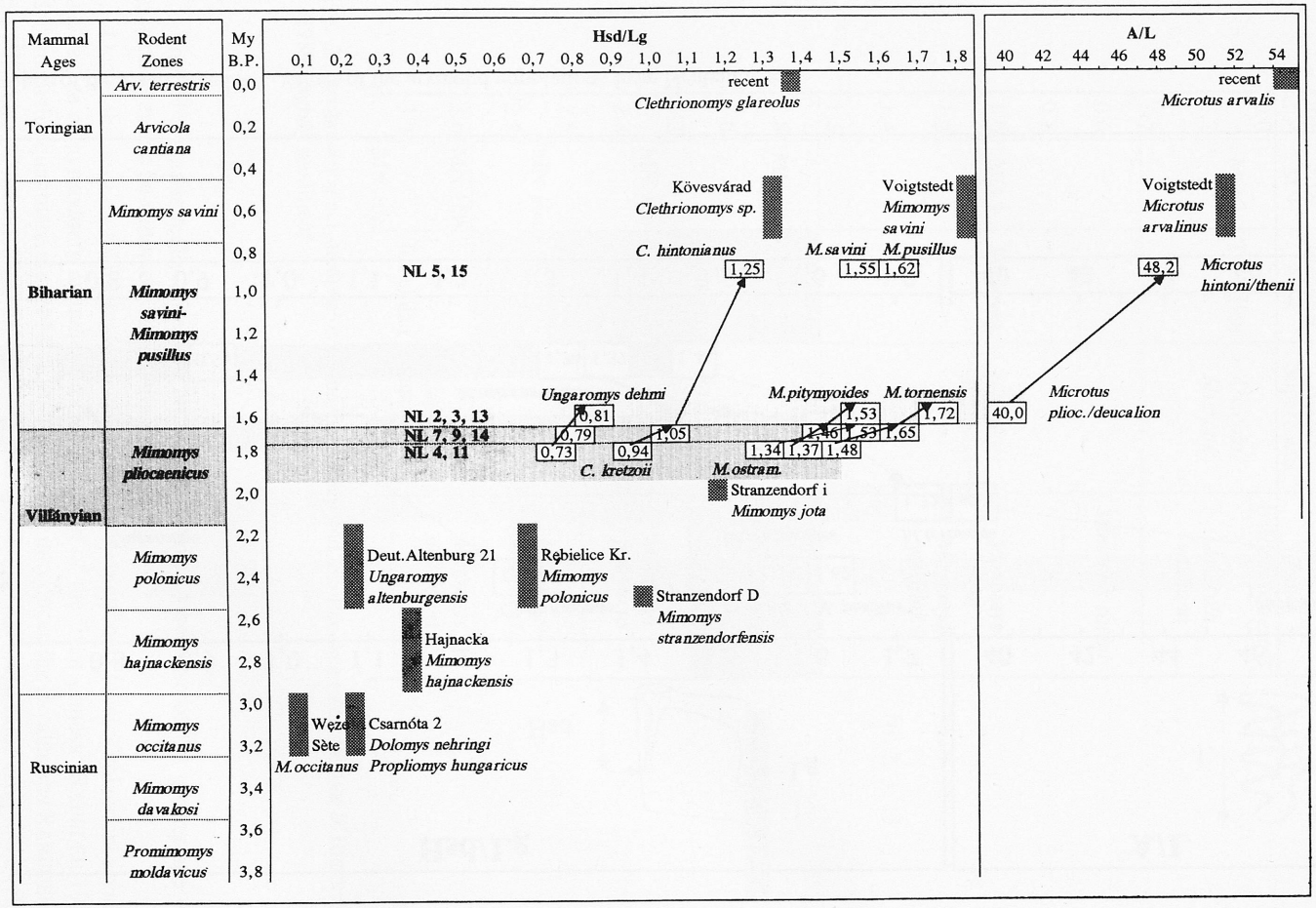


Fig. 3. Sequence of the Hsd/Lg and A/L values of the arvicolid populations from Neuleiningen.



.Fig. 4. Compilation of biochronological subdivision (after FEJFAR & HEINRICH 1980, 1989) and Hsd/Lg and A/L values of the arvicolid populations from Neuleiningen and other localties.

For the rootless molars of *Microtus* the use of the A/L-Index, introduced by VAN DER MEULEN (1973), provides the best results. It tracks the successive elongation of the anteroconid complex in relation to the length of the M_1. Fig. 3 shows the successive increase in the respective values in the faunas of Neuleiningen. This result agrees with the already inferred stratigraphy. In addition, these data indicate lower values of the Hsd/Lg in NL 4 and 11 than in NL 14 and 7. This is seen in *Mimomys pitymyoides* as well as in *Mimomys ostramosensis, Mimomys tornensis, Ungaromys dehmi,* and *Clethrionomys kretzoii.*

It is remarkable that the comparison between the different levels always indicates the same trend and order of the faunas. It is therefore highly probable that this order reflects real chronological differences and a biochronological succession.

The next step is to combine the biochronological subdivision and the quantitative succession. Values of investigated populations from other localities, mainly those which have yielded absolute, paleomagnetic or palynological data, have been added.

Such a scheme (Fig. 4) naturally has some limitations as a result of small samples, geographical clines, unclear lineages etc. However, the picture will not change very drastically, and details can be completed and corrected using further data from other sites.

The FAD of *Microtus* corresponds to the Eburonian (approx. 1.4-1.7 Ma) (VAN DER MEULEN & ZAGWIJN 1974), whereas the slightly older Tegelen (approx. 1.7-1.8 Ma) is still without *Microtus* (FREUDENTHAL et al. 1976). The fauna of Untermassfeld, which is situated near the Jaramillo event (approx. 0.9-1.0 Ma) has a *Microtus*-population at a similar evolutionary level as NL 5 and 15. Thus, the faunas from NL 4, 11 and NL 7, 9, 14 can be estimated to lie between 1.6 and 2.0 Ma, and NL 2, 3 and 13 to be somewhat younger.

Further agreements concern two *Mimomys* species from Stranzendorf i and D, which are dated to 2.0 and 2.5 Ma (RABEDER 1981). Moreover, the values and the estimated ages of the Rodent Zones based on populations from Hajnačka and Sète fit this picture.

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