Jens Lorenz Franzen[1], Oldrich Fejfar[2], Gerhard Storch[1] & Volker Wilde[1]
[1] Forschungsinstitut Senckenberg, Frankfurt am Main
[2] Charles University, Prague

Eppelsheim 2000 - new discoveries at a classic locality

Franzen, J. L., Fejfar, O., Storch, G. & Wilde, V., 2003- Eppelsheim 2000 – new discoveries at a classic locality - in: Reumer, J.W.F. & Wessels, W. (eds.) - Distribution and migration of Tertiary mammals in Eurasia. A volume in honour of Hans de Bruijn - DEINSEA 10: 217-234 [ISSN 0923-9308] Published 1 December 2003

First scientific excavations at the classic mammal locality of Eppelsheim carried out by the Senckenberg Research Institute during the years 1996 - 2000 are described (Senckenberg research project no. 150: Franzen & Storch). They resulted in the discovery of the first flora and determinable micromammals (*Talpa vallesensis*, *Plesiosorex* aff. *schaffneri*, *Crusafontina* sp.) as well as a phalange of a large hominoid (cf. *Dryopithecus* sp.) from that locality. The excavations also delivered new aspects for understanding the early formation of the Rhine river system.

Erste wissenschaftliche Ausgrabungen an der klassischen Säugetierfundstelle Eppelsheim durch das Forschungsinstitut Senckenberg (Senckenberg-Forschungsprojekt Nr. 150: Franzen & Storch) führten in den Jahren 1996 - 2000 zur Entdeckung der ersten Flora und bestimmbaren Kleinsäuger (*Talpa vallesensis*, *Plesiosorex*, *Crusafontina* sp.) sowie der Phalanx eines großen Hominoiden (cf. *Dryopithecus* sp.) an dieser Lokalität. Darüber hinaus ergaben die Grabungen neue Aspekte hinsichtlich der Entstehung des rheinischen Flußsystems.

Correspondence: J. L. Franzen, Jakobistr. 10, D-79822 Titisee-Neustadt, Germany, e-mail: jlfranzen@t-online.de; O. Fejfar, Department of Palaeontology, Charles University, Albertov 6, CZ-128 43 Praha 2, Czech Republic, e-mail: fejfar@natur.cuni.cz; G. Storch and V. Wilde, Forschungsinstitut Senckenberg, Senckenberganlage 25, D-60325 Frankfurt am Main, Germany, e-mail: Gerhard.Storch@Senckenberg.de and Volker.Wide@Senckenberg.de

Keywords: Mammalia, Insectivora, plants, taphonomy, Vallesian, Miocene, Europe

INTRODUCTION

Known already since the 18th century, the Late Miocene (Vallesian) locality of Eppelsheim is one of the classic sites of early mammalian palaeontology. It is situated about 35 km S of the city of Mainz, in the southern Mainz Basin (Fig. 1). Teeth, jaws, crania and postcranial bones were discovered by workmen digging in opencast pits for sand. Since 1817 the fossils were systematically collected by the Hessisches Landesmuseum Darmstadt. First descriptions of the fauna were published by Jean Jacques Kaup (1832-39) and August von Klipstein & J. J. Kaup (1836) as well as Hermann von Meyer (1829, 1832, 1842), while Georges Cuvier (1834, pp. 527-528) and William Buckland (1837, p. 603) commented on certain specimens.

It is in Eppelsheim where the first fossil ape, a complete femur, turned to light and where the first discoveries of the enigmatic 'Rhine elephant' *Deinotherium giganteum* were made (Fig. 2). Eppelsheim is also the type locality of no less than 25 valid mammal species, some of which still well known, e.g. *Amphicyon eppelsheimensis*, *Hippotherium primigenium*, *Chalicotherium goldfussi*, *Microstonyx antiquus*, and others (Appendix 1).

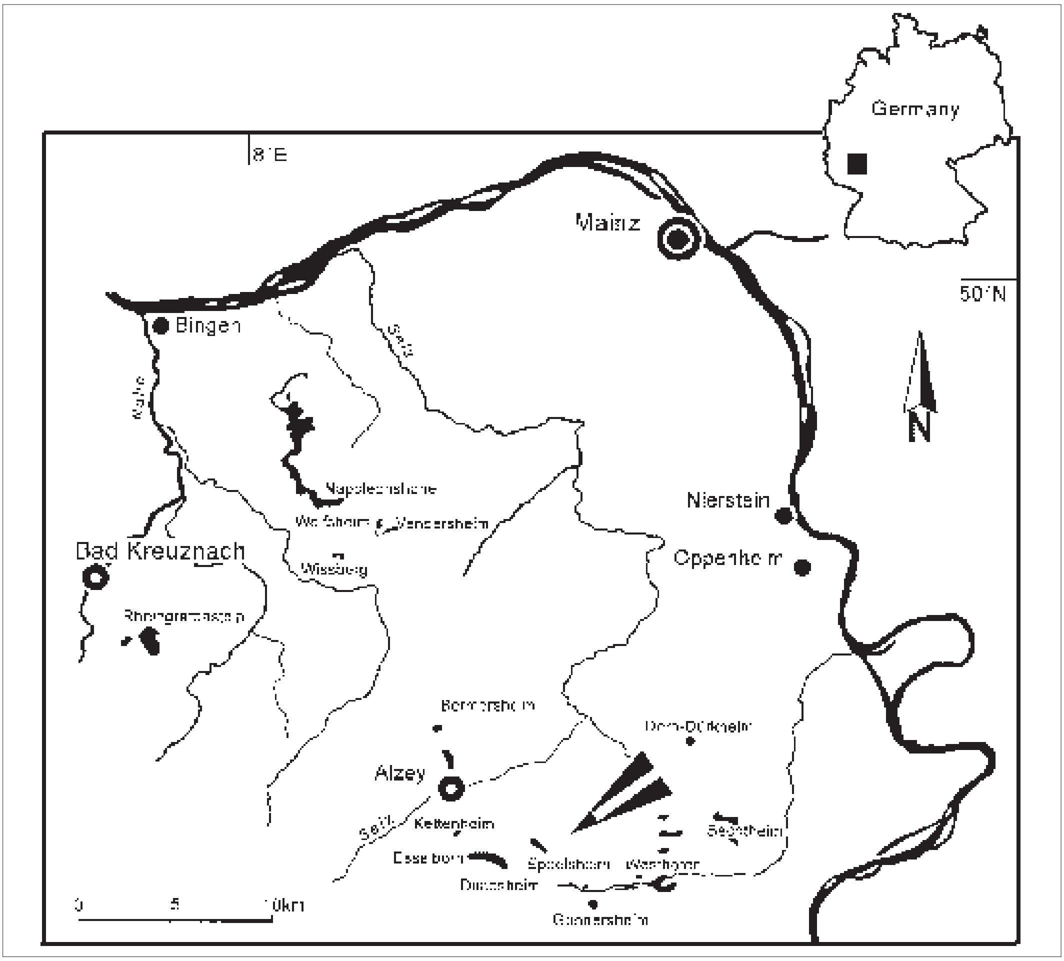

Figure 1 Location of Eppelsheim (arrow) and the Dinotheriensand Formation (black patches). (drawing: J.L. Franzen).

The steady flow of fossils came to an end during the 1930s, when the sand was no longer exploited by handwork, and its production moved from the Rhinehessian platform into the Rhine valley of today. So the old sand pits disappeared and were forgotten.

FIRST SCIENTIFIC EXCAVATIONS

It was not earlier than 1996 that first scientific excavations were undertaken by the Forschungsinstitut Senckenberg on the initiative and under the leadership of J.L. Franzen and G. Storch (Franzen 2000). Since 1998 also O. Fejfar, and since 1999 V. Wilde participated in that project. The program aimed at the following items: first, to get an idea of the taphonomic situation, and second, to enlarge our knowledge of the palaeontological content of the site, particularly of micromammals and hominoids. Hominoids are known from Eppelsheim already by the femur of 1817 named *Paidopithex rhenanus* POHLIG, 1895, and an upper canine known today as *Rhenopithecus eppelsheimensis* (HAUPT, 1935).

The first problem was to relocate the fossilliferous area. This was not easy because the old sandpits are completely filled, and levelled. A three steps strategy was applied: first, a survey of the questionable area was undertaken by J.L. Franzen on the basis of the existing geological maps. Then, elder inhabi-

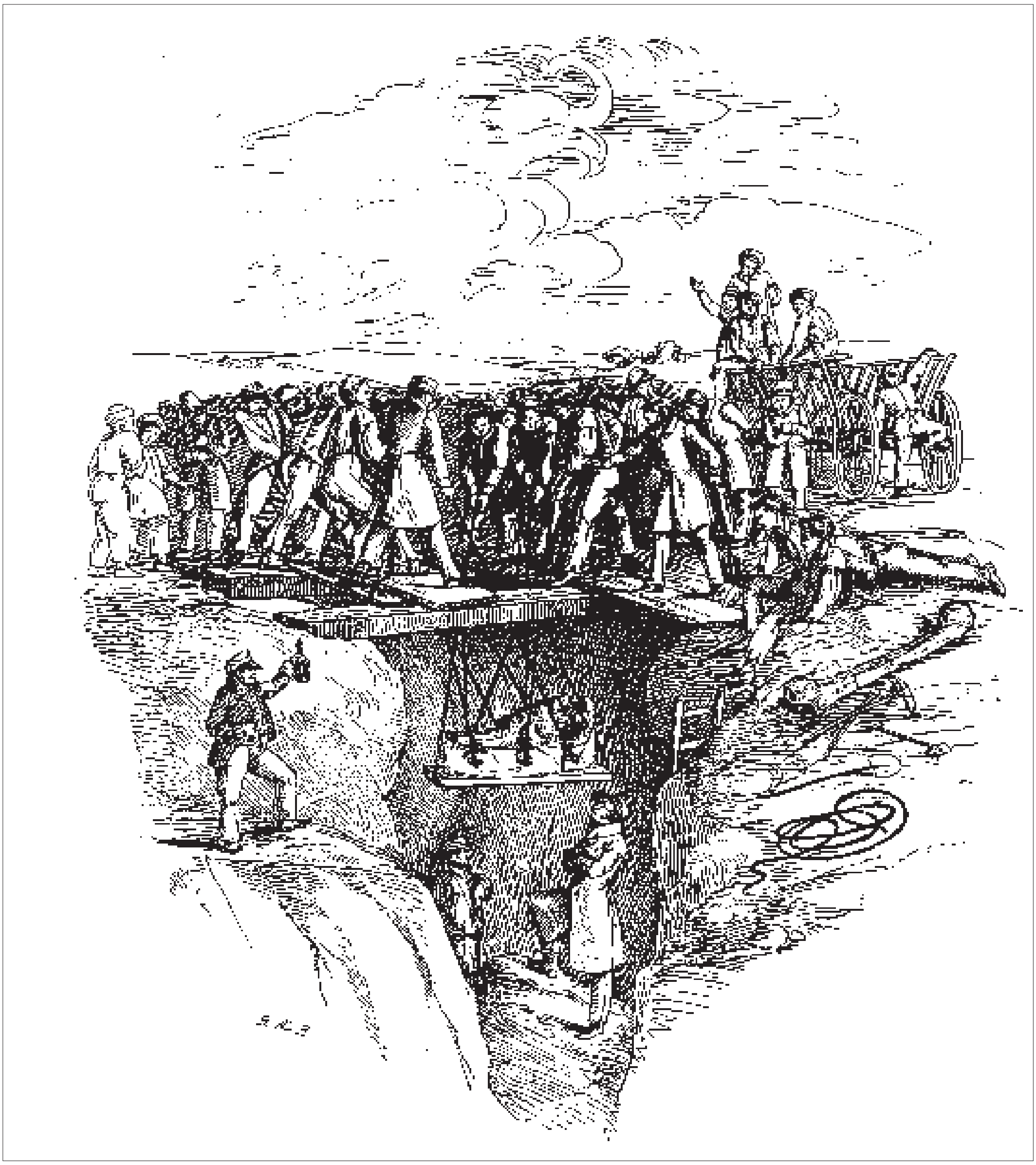

Figure 2 The classic scene when the first skull of the 'Rhine Elephant' *Deinotherium giganteum* was salvaged in 1835. (from Klipstein & Kaup 1836)

tants of the village of Eppelsheim were interviewed. Some of them still remembered more or less securely where they had played as young boys in the sandpits. This way a general idea developed where the Dinotheriensand Formation probably occurs below an overburden of several meters of Pleistocene loess. After that, a drilling program was begun in order to locate exactly the Dinotheriensand Formation in that area.

When that was successfully accomplished a large excavator was ordered (Fig. 3). Under three meters of soil and loess it uncovered the SW boundary of the Dinotheriensand Formation exactly as predicted. The sediments were evidently untouched, but we had to extend the hole 8 m down in order to reach the fossilliferous gravel situated at the base

Figure 3 Uncovering the Dinotheriensand Formation near Eppelsheim in September 1996 using a large excavator. (photo: J.L. Franzen)

of the sands on top of an olive green claystone.

Now, a first investigation could begin. It was our French colleague Sophie Montuire who was lucky to discover the first mammal fossil from Eppelsheim since more than half a century, a fragment of a mastodont molar. In spite of a very careful investigation it was the only fossil found on the SW riverbank where the Dinotheriensand Formation is only a few decimetres thick, and situated directly on top of the Early Miocene Inflata layers. All other fossils came from the gravel horizons occurring at the bottom of the sands (Fig. 7): several teeth and an almost complete femur of *Hippotherium primigenium* as well as teeth and a mandibula with the complete series of cheek teeth of rhino, a mandibular fragment with teeth of *Propotamochoerus palaeochoerus*, and an antler of *Euprox furcatus*.

It was also during the exploration of 1996 that J.L. Franzen discovered the first relics of leaves in clay lenses intercalated with the basal gravel and sands while he found worm tubes resembling those of the recent *Arenicola* from the underlying olive green clay (Fig. 4). Whereas the leaves were not so astonishing in view of the flora described already by Meller (1989) from the Dinotheriensand locality of Sprendlingen, the *Arenicola* like structures appeared rather strange for a fluviatile environment.

Based on the promising results of the exploration of 1996, it was possible to carry out an ambitious excavation program during the following years, and to get the financial support necessary for this. A net of square meters was installed, and exactly located applying GPS (Fig. 5). Each square meter

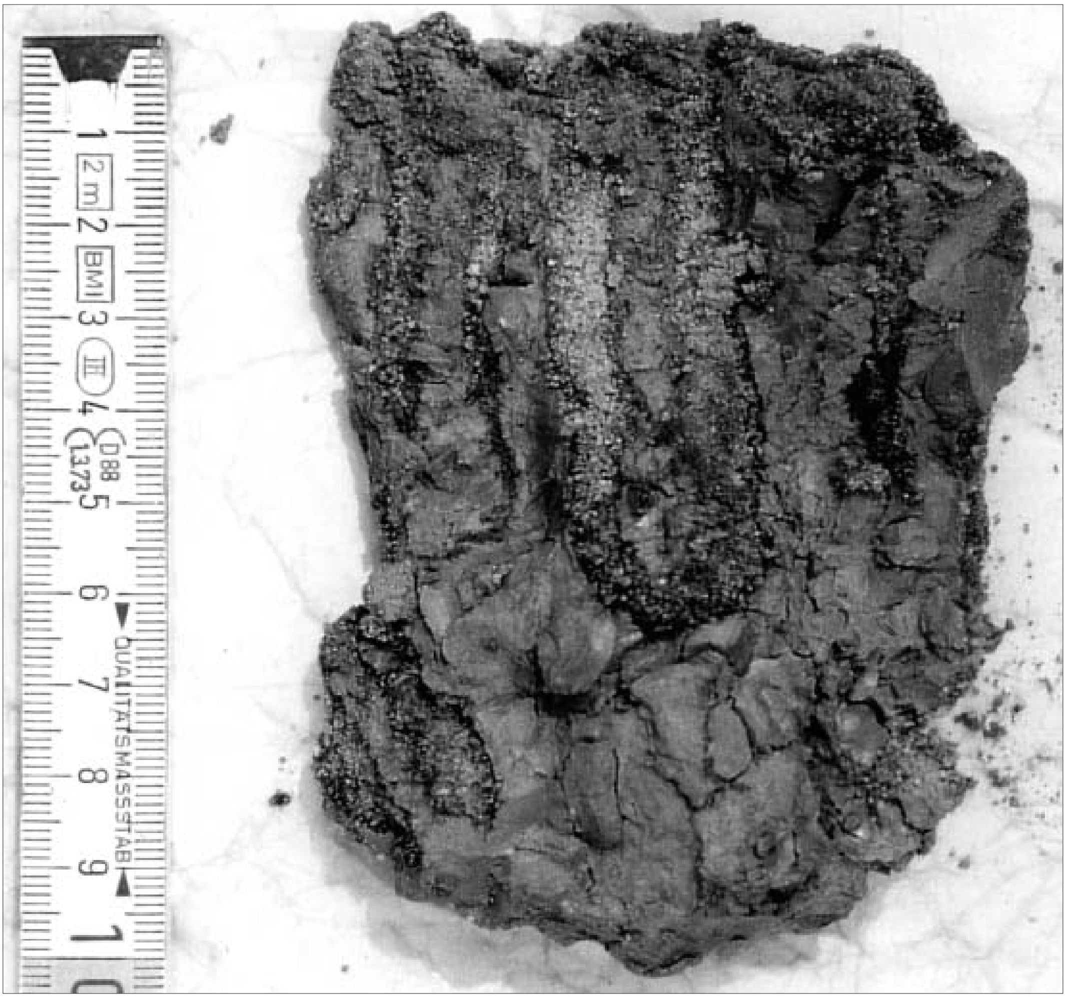

Figure 4 *Arenicola* like U-shaped worm tubes from the so-called basal claystone = Oligocene 'Süßwasserschichten'. (photo: J.L. Franzen)

was carefully investigated, and recorded using a drawing table equipped with a laser, and a pantograph. Also the height of each object was measured with a theodolith. This way, the results of our excavations were directly documented in a most detailed manner at a scale of 1 : 5 on prepared paper sheets. The entire excavated matrix from each square meter was then screenwashed to search for smaller teeth and bones, particularly of micromammals.

THE DRILLING PROGRAM

Subsequently to the rediscovery of the Dinotheriensand Formation, the drillings were continued during the following years in collaboration with the Geological Survey of Rheinland-Pfalz (W. Kuhn, M. Weidenfeller) as well as with D. Grüll from the Trischler Company at Darmstadt. Altogether 50 drillings were carried out up to now, most of them not deeper than 10 m (Fig. 6). Only two core drillings were conducted into depths of 29 and 21 m respectively. One of them (Eppelsheim 2) was located immediately east

of the excavation site. Unfortunately it disclosed an old sand pit instead of delivering a standard section for the Dinotheriensand Formation in that area (Appendix 2).
The drilling program led to the following results:
1. It was possible to trace the distribution of the Dinotheriensand Formation in that area.
2. The drillings showed that the Inflata layers occur in that area not only southwest but also northeast of the Dinotheriensand Formation (for the definition of Inflata layers = 'Inflata-Schichten' see Kadolsky & Schäfer 1995).
3. They showed also that the north-eastern bank of the early Rhine is as steep as the south-western one, and that it consists of Inflata layers too.
4. It was possible to reconstruct the course of the early Rhine River across about 300 m, and to measure its breadth as 45 – 60 m (Fig. 6).
5. The boreholes displayed considerable differences in the thickness of the Dinotheriensand Formation even at short distances pointing to a remarkable relief below the Dinotheriensand Formation. Such a relief was already observed by Klipstein & Kaup (1836, pp. 11-12).
6.The point indicated in the map of Ludwig (1866) as the site of the *Deinotherium* skull is evidently misplaced. A close net of boreholes provided neither any evidence of Dinotheriensand nor any indication of a former sandpit in that area. So the exact locality where the skull of *Deinotherium giganteum* was discovered and salvaged in 1835 remains enigmatic.
7. The drillings also showed that a sequence of former sand pits follows the valley of the early Rhine River (Fig. 6). Therefore, the old valley is recognisable today as a shallow depression resulting from the exploitation for

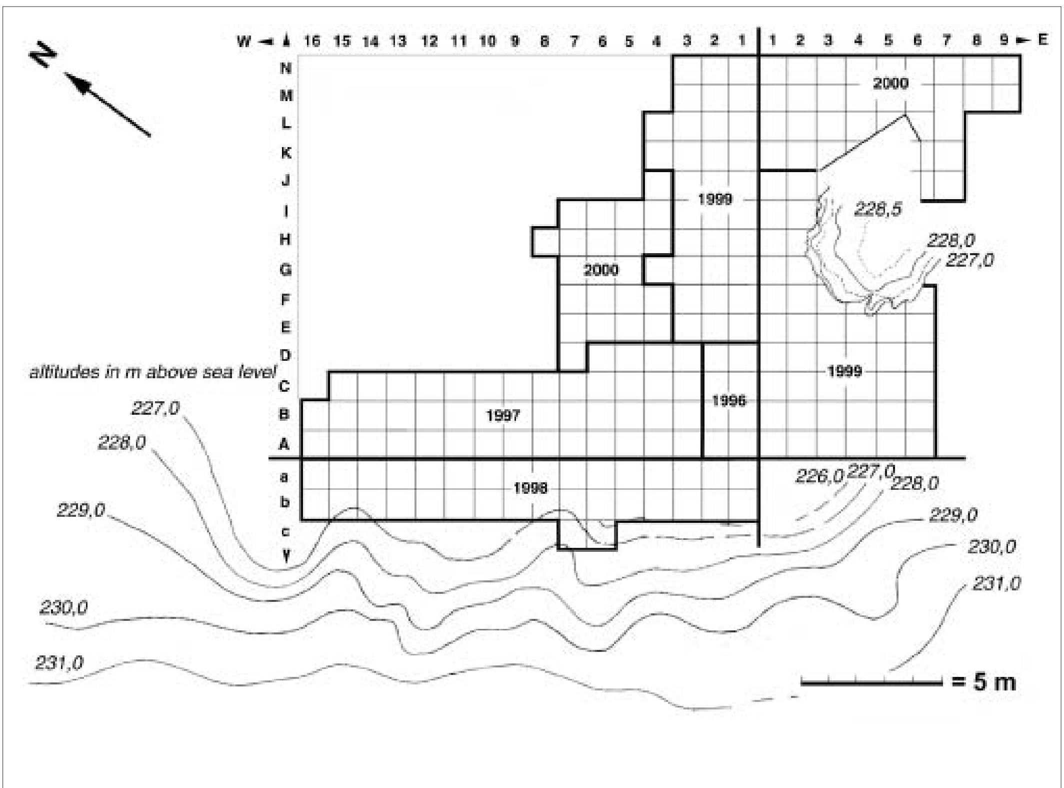

Figure 5 Map of the Senckenberg excavations at Eppelsheim during the years 1996 - 2000. (drawing: J.L. Franzen after C. Hemm)

sand. It starts near the village in the field 'Im Jörgenbauer', and extends from there in a north-western to northern direction away from the village of Eppelsheim towards the field 'Hundsbacken'. Presumably the earliest sand pits were closest to the village, where the transport of sand was not so far, and they are all the way younger the further they are situated from the village. So the sand pit in the field 'Hundsbacken' was the latest one, still being open when Bartz (1936, p. 141) was working in that area.

GEOLOGY

The campaign of 1997 enlarged the excavation site in a north-western direction, following the steep south-western wall of the quarry. This wall consists of Inflata layers, striking 144° (100°-155°) and dipping at their steepest part 49° (44°-67°) NE. Such a relief was quite unexpected although the section published by Klipstein & Kaup (1836, pl. 6, fig. 4) showed almost vertical walls of presumably Inflata layers at both sides too. That, however, seemed to represent a special situation, possibly a small channel because those walls were only 4 – 5 m apart from each other. By contrast the new site is evidently situated at the south-western border of the main stream.

Two interpretations of the steep inclination of the Inflata layers seem possible. One is to regard it as a flexure due to tectonics. The alternative is to consider it as result of a breakdown of a cave system formed by subrosion due to karst processes. The cave hypothesis was first suggested by Winfried Kuhn of the Geological Survey (Geologisches Landesamt) of Rheinland-Pfalz. It was supported by the discovery of lawns of calcite crystals formed evidently in cavities of the Inflata layers. It is corroborated by the extraordinary relief disclosed in the course of the drilling program.

The karst hypothesis solves a problem recognised already by Bartz & Weiler (1954), who pointed to the contradiction that the Dinotheriensand Formation was said to be

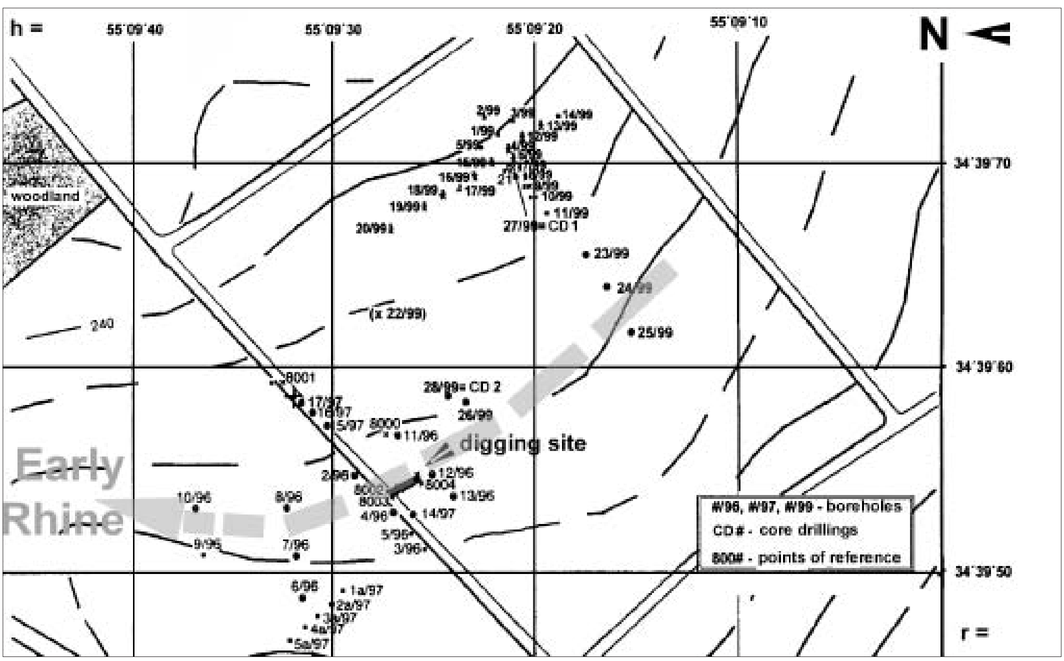

Figure 6 Map showing the location of the boreholes of 1996 – 1999, as well as a first, still tentative reconstruction of the course of the early Rhine in that area. Full circles = Dinotheriensand, black squares = limestone or marls, open squares = fine grey sand without mica (? Plio- or Pleistocene). (drawing: J.L. Franzen after C. Hemm and C. Hertler)

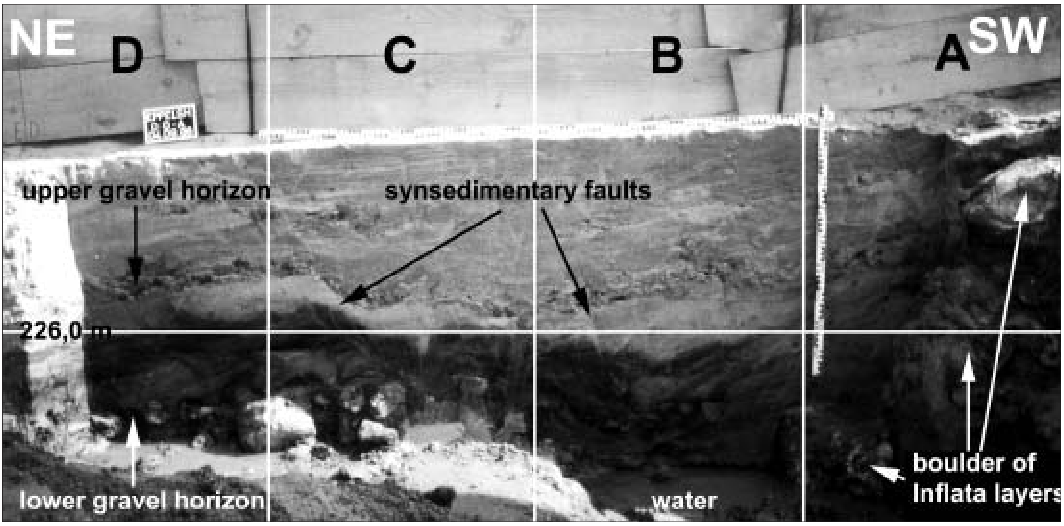

Figure 7 Section through the fossiliferous layers at the base of the Dinotheriensand Formation 0.5 m E along (see A - D/O Fig. 5). (photo: J.L. Franzen)

deposited in erosional channels or crevasses, although its sequence allegedly begins with a claystone, hence a stillwater sediment. However, as it turned out in the course of our investigations, the claystone does not belong to the fluviatile Dinotheriensand Formation. A drilling undertaken by the Geological Survey showed that the sequence of claystones and argillaceous marls is more than 15 m thick (Appendix 2), and not 6 – 7 feet (= 1,8 – 2,1 m) as stated by Klipstein & Kaup (1836). The microfauna of this sequence was investigated by P. Schäfer and W. Kuhn of the Geological Survey. The results of their analyses as well as the facies clearly indicate that these layers belong to the Late Oligocene 'Süßwasserschichten' (freshwater layers). Earlier studies have shown (Mödden *et al.* 2000) that the faunistic content of the 'Süßwasserschichten' does not contradict a brackish environment, which would explain the discovery of the *Arenicola* like worm tubes mentioned before.

Strange is the extent of the hiatus at the base of the Dinotheriensand Formation. It comprises not only the Inflata layers. The whole sequence of the Late Oligocene to Early Miocene 'Cerithienschichten' appears to be lacking too. This amazing evidence cannot be explained by a tectonic uplift setting side by side the Late Oligocene 'Süßwasserschichten' with the Early Miocene Inflata layers because the strong NE dip of the Inflata layers indicates a movement in the opposite direction.

On the present stage of our knowledge the situation can be explained by the following scenario: while at least the lower part of the 'Cerithienschichten' was primarily lacking in that area (Wagner 1933, p. 38), the rest of it and the Inflata layers were severely karstified when the sea retreated from the Mainz Basin. The damming horizon for that karstification was evidently the argillaceous 'Süßwasserschichten', being 30-45 m thick (Wagner 1933, p. 37). As a consequence of that karstification, valleys appeared that cleared the pass for the development of a fluviatile drainage system that finally became the early Rhine river ('Urrhein').

Interestingly, the fluvial sedimentation began with gravel, sands and even claystones. While the gravel points to a marked relief of the landscape as it is indicated by the drillings, the rapidly changing grain size points to rapidly changing hydrodynamics, perhaps due to occasional flood disasters. It is only about one meter above the basal olive green claystone that the fluvial sedimentation becomes more regular, indicating that the early Rhine river began to flow more steadily (Fig. 7). It is possible that the early Rhine originated in the Eppelsheim area as a cave river. This hypothesis would not only match the karstification. It would also explain the large block of Inflata layers, that appeared in the middle of the Dinotheriensand during our excavations of 1998 (Figs. 8-9). Its volume is about 35 m^3. The river could not have transported such a block because of its size but the block could very well be a relic of the former cave roof. Up to now the high level of groundwater prevented us from excavating the underlying layer. As soon as this will be achieved we shall know the origin of the block as well as the time of the eventual breakdown of the cave. Additionally, a drilling through the Inflata layers would help to clarify the geologic situation.

TAPHONOMIC CONTEXT

An important aspect for all future excavations is the development of the fossil lagerstaette. At least three different situations were observed that evidently led to an accumulation of fossils.

The first situation is in front of the steep wall in the south-west of the lagerstaette. Here, the river channel turns slightly into a more northern direction (Fig. 6) while the gradient of the current was NW in general (Bartz 1936, pp. 209-210). Obviously due to erosional undermining of the steep channel wall large boulders of limestone tumbled down the slope forming a barrier on the bottom of the river. It is in front and behind this barrier as well as between the boulders that accumulations of fossils occur (Fig. 9). Another situation is behind the large block of Inflata layers appearing in the middle of the river channel. Here, a fan shaped accumula-

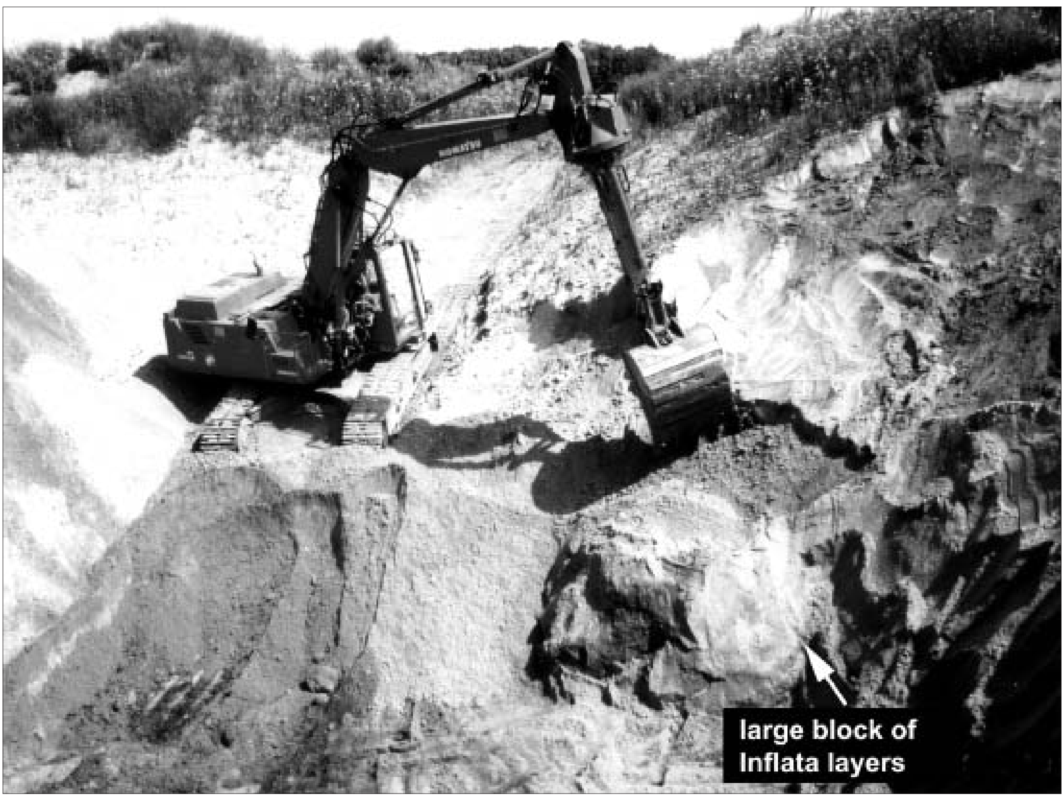

Figure 8 A large block of Inflata layers showed up in the middle of the Dinotheriensand during the preparation of the excavations of 1998. (photo: J.L. Franzen)

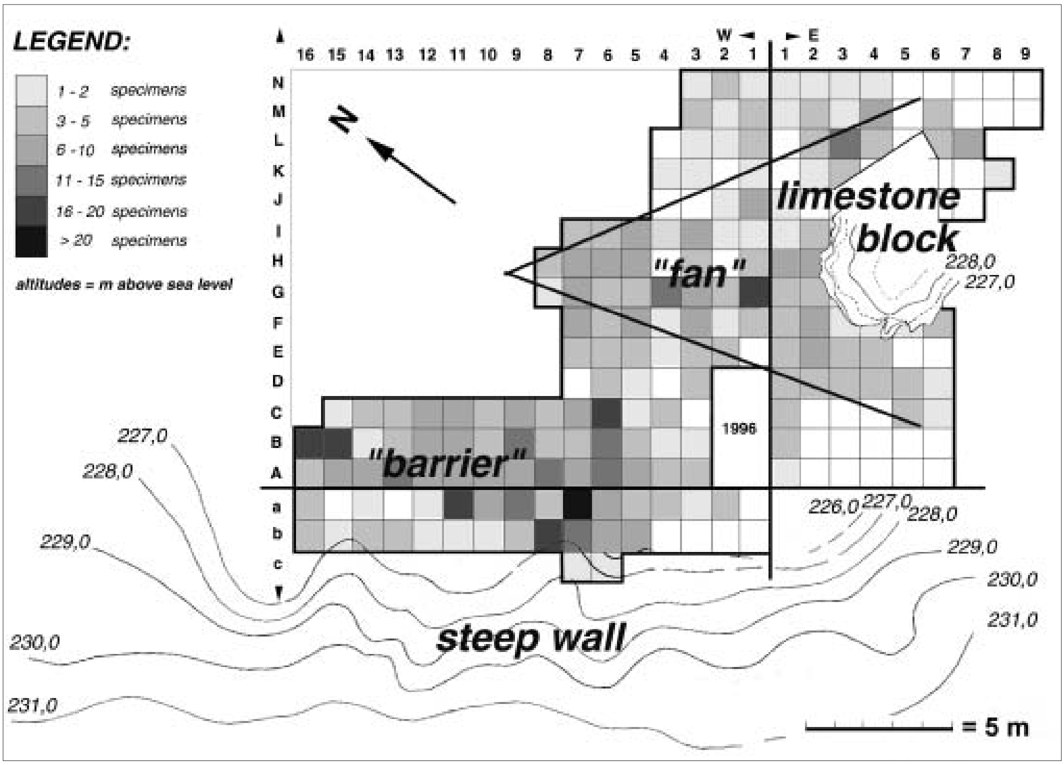

Figure 9 Frequency of fossils in the area excavated 1996 – 2000 (number of fossils per square meter). (drawing: J.L. Franzen)

tion of fossils was found N of that block in its backwater. The third situation concerns the plant material. This occurs in light green to grey or yellowish clay lenses intercalated with the sandy and conglomeratic facies near the bottom of the Dinotheriensand Formation. This clay obviously comes from the weathering of the Inflata layers that is often thickly covered by such clay. That clay was later on washed off and deposited in puddles indicating occasional stillwater conditions and even draining of the riverbed. Leaves were blown into those puddles, and preserved this way.

The preservation of the fossil mammals corresponds with stages 3 and 4 as Tobien (1983, p. 197) already observed from the old collections. Stage 3 (skeletal parts) is represented e.g. by a complete mandible of a mastodont and several bones of *Deinotherium*, among others an almost complete femur. Most of the specimens belong to stage 4 (dentaries as well as isolated teeth and bones), while stages 1 (skeletons) and 2 (partial skeletons) did not occur up to now. There is no indication that the fossilliferous horizons (mainly the two gravel horizons shown in Fig. 7) represent different biostratigraphic levels. The whole fauna of the collections recovered during the years 1996-2000 appears to be uniform except for two shark teeth and a fragment of a rib of *Halitherium* being evidently reworked (but see footnote no. 3 on pp. 232 referring to the old collections).

PALEONTOLOGICAL CONTENT

Plant remains

Except for earlier records of silicified dicotyledonous wood from Gau-Algesheim and Westhofen (Wagner 1947, p. 171), plant remains in the Dinotheriensande of Rheinhessen were hitherto restricted to a lens of clay that was formerly exposed in a sand pit at the Steinberg near Sprendlingen, ca. 25

km NW of Eppelsheim (Meller 1989). The respective taphocoenosis (Appendix 3) was preserved as impressions without any remaining organic material. It consists mainly of foliage and a few fructifications. Due to inadequate preservation, unequivocal determination of individual taxa is limited (Meller 1989).

Now, the excavations at the classic locality of Eppelsheim also exposed a few lenticular layers of light green to grey or yellowish clay within the coarse grained fluvial deposits delivering the faunal remains. Similar to the situation at Sprendlingen, impressions of leaves, limonitic casts of wood and a single *Trapa*-fruit were found (Fig. 10a-d). The leaf remains are devoid of any organic material but carry a brown and/or black stain caused by the precipitation of limonitic material and/or manganese oxides, sometimes preferably along the venation. Due to the oxidative destruction of organic material the clay turned out to be palynologically barren. Preservation of the leaves is at Eppelsheim much worse than at Sprendlingen. In most cases the remains are highly fragmentary and details are frequently obscured by limonitic encrustations. Therefore, features of the leaf margin often remain questionable and visible characters of the venation are mostly restricted to patterns of the lower orders. Higher order venation is rarely exposed. It was possible, however, to identify some taxa more or less securely by their leaves (Fig. 10a-c). Conifers are represented by a single taxodiaceous leafy shoot (cf. *Taxodium* sp.). Fagaceae are represented by *Fagus*-type leaves with percurrent tertiaries while quercoid leaves display a lobed margin. Some of the leaves roughly recall a betulaceous type, while others may belong to *Populus* (Salicaceae). Fragments of linear monocotyledonous leaves cannot be determined in more detail. The single fruit of *Trapa silesiaca* Goeppert, 1855 (Trapaceae; det. J. Wojcicki) is an exception in being almost completely preserved (Fig. 10d).

Not surprisingly, all of the taxa recovered

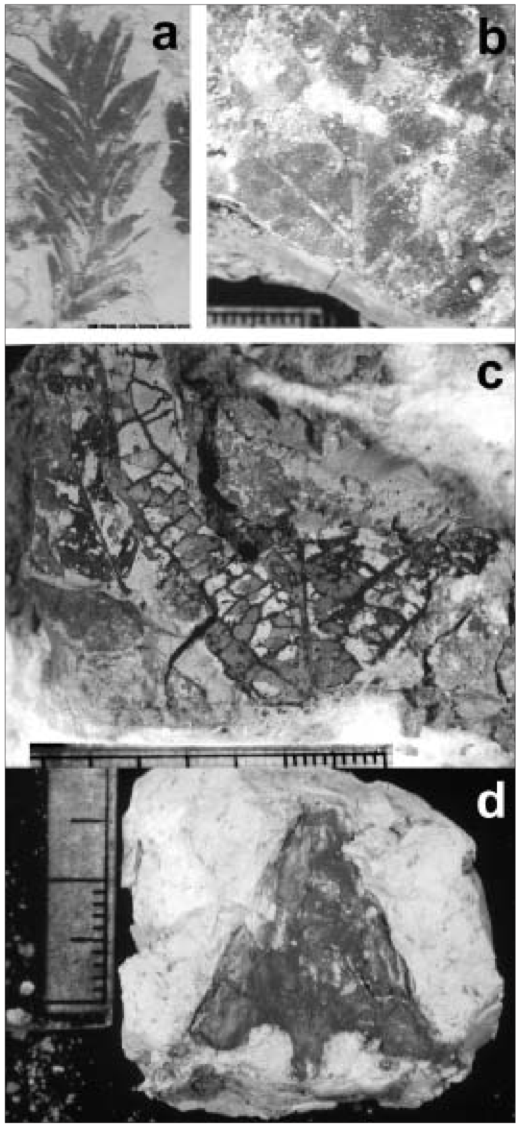

Figure 10 The first plant remains from Eppelsheim. **a** taxodiaceous leafy shoot cf. *Taxodium* sp., **b** *Fagus*-type leaf, **c** *Populus*-type leaf, **d** fruit of *Trapa silesiaca.* (photos: V. Wilde)

from Eppelsheim are also represented at Sprendlingen (Appendix 3). In combination with a similar taphonomic scenario which is indicated by lenticular intercalations of clay in coarse clastic sediments at both localities, the leaves at Eppelsheim may also derive from some kind of riparian forest as suggested for Sprendlingen by Meller (1989). With regard to climate, the plant taphocoenosis of

Sprendlingen suggests balanced humid and warm-temperate conditions without a marked dry period (Meller 1989, p. 83; Mai 1995, Tab. 19). This corresponds well with *Taxodium* and *Trapa* occurring more or less contemporaneously at Eppelsheim.

Fossil vertebrates

Except for some undetermined fish teeth and vertebrae and many fragments of turtles, the fauna of Eppelsheim consists almost entirely of mammals (Appendix 1). Most of the mammal species became already known in the 19th century mainly by the work of Jean Jaques Kaup (1832-1839, 1854-1861). Some additions were later made by Klähn (1931), Haupt (1935a,b), Tobien (1953, 1955), Gräf (1957), and Hünermann (1968). It is astonishing that, except for the beaver *Palaeomys castoroides*, the mammal fauna consisted up to now only of primates, carnivores, proboscideans, and ungulates. Micromammals, providing today the standard for mammalian biochronology, were completely unknown from the Dinotheriensand Formation in spite of considerable efforts undertaken by Tobien and his students (Tobien 1983). This is the more deplorable as the Dinotheriensand Formation as a whole plays an important role in stratigraphic schemes, Eppelsheim and the Wissberg also as hominoid localities.

We did not only screenwash large amounts of sediment but tried from the beginning to find special pockets of micromammals. Therefore, we looked particularly into fissures of the Inflata layers as well as behind large boulders or fossils or into the interior of large bones. All this, however, led only to a few rodent incisors as well as some very rare and indeterminable molar fragments. It was not earlier than in 2000 that Oldrich Fejfar identified a left mandible of *Plesiosorex* aff. *schaffneri* Engesser, 1972 that was discovered in three parts by screenwashing. All three parts belong evidently to one and the same individual. The middle of the fragments contains m1-2. Comparisons show that *Plesiosorex* aff. *schaffneri* from Eppelsheim is smaller than the type specimen from Anwil. It resembles very much *Plesiosorex* aff. *schaffneri* from Rudabanya. A comparison with *Plesiosorex* from Hammerschmiede, determined by Ziegler (1999) as *P. styriacus* (Hoffmann, 1892) is difficult because m1 is

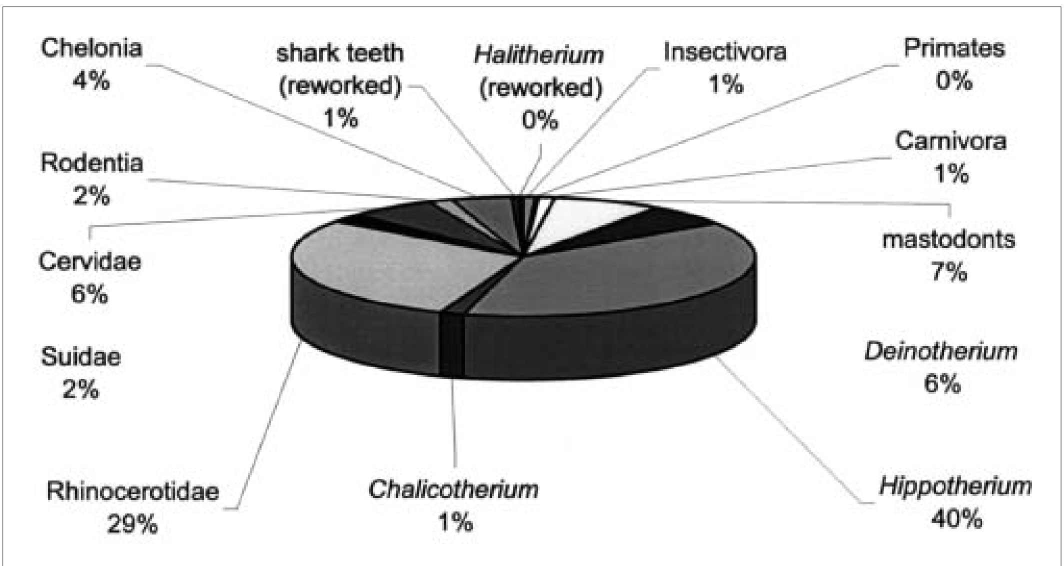

Figure 11 Preliminary taxonomic distribution of vertebrate fossils discovered during the Senckenberg excavations at Eppelsheim 1996 – 2000. Total number of identified specimens = 341. (drawing: J.L. Franzen)

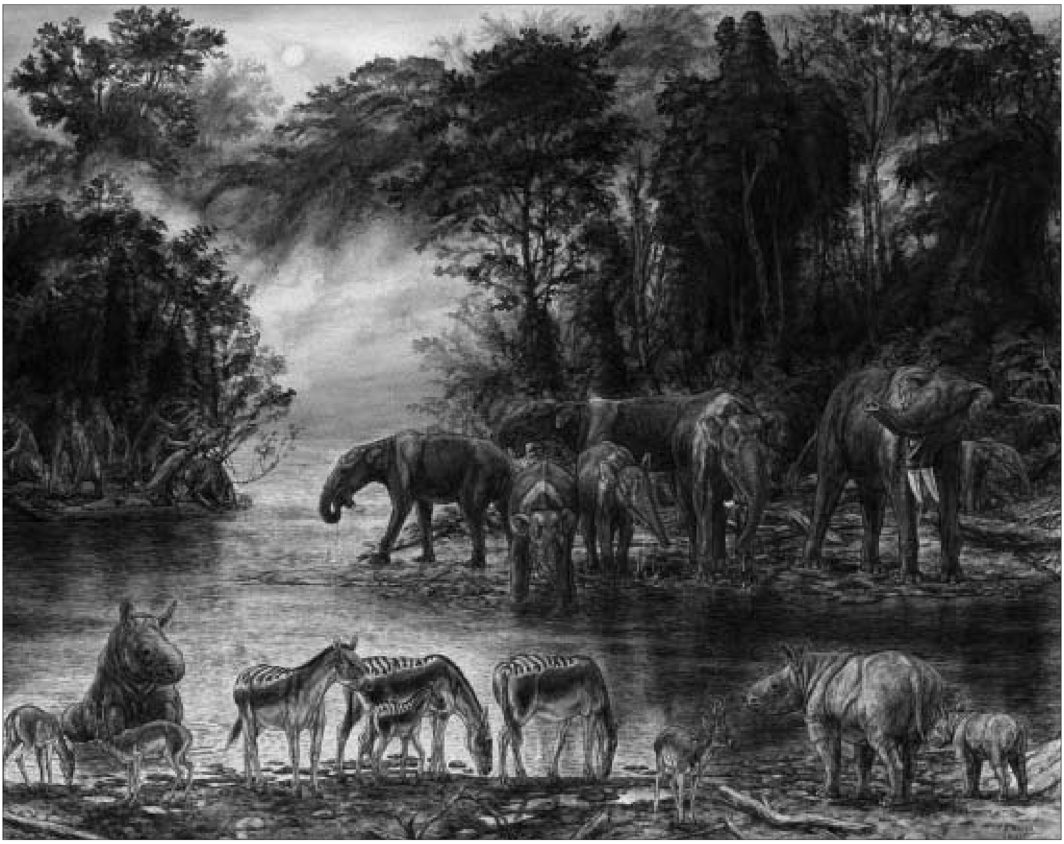

Figure 12 (see also cover of this volume) Early summer morning on the banks of the Late Miocene Rhine river. In the foreground hornless rhinos (*Aceratherium incisivum*), deer (*Euprox furcatus*), and horses (*Hippotherium primigenium*), in the right background a herd of "rhine elephants" (*Deinotherium giganteum*), and on the left side at a distance a group of the strange claw-footed perissodactyls (*Chalicotherium goldfussi*). (watercolour: Pavel Major, Prague; courtesy of the community of Eppelsheim)

lacking in that specimen. A more detailed study will hopefully clarify the taxonomic position of these specimens (Franzen, Fejfar & Storch in prep.). It was also in the year 2000 that two humeri of *Talpa vallesensis* Villalta & Crusafont, 1944 turned to light as well as the distal half of an intermediate phalange of a large hominoid resembling very much *Gorilla* and *Pan*, and being almost identical with *Dryopithecus laietanus* from Can Llobateres (Franzen in prep.).

All those discoveries came from the uppermost fossiliferous layers although the exact facies of their occurrence remained enigmatic. It was one year later, in the campaign of 2001, co-operatively organised and carried out by the 'Naturhistorisches Museum Mainz / Landessammlung für Naturkunde Rheinland-Pfalz' and the 'Forschungsinstitut Senckenberg Frankfurt' that more micromammals were discovered in that horizon. Except for a few rodent incisors this was an upper jaw with teeth of the soricid *Crusafontina*. Some of the micromammals were recognised to come from large rounded chunks made of a light brown soil-like silt that possibly slided down from the banks of the early Rhine river (an idea suggested by H. Lutz of the Mainz Museum) while others were screenwashed from coarse sediments. In any case, there is now some evidence where to search for more micromammals.

Altogether, nearly 350 determinable vertebrate fossils were discovered during the years

1996-2000, representing 19 mammal species, some of them obviously hitherto unknown (Fig. 11; Appendix 1). Most of the determinable specimens belong to *Hippotherium*. Rhinos are also quite frequent. All other taxa are more or less rare, the rarest being the insectivores, the rodents, and - as usual - the primates.

CONCLUSIONS

The first scientific excavations carried out at the classic locality of Eppelsheim did not only result in the discovery of the first determinable micromammals (*Talpa vallesensis*, *Plesiosorex* aff. *schaffneri*, *Crusafontina* sp.), and the first record of a large hominoid (cf. *Dryopithecus* sp.) from that locality but delivered also interesting new aspects for understanding the early formation of the Rhine river system. It appears promising to continue and expand this program in the future.

ACKNOWLEDGEMENTS

The excavations and their results would not have been possible without a very good cooperation between the 'Forschungsinstitut Senckenberg', the 'Landesamt für Denkmalpflege Rheinland-Pfalz', the 'Naturhistorisches Museum Mainz / Landessammlung Rheinland-Pfalz', and the 'Geologisches Landesamt Rheinland-Pfalz' (Geological Survey). Invaluable was the practical support that came from Dipl.-Ing. Dieter Grüll of the Trischler Company at Darmstadt. The same holds true for the financial support we got over the years from the Paul Ungerer Foundation, the Erika and Walter Datz Foundation, the Rüppelfonds of the 'Senckenbergische Naturforschende Gesellschaft', the 'Landessammlung für Naturkunde' and the 'Landesamt für Denkmalpflege Rheinland-Pfalz'. We are particularly indebted to the community of Eppelsheim that helped considerably to realise the excavations of 1997. Among many others, we thank particularly Heiner Bicking, Cläre and Walter Bieser, and last not least the former mayor of Eppelsheim, Heiner Roos, and his successor Erich Wetz for their permanent interest and help. The installation of the square meter system of our excavation area is due to the effort of Prof. Wiemann (Fachhochschule Frankfurt). Greatly acknowledged is the many years long hospitality of the Oswald family at Eimsheim. Last not least, is V.W. grateful to J. Wojcicki (Inst. Bot. PAN, Kraków) who kindly provided the specific determination of the *Trapa*-fruit. Thanks go also to the reviewers, Jorge Agusti (Sabadell) and Thomas Mörs (Stockholm), for their useful suggestions, as well as to the editors of this volume.

REFERENCES

Andrews, P., Harrison, T., Delson, E., Bernor, R.L. & Martin, L., 1996 – Distribution and Biochronology of European and Southwest Asian Miocene Catarrhines – in: Bernor, R.L., Fahlbusch, V. & Mittmann, H.-W. (eds.) - The Evolution of Western Eurasian Neogene Mammal Faunas: 168-207

Bartz, J., 1936 – Das Unterpliocän in Rheinhessen – Jahresberichte und Mitteilungen Oberrheinischer geologischer Verein, Neue Folge 25: 121-226

Bartz, J. & Weiler, W., 1954 – Bericht über die 75. Tagung des Oberrheinischen Geologischen Vereines vom 20. bis 24. April in Alzey (Rheinhessen) – Jahresberichte und Mitteilungen Oberrheinischer geologischer Verein 36: vii-xvii

Begun, D.R., 1992 – Phyletic Diversity and Locomotion in Primitive European Hominids – American Journal of Physical Anthropology 87: 311-340

Buckland, W., 1837 – Supplementary Notes to the First and Second Edition of Dr. Buckland's Bridgewater Treatise with a Plate of the Fossil Head and Restored Figure of the Dinotherium – pp. 595-618; William Pickering, London

Cuvier, G., 1834 – Recherches sur les ossemens fossiles où l'on rétablit les caractères de plusieurs animaux dont les revolutions du globe ont détruit les espèces – 4th ed., 3: 1-436; Edmond d'Ocagne, Paris

Franzen, J.L., 2000 – Auf dem Grunde des Urrheins – Ausgrabungen bei Eppelsheim – Natur und Museum 130 (6): 169-180

Gräf, I.E., 1957 – Die Prinzipien der Artbestimmung bei Dinotherium – Palaeontographica (A) 108: 131-185

Harris, J.M., 1973 – *Prodeinotherium* from Gebel Zelten,

Libya – Bulletin of the British Museum of Natural History, Geology 23: 285-350
Haupt, O., 1935a – Andere Wirbeltiere des Neozoikums – in: Salomon-Calvi, W. (ed.), Oberrheinischer Fossilienkatalog 4 (9): 1-103; Berlin: Borntraeger
Haupt, O., 1935b – Bemerkungen über die Hirsche aus dem Dinotheriensand Rheinhessens – Notizblatt des Vereins für Erdkunde und der Hessischen Geologischen Landesanstalt Darmstadt (5) 16: 50-55
Hünermann, K. A., 1968 – Die Suidae (Mammalia, Artiodactyla) aus den Dinotheriensanden (Unterpliozän = Pont) Rheinhessens (Südwestdeutschland) – Schweizerische Paläontologische Abhandlungen 86: 1-96
Kadolsky, D. & Schäfer, P., 1995 – "*Corbicula*-Schichten" und "Inflata-Schichten" (Miozän, Mainzer Becken) : Zur Begriffsklärung zweier unterschiedlicher stratigraphischer Einheiten – Mainzer geowissenschaftliche Mitteilungen 24: 71-86
Kaup, J. J., 1832-39 – Description d'Ossements fossiles de Mammifères inconnus jusqu'à présent, qui se trouvent au Muséum grand-ducal de Darmstadt – J.G. Heyer, Darmstadt
Kaup, J. J., 1854-61 – Beitraege zur naeheren Kenntniss der urweltlichen Saeugethiere – C. W. Leske, Zernin, Darmstadt und Leipzig
Klähn, H., 1931 – Rheinhessisches Pliozän, besonders Unterpliozän im Rahmen des mitteleuropäischen Pliozäns – Geologisch und Palaeontologische Abhandlungen, Neue Folge 18 (5): 277-340
Klipstein, A. v. & Kaup, J. J., 1836 – Beschreibung und Abbildungen von dem in Rheinhessen aufgefundenen colossalen Schedel des *Dinotherii gigantei* mit geognostischen Mittheilungen über die knochenführenden Bildungen des mittelrheinischen Tertiärbeckens – C. F. Will, Darmstadt
Ludwig, R., 1866 – Geologische Spezialkarte des Grossherzogthums Hessen und der angrenzenden Landesgebiete im Maasstabe von 1 : 50000. Herausgegeben vom mittelrheinischen geologischen Verein, Section Alzey – G. Jonghaus, Darmstadt
Mai, D.H., 1995 – Tertiäre Vegetationsgeschichte Europas – Gustav Fischer Verlag, Jena, Stuttgart, New York
Meller, B., 1989 – Eine Blatt-Flora aus den obermiozänen Dinotherien-Sanden (Vallesium) von Sprendlingen (Rheinhessen) – Documenta naturae 54: 1-109
Meyer, H. v., 1829 – Ueber Choeropotamus Soemmeringii et Equus primigenius – Zeitschrift für Mineralogie 1829: 150-153
Meyer, H. v., 1832 – Beiträge zur Petrefaktenkunde, fossile Säugethiere – Acta Acad. Caes. Leop. Carol. Nat. Cur. 16 (2): 423-462 (1-40)
Meyer, H. v., 1842 – *Tapirus priscus*, *Dorcatherium* von Eppelsheim. *Palaeomeryx* von Mombach. *Rhinoceros Merckii* von Daxlanden – Neues Jahrbuch für Mineralogie 1842: 585-587
Mödden, C., Schäfer, P., Reichenbacher, B., Schwarz, J. & Kadolsky, D., 2000 – Säugetiere, Fisch-Otolithen, Ostrakoden, Mollusken und Charophyten aus den Süßwasserschichten (Oligozän) von Wolfsheim im Mainzer Becken – Paläontologische Zeitschrift 74 (3): 343-361
Tobien, H., 1953 – *Miotragocerus* Stromer (Bovidae, Mamm.) aus den unterpliocänen Dinotheriensanden Rheinhessens – Notizblatt des Hessischen Landesamtes für Bodenforschung 81: 52-58
Tobien, H., 1955 – Neue und wenig bekannte Carnivoren aus den unterpliozänen Dinotheriensanden Rheinhessens – Notizblatt des Hessischen Landesamtes für Bodenforschung 83: 7-31
Tobien, H., 1980 – Taxonomic Status of some Cenozoic Mammalian Local Faunas from the Mainz Basin – Mainzer geowissenschaftliche Mitteilungen 9: 203-235
Tobien, H., 1983 – Bemerkungen zur Taphonomie der spättertiären Säugerfauna aus den Dinotheriensanden Rheinhessens (Bundesrepublik Deutschland) – Weltenburger Akademie (Erwin Rutte-Festschrift): 191-200
Wagner, W., 1933 – Die Schollentektonik des nordwestlichen Rheinhessens – Notizblatt des Vereins für Erdkunde und der Hessischen Geologischen Landesanstalt Darmstadt (5) 1931/1932 (14): 31-45
Wagner, W., 1947 – Das Gebiet des unterpliozänen Ur-Rheins in Rheinhessen und seine Tierwelt – Die Naturwissenschaften 34 (6): 171-176
Ziegler, R., 1999 – Order Insectivora – in: Rössner, G.E. & Heissig, K. (eds.) - The Miocene land mammals of Europe- pp. 53-74, Pfeil, München

Received 8 October 2001
Accepted 16 September 2002

APPENDIX 1 Mammal fauna of Eppelsheim (after Tobien 1980, pp. 216-218, and present paper). (T) = Species for which Eppelsheim is the type locality (25 of 352!), * = Species discovered during the excavations of 1996-2001

Lipotyphla	
	* *Talpa vallesensis* Villalta & Crusafont, 1944
	* *Plesiosorex* aff. *schaffneri* Engesser, 1972
	* *Crusafontina* sp.
Primates	
	Paidopithex rhenanus Pohlig, 1895 (T) [1]
	Rhenopithecus eppelsheimensis (Haupt, 1935) (T) [2]
	* cf. *Dryopithecus* sp.
Carnivora	
	Agnotherium antiquum (Kaup, 1833) (T)
	?* *Amphicyon eppelsheimensis* Weitzel, 1930 (T)
	Simocyon diaphorus (Kaup, 1832) (T)
	"*Lutra*" *hessica* Lydekker, 1890 (T)
	Ictitherium robustum (Gervais, 1850)
	* *Machairodus aphanistus* (Kaup, 1832) (T)
	Paramachairodus ogygius (Kaup, 1832) (T)
Rodentia	
	* *Palaeomys castoroides* Kaup, 1832 (T)
Proboscidea	
	Prodeinotherium bavaricum (H. v. Meyer, 1831) [3]
	* *Deinotherium giganteum* Kaup, 1829 (T)
	* *Gomphotherium angustidens* (Cuvier, 1806)
	* *Tetralophodon longirostris* (Kaup, 1832) (T)
	Stegotetrabelodon gigantorostris (Klähn, 1922)
Perissodactyla	
	* *Tapirus priscus* Kaup, 1833 (T)
	Tapirus antiquus Kaup, 1833 (T)
	* *Aceratherium incisivum* Kaup, 1832 (T)
	Brachypotherium goldfussi (Kaup, 1834) (T)
	* *Dihoplus schleiermacheri* (Kaup, 1832) (T)
	* *Chalicotherium goldfussi* Kaup, 1833 (T)
	* *Hippotherium primigenium* (H. v. Meyer, 1829) (T)
Artiodactyla	
	* *Propotamochoerus palaeochoerus* (Kaup, 1833)(T)
	Conohyus simorrensis (Lartet, 1851)
	Microstonyx antiquus (Kaup,1833) (T)
	Dorcatherium naui Kaup, 1834 (T)
	* *Euprox furcatus* (Hensel, 1859) (T)
	* *Euprox dicranocerus* Kaup, 1833 (T)
	Amphiprox anocerus (Kaup, 1833) (T)
	? * "*Cervus*" *nanus* Kaup, 1839 (T) [4]
	Miotragocerus cf. *pannoniae* (Kretzoi, 1941)

1 The Eppelsheim femur "most closely resembles the femur of *Pliopithecus vindobonensis*" from Neudorf (Begun 1992, p. 330), and is certainly a pliopithecid but it is still an open question whether it belongs to *Pliopithecus* Gervais, 1849, "*Rhenopithecus*" G.H.E. v. Koeningswald, 1956 or "*Anapithecus*" Kretzoi, 1975 (see Andrews *et al.* 1996, p. 176).

2 This taxon is based on one isolated upper canine which was recently also referred to the Pliopithecidae (see Andrews *et al.* 1996, p. 176).

3 This taxon, otherwise known from MN3b/4 - 6 in Europe, is documented from Eppelsheim in the old collections of the "Hessisches Landesmuseum Darmstadt" by 14 premolars and molars. 12 of them are rounded or even well rounded (written information by Dr. Oliver Sandrock, March 19th, 2002). Therefore it appears possible that the teeth of this taxon are reworked from older layers. On the other side Gräf (1957) mentioned no less than 86 isolated teeth of *Prodeinotherium bavaricum* from all Dinotheriensand localities. Such a frequency contradicts to some extent a redeposition from older layers.

4 During the field seasons 1999-2000 some very small dental remains were recovered that may represent this taxon.

APPENDIX 2 Research drilling Eppelsheim 2.

Direction: Geological Survey of Rheinland-Pfalz
Carried out by: Erkelenzer Bohrgesellschaft
Kind of drilling: ramming core drilling (diameter of core = 100 mm)
Date: September 1999
Topographic map: no. 6214 Alzey (1: 25 000)
Locality: farmland 1,2 km NW Eppelsheim
r = 3439570; h = 5509210
Documentation of core: September 15th, 1999
Persons in charge: Dr. Peter Schäfer, Dr. Michael Weidenfeller
(both Geological Survey of Rheinland-Pfalz)

Remarks: The point of drilling was surveyed by Dr. Franzen (Senckenberg Institute Frankfurt)
The drilling showed that the Dinotheriensand Formation was already exploited down to a depth of 5,7 m, and was afterwards filled with loess material
Final depth of drilling: 21,0 m
Section:
0 – 5,7 m: artificial filling
5,7 – 5,8 m: Dinotheriensand Formation
5,8 – 21,0 m: argillaceous marls and silt

Record of layers:
- 0,25 m loamy soil
- 5,70 m loess material mixed up with humous soil material, sporadic fragments and pebbles of limestone
- 5,80 m gravelly sand, Dinotheriensand
- 6,70 m argillaceous marls, grey olive with rusty brown and light brown streaks, at the base concretions of carbonate
- 7,10 m marls, silty, grey beige with light rusty brown streaks, sporadically grey olive intercalations of argillaceous marls, at the base passing into light grey calcareous silt with concretions of carbonate
- 7,95 m argillaceous marls, grey, with light brown patches
- 8,07 m silt, light grey, strongly calcareous
- 8,95 m fine sand, silty, strongly calcareous, at the base intercalations of olive grey argillaceous marls, sporadically small concretions of carbonate
- 10,55 m calcareous marls, slightly silty, a lightly fine-sandy, at the base more argillaceous and marly
- 11,10 m argillaceous marls, grey brown olive, with intercalations of beige grey silt
- 11,93 m argillaceous marls, grey to dark grey, with brown patches
- 12,40 m argillaceous marls, silty, light grey, with light brown patches
- 13,08 m silt, somewhat fine-sandy, light grey, sporadically light brown streaks
- 13,23 m argillaceous marls, silty, light grey, with light brown streaks
- 14,68 m silt, in the upper part fine-sandy, towards the base more argillaceous marly, light grey, at the base with light brown patches
- 15,45 m argillaceous marls, slightly silty, light grey to grey, with light brown patches
- 15,90 m silt, fine-sandy, light grey
- 16,00 m argillaceous marls, grey olive, with brown patches
- 16,80 m silt, light grey, strongly calcareous
- 18,07 m argillaceous marls, grey olive, with brown patches
- 19,00 m argillaceous marls, silty, light grey with light brown streaks
- 19,16 m argillaceous marls, grey olive, with brown patches
- 21,00 m argillaceous marls, light grey to grey, with white grey intercalations of silt, sporadically light brown streaks, in the lower part dark grey intercalations of argillaceous marls

APPENDIX 3 The plant taphocoenosis of Sprendlingen (after Meller 1989)

Conifers

Pinaceae
Pinus spp. (foliage)

Cupressaceae s.l., Taxodioideae/Sequoioideae
Taxodium sp. (foliage and conescale)
Taxodium sp. vel *Sequoia* sp. (foliage)

Dicotyledonous angiosperms

Aceraceae
Acer spp (2 types of leaves)

Altingiaceae
Liquidambar cf. *europaea* A. Braun in Buckland, 1836 (leaves)
Liquidambar sp. (fruits)

Betulaceae
? *Betula* sp. (fructification)
Carpinus sp. 1 and sp. 2 (fruits)
? *Carpinus* sp. (leaves)
? *Corylus* sp. (nuts)
Ostrya sp. vel *Carpinus* sp. (leaf)

Betulaceae div. gen. (?) et sp. (leaves)
Fagaceae
Fagus sp. (leaves and cupules) -
Quercus cf. *pontica-miocenia* Kubat, 1955 (leaf)
Quercus spp. (>2 types of leaves)

Hamamelidaceae
Hamamelidoideae gen. et sp. indet. (leaves and ?fruit)

Juglandaceae
? *Carya* sp. (leaves)
? Lauraceae
Daphnogene sp. (leaf)
? Lauraceae gen. et sp. indet. (leaves)

Leguminosae
Leguminosae gen. et sp. indet. (leaf-fragment and leaflets)
Leguminocarpum sp. (fruit)

Platanaceae
Platanus cf. *leucophylla* (Unger, 1850) Knobloch, 1971 (leaves)

Salicaceae
Salix sp. (leaves and infructescence)
Populus cf. *balsamoides* Göppert, 1855 (leaves)
Populus cf. *populina* (Brongniart, 1822) Knobloch, 1964 (leaves)

Trapaceae
Trapa silesiaca Göppert, 1855 (fruit)

Ulmaceae
Ulmus sp. (2 types of leaves)
Zelkova sp. (leaves and fruits)

Monocotyledonous angiosperms

Monocotyledoneae fam., gen. et sp. indet. (leaf fragments)

DEINSEA - ANNUAL OF THE NATURAL HISTORY MUSEUM ROTTERDAM
P.O.Box 23452, NL-3001 KL Rotterdam The Netherlands