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Environmental significance and stratigraphic position of some mammal faunas in the Neogene of eastern Austria

Ökologische Bedeutung und stratigraphische Stellung einiger Säugetier-Faunen im Neogen von Ost-Österreich

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(With 1 textfigure)

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Zusammenfassung

Vier Kleinsäugerfaunen aus dem östlichen Teil von Niederösterreich werden hier behandelt. Drei kommen aus geschichteten Ablagerungen im Wiener Becken (Vösendorf, Götzendorf, Eichkogel) und eine aus Spaltenfüllungen (Kohfidisch), etwa 115 km südlich von Wien. Kleinsäuger werden in steigendem Ausmaß für biostratigraphische Untersuchungen kontinentaler känozoischer Ablagerungen in Europa verwendet. Es müssen dabei aber geographische und Umwelt-Faktoren berücksichtigt werden, welche den Charakter der lokalen Faunen verändern können. Die vorliegende Studie macht es wahrscheinlich, daß ökologische Unterschiede die Anwesenheit oder das Fehlen von Gattungen, besonders von Insectivoren-Gattungen, in erheblichem Ausmaß bewirken können. Allein auf der Basis des Faunenbestandes hat es sich als schwierig erwiesen, das relative Alter der vier Faunen zu bestimmen. Es ist offenbar noch viel Arbeit erforderlich bis Kleinsäugerfaunen, besonders bei geringem Umfang, verläßlich in der Biostratigraphie verwertet werden können.

Abstract

Four micromammalian faunas from eastern Austria are reviewed. Three are from a bedded sequence in the Vienna Basin (Vösendorf, Götzendorf, Eichkogel), and one is from fissure fillings (Kohfidisch) some 115 kilometers south of Vienna, Austria. Small mammals are used increasingly in biostratigraphical studies of Cenozoic continental deposits of Europe, but attention must be paid to environmental and geographic factors that may change the character of the local faunas. The present study suggests that environmental differences have influenced the presence or absence of genera, especially insectivore genera, to a marked degree. Relative times of existence of the four faunas have proved difficult to determine on the basis of faunal content alone, and it is evident that much work remains to be done before micromammalian faunas, especially if scanty, can be used with confidence in biostratigraphy.

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Introduction

It is of course a fact that a species list of fossils recovered from either bedded deposits or fissure fills is a biased accounting, and is perhaps even more so if an attempt is made to quantify such a list. If the fossil fauna, however, has been collected over a wide area and obtained over a long time such as is the case for the White River fauna (Oligocene, USA), the fauna is more representative of the once living fauna than if it has been obtained from a single small quarry excavation or a single fissure. Yet some attempt to reconstruct the environment of the more restricted fauna should be made if satisfactory biostratigraphical results are to be achieved. Confusing facies changes with time changes must be avoided, if possible, or at least we must be aware of possible confusion of the two. The problem may be especially acute in dealing with small animals which are more sensitive to environmental changes than large animals which have large home ranges. Unfortunately, establishment of environment preference becomes more difficult as we deal with faunas increasingly remote from the present even when the life habits of the still living descendants are well known. A final additional element of difficulty in treating with micromammalian remains is that preservation is frequently a matter of single teeth. Lithology, associated invertebrates, and especially associated plants may well be more illuminating from an environmental standpoint than the frag-

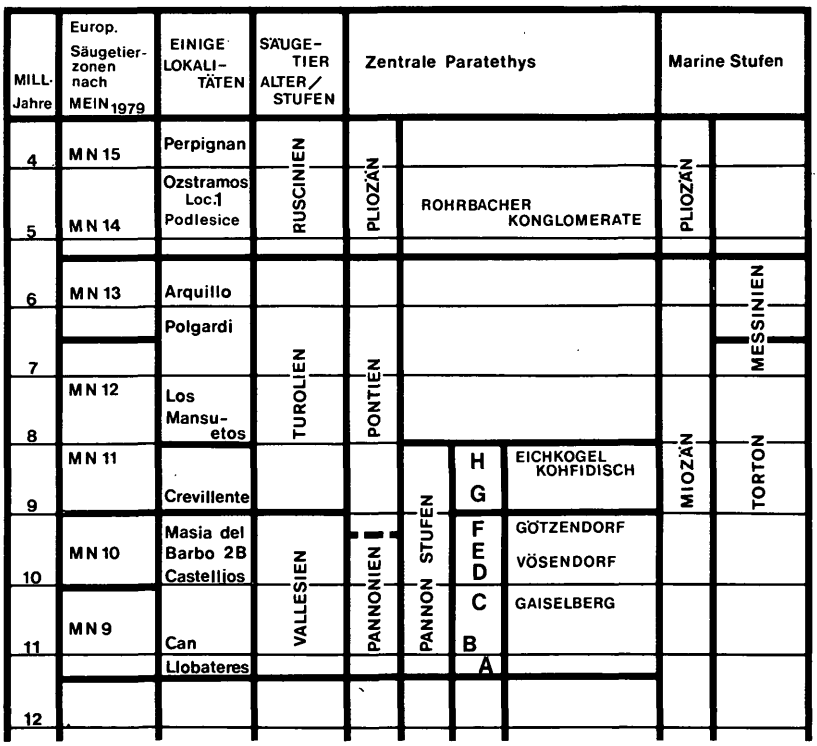

Fig. 1. Biostratigraphic relationships of Vienna Basin and Kohfidisch faunas.

mentary remains of small mammals. Still it is worth making an attempt to evaluate several collections of small mammals from eastern Austria as to environment and relative stratigraphic position on a broader geographic scale, if only to emphasize some of the problems. The Austrian mammalian local faunas to be discussed are four in number as follows.

(1) Brunn-Vösendorf bei Wien. Shallow, brackish water deposits of impure clay and sand. Pannon E (Pannonian) of the Vienna Basin. With abundant plants (mostly broadleaf deciduous of beech, myrtle, sweet gum, water elm, poplar, chestnut, hickory, and water pine).

(2) Götzendorf. Freshwater sandstone. Pannon F (Pontian) of the Vienna Basin. Locality now destroyed.

(3) Eichkogel bei Mödling. Freshwater limestone and marl. Pannon H (Pontian) of the Vienna Basin.

(4) Kohfidisch, Burgenland. Fissure fills. Previously correlated with Pannon F of Vienna Basin.

Micromammalian Faunal Lists

Vösendorf bei Wien:

Schizogalerix voesendorfensis (RABEDER)
Dinosorex sansaniensis GAILLARD
Talpid indet. (scalopine?)
Trogontherium minutum (v. MEYER)
Megacricetodon (Mesocricetodon) minutus DAXNER
Megacricetodon n. sp.? (aff. *gregarius* SCHAUB)
Kowalskia sp. (or *Democricetodon-Cricetulodon*)
Anomalomys ? sp.

Götzendorf:

Lanthanotherium sp.
Erinaceid sp.
Plesiodimylus chantrei GAILLARD
Dinosorex, possibly n. sp.
Cf. *Crusafontina* sp.
Talpa minuta BLAINVILLE
Desmana sp.
Talpid sp.
Prolagus oeningensis (KÖNIG)
Spermophilinus bredai (v. MEYER)
Albanensia grimmi (BLACK)
Trogontherium minutum (v. MEYER)
Castor ? sp.
Democricetodon minor ?(LARTET)
Microtocricetus molassicus FAHLBUSCH & MAYR or n. sp.
Anomalomys cf. *A. gaillardi* VIRET & SCHAUB

Eichkogel bei Mödling[3]):

Schizogalerix moedlingensis (RABEDER)
Lanthanotherium cf. *sanmigueli* DE VILLALTA & CRUSAFONT
Plesiodimylus cfr. *chantrei* GAILLARD
Petenyia hungarica KORMOS
Petenyiella cf. *pannonica* (KORMOS)
Anourosorex sp.
Sorex spp.
Limnoecus ? sp.
Desmana cf. *kormosi* SCHREUDER
Desmanine spp.
various remains of talpids
undet. fragments of Chiroptera
Pliopetes cf. *hungaricus* KRETZOI
Pliopetaurista bressana MEIN
Blackia miocaenica MEIN
Spermophilinus bredai-turolensis – Formenkreis
Chalicomys jaegeri KAUP
Glirulus lissiensis (HUGUENEY & MEIN)
Myomimus dehmi (DE BRUIJN)
Vasseuromys thenii DAXNER–HÖCK
Muscardinus pliocaenicus KOWALSKI
Glirid, gen. and sp. indet.
Protozapus intermedius BACHMAYER & WILSON
Keramidomys aff. *mohleri* ENGESSER
Kowalskia cf. *fahlbuschi* BACHMAYER & WILSON
Epimeriones austriacus DAXNER–HÖCK
Collimys primus DAXNER–HÖCK
Anomalomys gernoti DAXNER–HÖCK
Prospalax petteri BACHMAYER & WILSON
?Progonomys woelferi BACHMAYER & WILSON
Parapodemus lugdunensis SCHAUB

Kohfidisch:

Schizogalerix cf. *S. moedlingensis* (RABEDER)
Schizogalerix zapfei (BACHMAYER & WILSON)
Lanthanotherium sp.
Erinaceus ? sp.
Petenyia dubia BACHMAYER & WILSON
Petenyiella repenningi BACHMAYER & WILSON
Anourosorex kormosi BACHMAYER & WILSON

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[3]) The above list is from RABEDER, DAXNER-HÖCK and DE BRUIJN based on excavation carried out by DAXNER-HÖCK and RABEDER except for *Plesiodimylus* cfr. *chantrei* which was described by THENIUS and is not from the HÖCK & RABEDER excavation. Other sites have yielded various fish.

Neomyine ? sp.
Desmana pontica ? SCHREUDER
Cf. *Desmanella crusafonti* RÜMKE
Talpa gilothi STORCH
Talpid sp.
Megaderma vireti MEIN
Rhinolophus delphinensis GAILLARD
Rhinolophus grivensis (DEPERET)
Myotis nr. *M. boyeri* MEIN
Plecotus (Paraplecotus) sp.
Cf. *Myotis* sp.
Prolagus cf. *P. oeningensis* (KÖNIG)
Pliopetaurista cf. *P. bressana* MEIN
Spermophilinus cf. *S. bredai* (v. MEYER)
Cf. Chalicomys jaegeri KAUP
Paraglirulus cf. *P. lissiensis* (HUGUENEY & MEIN)
Myomimus dehmi (DE BRUIJN)
Cf. Vasseuromys thenii DAXNER-HÖCK
Muscardinus austriacus BACHMAYER & WILSON
Graphiurops austriacus BACHMAYER & WILSON
Glis cf. *G. minor* KOWALSKI
Protozapus intermedius BACHMAYER & WILSON
Keramidomys sp.
Leptodontomys sp.
Kowalskia fahlbuschi BACHMAYER & WILSON
Epimeriones cf. *E. austriacus* DAXNER-HÖCK
Prospalax petteri BACHMAYER & WILSON
Promimomys (Prosomys) sp.
Progonomys woelferi BACHMAYER & WILSON
Parapodemus lugdunensis SCHAUB
Hystrix cf. *H. suevica* SCHLOSSER

Of these four faunas, two, Eichkogel and Kohfidisch, are known by a diversified micromammalian fauna, and seem clearly assignable to zone 11 of MEIN (1975). Two, Vösendorf and Götzendorf, have much less diverse faunas, expecially the former, and are, consequently, more difficult to assign to a MEIN zone. Vösendorf has been compared to the Montredon fauna of France (MEIN zone 10). The Götzendorf fauna resembles that of Vösendorf more closely than it does Eichkogel. In terms of the old standard divisions of the Pannon established by PAPP (1951), in sequence, Vösendorf is from Pannon E, Götzendorf from Pannon F, and Eichkogel from Pannon H. Kohfidisch had been viewed as equivalent to zone F by BACHMAYER & ZAPFE (1969), and BACHMAYER & WILSON (1978), on geologic grounds. If Götzendorf and Kohfidisch are time equivalents, however, then environmental and burial influences are more important in the Vienna Basin

than the presence or absence of specific zone indicators. PAPP & STEININGER (1979), however, in a chart (Tabl. 2) have positioned Kohfidisch as essentially equivalent to zone H of the Pannonian-Pontian sequence of the Vienna Basin.

Characteristics which unite Vösendorf and Götzendorf are largely, but not entirely, negative in that both agree in absence of the Muridae, Gliridae, Zapodidae, and of such advanced cricetids as *Kowalskia fahlbuschi.* In addition, both do have cricetids *(„Megacricetodon, Democricetodon")* which are characteristic of the Vallesian rather than the Turolian. Götzendorf, especially, is set off from Kohfidisch by the presence of such typically Vallesian and pre-Vallesian genera as *Lanthanotherium, Dinosorex, Plesiodimylus, Albanensia, Anomalomys,* and *Microtocricetus.* Nevertheless, except for *Albanensia* and *Microtocricetus,* these occur under proper environmental conditions in zone 11 faunas such as Dorn-Dürkheim (Germany) and Eichkogel.

Schizogalerix cf. *G. moedlingensis* of Kohfidisch may be somewhat less advanced than *S. moedlingensis* from the type locality of Eichkogel. In fact, ENGESSER (1980) refers to the Kohfidisch species as *Schizogalerix* aff. *voesendorfensis.* Among the glirids, Cf. *Vasseuromys thenii* has a less complex molar pattern than the Eichkogel *V. thenii.* If increasing complexity is progressive, as it seems, Eichkogel is the younger. Lastly, *Kowalskia fahlbuschi* from Kohfidisch and *K.* cf. *fahlbuschi* from Eichkogel exhibit different, but overlapping distinctions in some characters, which suggest that the two samples are not drawn from the same population (BACHMAYER & WILSON, 1980). These distinctions, however, are difficult to interpret as geologic age differences. For example, in $M\underline{3}$ the entoconid in specimens from Kohfidisch exists as a large cusp in 60 percent of the specimens, and only in a few specimens from Eichkogel. This suggests a more advanced Eichkogel species. Contrarywise, in $M\underline{1}$ the internal root is at least partially divided in 70 percent of the Kohfidisch specimens, and only in some specimens at Eichkogel. This condition, since the ancestral form seems to be one with an undivided root, would make the Kohfidisch species more advanced.

The sum of the above evidence is inconclusive. The two faunas are essentially the same age, as seems indicated on balance, and thus it is very unlikely that Kohfidisch is equivalent to PAPP's Pannon F. Nevertheless, the geological evidence given by BACHMAYER & ZAPFE (1969), by which the conclusion was reached, „Das geologische Alter der Fauna der Höhlen- und Spaltenfüllungen bei Kohfidisch ist mit sehr großer Wahrscheinlichkeit Oberes Pannonien, Zone F", still seems to have some pertinence.

It has proved difficult, strangely enough, to correlate Kohfidisch with relatively nearby deposits in Hungary. For example, if the recent correlation by KRETZOI & PÉCSI of the MEIN zone 11 with the Csakvarian (1979) were accepted, then Kohfidisch seems closer in time to this Hungarian substage. KRETZOI & PÉCSI, however, indicate that the Csakvarian marks a transgressive phase of the Pannonian, hardly appropriate to occupation of the Kohfidisch fissures, and PAPP & STEININGER (1979) equate Eichkogel and Kohfidisch with the overlying Hatvanian.

In a review of the Neogene rodent succession in Greece, DE BRUIJN & VAN DER

MEULEN (1979) have put forth the proposition that "Miocene" cricetids, the Muridae, and the Arvicolidae arrived earlier in Greece than in Spain. They indicate *Prognomys woelferi* as appearing first in zone 9 of MEIN, *Parapodemus* sp. in zone 10, and *Kowalskia fahlbuschi* also in zone 10. These are important elements in the Kohfidisch fauna. On the other hand, murids are absent in the Vallesian (zones 9 and 10) of the Vienna Basin faunas, and a microtine, *Prosomys* sp., is recorded at Kohfidisch[4]). Moreover, DAAMS & FREUDENTHAL (1981) have attacked the validity of the MEIN zones, going so far as to state (p. 13), ". . . they may lead to false conclusions. They might be used in geographically restricted areas (each area having its own set of zones), but they are not useful at a continental scale." If a correlation between France and Spain on the one hand, and southern Germany, Austria on the other using MEIN zones can be satisfactorily made, it would seem to be zone 11, where MEIN goes so far as to suggest (1979) as short-lived guides to zone 11, the presence of *Protozapus intermedius* and *Epimeriones austriacus*. It seems obvious to us, that although the view of DAAMS & FREUDENTHAL may be extreme, there are severe difficulties in the application of these zones over wide distances.

As late as 1979, DE BRUIJN & VAN DER MEULEN record Greek local faunas which they assign to MEIN zones 9, 10, 12, 13, 14, 15 and 16, but zone 11 seems not to be represented. Our suspicion is that the time equivalent of zone 11 is in fact represented by one of the Greek local faunas, but without its supposed characteristics.

Review of the accumulated data on the small mammals of Kohfidisch does not point to any discernable lapse of time in deposition of the various specimens. Neither does it show any marked faunal differentiation among mini-localities. The only striking item in this regard is that almost, if not all, lagomorphs came from Fundstelle II, and mainly were obtained during excavations in 1960. *Protozapus intermedius* was especially abundant at III oben, and *Schizogalerix* at Fundstelle II, but the only really outstanding restriction is that of *Prolagus*. Both II and III were rich in small mammal remains.

Environmental Significance of Kohfidisch and Eichkogel

Kohfidisch and Eichkogel agree in possessing a mixture of elements from the older Miocene and various genera invading from the east, and possibly from the south. Together they suggest a decline in rainfall and in forest cover and of the old genera which occupied these Miocene forests. Temperatures seem still to have been mild, and with locally abundant water areas, although swamp conditions were absent from these sites.

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[4]) The presence of a microtine in the Kohfidisch fauna appears more acceptable than previously, because of the occurrence of microtines in the Mala Cave in Poland (SULMSKI & al., 1979) which cannot be much younger than Kohfidisch.

Preservation of the micromammalian remains are, of course, rather different in the two cases. Jaws, fragmentary to complete, are abundant at Kohfidisch. At Eichkogel, isolated teeth are the rule, especially with the Eichkogel rodents. According to RABEDER (1970) and HÖCK (1980), there were 1230 molar teeth of rodents recovered, and only three jaw fragments. The Insectivora fared better with 90 isolated teeth and 65 jaw fragments, mostly toothless. The jaws were chiefly of soricids and *Desmana,* the water mole. The Eichkogel specimens suggest that the original source was some distance away from final deposition in the marl, and, in the absence of castorids, from bank and shore conditions. The jaws may have been contained in owl pellets rafted out from the roosting areas. Whatever the exact nature of the depositional site, current activity was low.

Bats of Kohfidisch include the genera *Megaderma, Rhinolophus, Myotis,* and *Plecotus. Megaderma* is a tropical, carnivorous and insectivorous bat requiring a minimum of 18 degrees centigrade. *Rhinolophus* is a bat that needs relatively warm winters, but even today lives close to Kohfidisch (Neusiedlersee). *Myotis* and *Plecotus* are not so cold sensitive as the former two. *Megaderma* is the key here for temperature, and the fissure system for daytime roosting of the bats. The occurrence of *Megaderma* at Kohfidisch is almost its latest in central Europe, but persists into somewhat later times in France (Lissieu). ZAPFE (oral communication) suggests the climate was much like that of the present Dalmatian Coast.

Proximity to water is indicated by rare beavers, and more common water moles *(Desmana). Prolagus* may also be a stream and pond border resident (BACHMAYER & WILSON, 1970). It is absent at Eichkogel. Both Kohfidisch and Eichkogel seem to have nearly the same frequency of occurrence of rodent groups at a family level in spite of the difference in accumulation, and sampling of the living fauna must have been the same at the two localities, and probably represents something close to real populations. *Progonomys* is common at Kohfidisch and rare at Eichkogel. This distinction may be time-related rather than environment-related, but this is not certain. *Anourosorex* is common at Kohfidisch and not uncommon at Eichkogel. The living *Anourosorex squamipes* is a mountain forest genus (1,500 to 3,100 meters). It is a burrowing shrew living underground and digging burrows among the roots of plants, and feeding on insects, their larvae, and earthworms. The abundance of this fossil species at Kohfidisch is rather surprising, but it may not have reached its present level of specialization in the late Miocene. The statement of environment given in BACHMAYER & WILSON (1970) still seems satisfactory for Kohfidisch. To repeat, the Kohfidisch area during the time of accumulation seems best visualized as largely open grassland, but with local bodies of water. Woodland areas were present, but perhaps restricted to stream borders. The climate was mild, warm, and with sufficient rainfall to maintain permanent water supply and a varied animal population. Concerning the herpetofauna, BACHMAYER & MŁYNARSKI report (1983, p. 124), „Die Schildkrötenfauna von Kohfidisch, sowie die ganze Herpetofauna dieser Fundstelle, besteht aus thermophilen, für xerotherme Biotope charakteristischen Formen. . . . sind Bewohner von Steppen- und Gebüschzonen und kommen stets auf felsigem Hügellände

vor"[5]). Eichkogel deposits are freshwater limestone and marl (marl in the case of the excavation carried on by DAXNER-HÖCK & RABEDER), but the general environment of the fauna was probably not much different from that at Kohfidisch with well-watered open, well-drained woodland and prairie.

Environment at Vösendorf in Respect to Eichkogel-Kohfidisch

The micromammalian remains from Vösendorf are limited, and tell little about the environment. Fortunately, other elements, especially the fossil plants, give us good reasons to reconstruct such environments as are pictured by THENIUS (1962, p. 111). The Pannonian "lake" was brackish with a salt content of 15 to 3 ‰, and was much like the present Caspian, but as land emerged during the course of the late Miocene, stream drainages were being established. At Vösendorf, itself, the tree growth was heavy, and indicated subtropical to warm temperate climates.

The absence in the micromammalian fauna of the Muridae and Gliridae is striking. The low number of small mammal specimens may account for these absences at Vösendorf, but in the overlying Eichkogel, murids constitute 44 percent of the rodent fauna, and glirids 12 percent. Perhaps the screen size used in recovery may have been too coarse. Predator preference seems hardly a significant factor. Environmental conditions may have been adverse, but in just what way is not clear. That environment may have been a factor is suggested by the absence of these groups in the somewhat better-known Götzendorf fauna which overlies the Vösendorf level, and is only 23 kilometers distance in the same basin.

Environment of the Götzendorf Micromammalia

The Götzendorf fauna (BACHMAYER & WILSON 1985) consists largely of genera characteristic of the older Miocene woodland fauna of western Europe, but biased toward a stream border or lake border biotope. Little suggests any recently invading steppe fauna or Asiatic element. *Microtocricetus* and *Miotragoceras* seem to indicate an open prairie environment, although *Microtocricetus* could have fed on harsh stream bank sedges. Older Miocene European elements are *Dinosorex, "Democricetodon", Plesiodimylus, Albanensia, Spermophilinus, Anomalomys,* and *Prolagus.* Stream and stream border elements are *Trogontherium, Castor ?,* and desmanine moles, but *Dinosorex, Democricetodon, Prolagus, Crusafontina,* and tapir would not be out of place in a stream bank-lake border assemblage. A special note should be made of the large flying squirrel, *Albanensia grimmi.* This species is comparable in size to the "giant" flying squirrel of southeastern Asia, *Petaurista.* This genus inhabits dense hillside forests, and at 15 to 30 or more meters above the ground (WALKER 1968, p. 716). The presence of *A. grimmi* suggests an

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[5]) The turtle fauna of Kohfidisch, as well as the whole herpetofauna of this locality, consists of thermophilic forms characteristic of xerothermic biotopes. . . . are dwellers of steppe and bush zones, and occur always in rocky hill country.

area of large and abundant trees, for the Asiatic species can glide for better than 400 meters. This makes the absence of glirids and *Progonomys* curious because they are inhabitants of wooded areas (glirids certainly, *Progonomys* probably). This same absence is of course true of the Vösendorf fauna, and the two faunas tend to reinforce each other in these negative aspects. It may be that a real change in fauna and environment took place between the time of the Vösendorf-Götzendorf faunas and those of the Eichkogel-Kohfidisch. It is perhaps possible that ground conditions (wet or marshy vs. dry) has made a difference. In any case, the three most common elements at Götzendorf, ochotonids, castorids, and sciurids, account for less than ten percent of the small mammals of Kohfidisch.

The relative abundance of castorids in the Götzendorf fauna suggests that the final depositional site was close to stream bank or pond edge under conditions of mild current activity.

The Dorn-Dürkheim Micromammalian Fauna of Southwest Germany (Rheinhessen)

The Dorn-Dürkheim fauna is from an abandoned sandpit, and is unusual in its association of a rich micromammalian fauna with many larger mammals. The rodents and insectivores have been described by FRANZEN & STORCH (1975) and STORCH (1978). The environment at the time of accumulation has been described as a well-watered and woodland biotope. The micromammalian fauna seems of early Turolian (MEIN zone 11) age as evidenced by the presence of *Parapodemus lugdunensis, Kowalskia,* and *Protozapus.* Likewise as at Eichkogel and Kohfidisch, specimens of *Epimeriones austriacus* and *Prospalax petteri* are found. In regard to the insectivores, STORCH remarks (1978: p. 437), „Die Insektivoren-Fauna hat insgesamt ein altertümliches Gepräge. 4 der 9 zumindest gattungsmäßig bestimmten Taxa sind Angehörige alter, miozäner Gruppen und finden in Dorn-Dürkheim oder vergleichbaren Fundstellen ihr stratigraphisch jüngstes Vorkommen“[6]). The occurrence together of this archaic element with more modern rodents suggests that the peculiarities of the Vösendorf-Götzendorf rodent faunas, especially in the absence of murids, are not so much the result of localized environmental control as of time, and/or distribution factors affecting the Vienna Basin. Castorids lead in abundance at Dorn-Dürkheim as well as at Götzendorf, and among sciurids, *Spermophilinus* is more abundant than flying squirrels at both places.

Götzendorf has little in its microfauna that ist not found at Dorn-Dürkheim. For certain there is only *Anomalomys* (known also from Eichkogel) und *Microtocricetus.* Other missing elements at least have near if not actual equivalents in *Democricetodon* vs. *Cricetulodon, Crusafontina* vs. *"Anourosorex",* and *Albanensia* vs. *Miopetaurista* (see BACHMAYER & WILSON 1985). At Dorn-Dürkheim,

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[6]) The insectivore fauna has collectively an archaic stamp. 4 of the 9 at least generically determined taxa are relatives of older Miocene groups and find in Dorn-Dürkheim or comparable localities their stratigraphically youngest occurrence.

Parapodemus lugdunensis is well-represented (18% of rodent fauna), and the glirids are modestly present (4%). The 18% murid representation is reduced in comparison with Eichkogel (44%) and Kohfidisch (41%), but still sufficiently abundant to suggest perhaps that absence of these groups in the Vösendorf-Götzendorf collections results not from environment but time and/or geographic area, as above mentioned. Castorids are rare at Eichkogel and Kohfidisch, and on the other hand are the most common rodents at Dorn-Dürkheim (33%), but this indication of a more immediate riparion source for the Dorn-Dürkheim fossils seems not to drastically reduce murid representation. On the other hand, murids are known from the western part of Europe as early as MEIN zone 9, so that it seems unlikely that time alone is responsible for murid absence at Vösendorf and Götzendorf (although this has been suggested by FREUDENTHAL & SONDAAR for the former fauna in an arrangement proposed in 1963). If the murids came from the

Faunal Comparison of Various Vallesian and Early Turolian Faunas

Group	Locality				
	Vösendorf	Götzendorf	Kohfidisch	Eichkogel	Dorn-Dürkheim
Plesiodimylus	absent	present	absent	absent at pit, but recorded otherwise	present
Lanthanotherium	absent	present	present	present	present
Heterosoricines	present	present	absent	absent	present
typical shrews	absent	present	varied	varied	present
desmanines	absent	present	present	present	present
typical talpines	present?	present	present	present	present
hedgehogs	present	present	present	present	present
bats	absent	absent?	varied	undet. fragments	absent?
pikas	absent	*Prolagus* common	present, in one pocket	absent	absent?
Spermophilinus	absent	present	present	present	present
flying squirrels	absent	present, giant	present	present	present, giant
castorids	present	present, common	present, rare	present, rare	present, and very common and diversified
eomyids	absent	absent	rare	rare	absent
glirids	absent	absent	present, and varied	present, and varied	present, and varied
zapodids	absent	absent	*Protozapus*	*Protozapus*	*Protozapus*
cricetids	present, but not advanced. Toothless jaw fragment *Anomalomys*	present, but not advanced. *Anomalomys* *Microtocricetus*	*Epimeriones* *Prospalax* *Kowalskia* common, no *Anomalomys*	*Epimeriones* *Prospalax* *Kowalskia* common, *Anomalomys*	*Epimeriones* *Prospalax* *Kowalskia*, no *Anomalomys*
murids	absent	absent	*Progonomys* 75%, *Parapodemus* 25%	*Parapodemus* *Progonomys* rare	*Parapodemus* only
Hystrix	*absent*	*absent*	*present*	*absent*	*absent*

east or southeast into Europe they would have expanded across the area of the Vienna Basin unless this basin was still too marshy for a possibly dry woodland kind of rodent, but this is shear speculation, and presence of *Spermophilinus* as a ground squirrel seems opposed. For the present, the absence of murids, and the possible real absence of glirids at Vösendorf and Götzendorf must remain a puzzle.

Several more or less recent papers have dealt with certain fossil mammals and their relation to environment. A paper by MÉON, BALLESIO, GUÉRIN & MEIN (1979) attempts to summarize palynology, climate, vertebrates, and time for the upper Neogene of western Europe. In this paper, various mammals are listed according to presumed forest, prairie, and marshland habitats. Such mammals as are pertinent to the present study are separated as follows.

Forest	Prairie	Marshy
Progonomys	*Microtocricetus*	*Castor*
Parapodemus lugdunensis	*Epimeriones austriacus*	*Trogontherium*
Miopetaurista thaleri	*Kowalskia fahlbuschi*	*Chalicomys*
	Protozapus	*Prosomys insuliferus*
	Pterospalax	
	Prosomys insuliferus	

About the best that can be made out of the above is that a combination of grassland interspersed with forested areas with dry floor represents Eichkogel-Kohfidisch, and a forested area with swamp or marsh floor represents Vösendorf-Götzendorf.

A. VAN DE WEERD & R. DAAMS (1978, 1979) have postulated for the Spanish sequence of rodent faunas a partial explanation of faunal shifts in terms of relatively wet periods alternating with relatively dry periods. In this sequence, the early Vallesian (zone 9) was relatively wet, the late Vallesian (zone 10), Turolian (11, 12, 13), and early Ruscinian (14) relatively dry. The taxa considered to be most useful for the recognition of dry and wet biotopes are ground squirrels such as *Spermophilinus* and castorids respectively. They believe also that as the murids become abundant, the cricetids decline, and these changes too are reflections of wet (cricetids dominant) to dry (murids dominant). A breakdown in percentages for MEIN zone 11 (dry) is for central Europe as follows.

	Dorn-Dürkheim		Kohfidisch*		Eichkogel		Götzendorf**
	Rank	%	Rank	%	Rank	%	Rank
(1)	Castoridae	(33)	Muridae	(41)	Muridae	(44)	Castoridae
(2)	Cricetidae	(28)	Cricetidae	(29)	Cricetidae	(34.5)	Sciuridae
(3)	Muridae	(18.5)	Gliridae	(19)	Gliridae	(12)	Cricetidae
(4)	Sciuridae	(16)	Sciuridae	(6)	Sciuridae	(7.5)	None
(5)	Gliridae	(4)	Zapodidae	(5)	Zapodidae	(2)	None

*) Eichkogel is more accurate than Kohfidisch census for reasons given in BACHMAYER & WILSON, 1980.

**) Götzendorf is too scanty to use percentages.

In general, for central Europe, it can be said that as castorids increase, zapodids, glirids, and murids decrease, cricetids and flying squirrels (probably) remain relatively constant, and *Spermophilinus* may increase. The *Spermophilinus* increase seems contrary to the Spanish sequence, and the above data seem partly in agreement and partly in strong disagreement with the interpretation of the Spanish sequence. At Götzendorf, the supposed ground squirrel, *Spermophilinus,* could have lived some distance from the stream and pond situation, and remains be brought in as disintegrating owl pellets. Still this should also have brought in glirids and murids if they too needed a dry floor environment. Murids may have not arrived in the Vienna Basin at this time, but glirids had reached the area long before.

In summary, it may be said that we surely have ways to go before unanimity in opinion is reached on the interpretation and correlation of the various micromammalian faunas of Europe.

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