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MIDDLE AND LATE PLEISTOCENE MACROFAUNAS OF THE NEUWIED BASIN REGION (RHINELAND-PALATINATE) OF WEST GERMANY

PART ONE:
LOCAL BIOSTRATIGRAPHICAL FRAMEWORKS

PART TWO:
THE NEUWIED BASIN REGION AND ITS LOCALITIES

PART THREE:
SYSTEMATIC DESCRIPTIONS

PART FOUR:
CONCLUSIONS

APPENDICES

NB. »Plate« refers to »Tafel« at back

PREFACE

In this study macrofaunas (larger mammals) from fossiliferous horizons dating to the Middle and Late Pleistocene periods (730,000 - 11,030 years before present) in the Neuwied Basin region of West Germany are presented. The aim of this study was to identify the species occurring in the fossiliferous horizons, and to establish a local biostratigraphical framework for macrofauna, using the detailed stratigraphies at the Neuwied Basin sites, the results of relative and absolute dating and the available palaeoenvironmental evidence. Macrofaunal fossils from horizon at fifteen localities in this region are described here. The known stratigraphic ranges and known occurrences in North-West Europe of the species identified are used to control the suggested age and palaeoenvironment of the assemblages in which they occur. Finally a provisional local biostratigraphic framework for the macrofaunas from the Middle and Late Pleistocene periods in the Neuwied Basin region is described.

This work was presented as a doctoral thesis at the University of Birmingham in May, 1989, before many of the recent political changes in Europe took place. References to German Democratic Republik (GDR) and Czechoslovakia have therefore been retained.

My thanks go first of all to Professor Gerhard Bosinski for his permission to study the macrofaunal remains from Neuwied Basin localities. My thanks are also due to Dr. Susan Limbrey, Department of Ancient History and Archaeology, University of Birmingham, for supervising the original thesis and for correcting and improving the text. Thanks also go to Dr. Mattijs van Kolfschoten, University of Utrecht, Netherlands, for his helpful discussion of the macrofaunal material, for permission to use his unpublished results from the mammalian microfaunas found in the Neuwied Basin assemblages, and for correcting and commenting upon the text. I would also like to thank friends and colleagues at the Römisch-Germanisches Zentralmuseum, Forschungsbereich Altsteinzeit at Neuwied-Monrepos. Martin Street provided me with a provisional macrofaunal list from the Andernach assemblage, and allowed me to use unpublished results

from the same locality. Gabriele Rutkowski completed many of the figures in the text and organised the tables.

Comparative material was used in the following museums and institutes. Forschungsinstitut und Naturmuseum Senckenberg, Frankfurt am Main; I would like to thank Dr. Storch and colleagues for their friendly assistance during my frequent visits to this museum. Naturhistorisches Museum, Mainz; my thanks go here to Dr. Neufer and Dr. Igel. Zoologisches Forschungsinstitut und Museum Alexander Koenig, Bonn; I would like to thank Prof. Dr. Nobis for his kindly assistance in identifying macrofaunal remains from the Niederbieber locality.

From January 1985 to March 1988 I received a grant from the Gerda Henkel Stiftung, Düsseldorf. I would like to take the opportunity to thank once again Frau Maskell and Dr. Ulbrich from the Foundation for this financial assistance. Recent excavations at Neuwied Basin sites, which produced some faunal material described here, were undertaken as part of the Deutsche Forschungsgemeinschaft sponsored project »Quartär der Osteifel«.

This work is dedicated to my parents for their constant support and encouragement.

INTRODUCTION

In a recent review of the European Middle Pleistocene hominid record, it was stated that »despite extensive study, Quaternary (=Pleistocene) mammalian biostratigraphy has not produced the results that approach the full potential of the material« (Cook et al., 1982). The acceptance of existing palaeoclimatic frameworks as a basis for the biostratigraphies or the naive reconstruction of past environments are stated as being some of the difficulties associated with the study of Quaternary mammals.

Many authors have applied themselves to the problems of establishing mammalian biostratigraphies, and various approaches have been used. Mammalian microfaunas are often considered to be the most useful biostratigraphical indicators (v. Königswald, 1973; van Kolfschoten, 1988). Some authors, such as Lister (1986), and Guerin (1980), have concentrated upon a particular mammalian family, whereas van Kolfschoten (in van Kolfschoten & Roebroeks, 1985) and Jacobshagen (in Jacobshagen, Huckriede & Jacobshagen, 1963) have described changes in mammalian assemblages from a single locality with several fossiliferous horizons. Stuart (1982), described faunal material from Early, Middle and Late Pleistocene localities in England, whereas Delpech (1983), confined her study to the rich faunas from Upper Palaeolithic (Late Pleistocene) localities in south-west France.

In the same review (Cook et al. 1982), the need to establish local biostratigraphical frameworks for Quaternary mammals was stressed. This thesis attempts to provide such a framework, based on macrofaunas (large mammals) recovered from Middle and Late Pleistocene assemblages, in a region of the central Rhineland of West Germany known as the Neuwied Basin.

Although macrofaunal remains from the Neuwied Basin region were first described as long ago as 1879 (Schaaffhausen, 1879), and were sporadically collected during the first half of this century, the mammalian faunal record was, according to Brunnacker in 1971 (Brunnacker, 1971), still too sparse to be of biostratigraphical use. The biostratigraphical potential of some of the macrofauna had, however, already been noted by Nobis (1970) and Rothausen (1970). The possibility of studying a larger corpus of macrofauna has only recently been realised, mainly due to the activities of Palaeolithic archaeologists in this area.

Over the past few years, archaeologists have been investigating an ever increasing number of Palaeolithic open sites in this region. Early man was obviously often attracted to the Neuwied Basin with its constant water supply (Rhine river and tributaries) and sheltered situation. More interesting, from the point of view of this thesis, is that the assemblages recovered from these sites consist predominantly of macrofaunal remains in the form of bone, teeth and antler.

Macrofaunal fossils from assemblages at fifteen localities in the Neuwied Basin region are discussed here. The macrofaunal remains from nine of these localities have been identified by the author and material already published by other authors has also been included in this work.

This study begins with a discussion of the possibilities and problems associated with the establishment of local biostratigraphic frameworks. A detailed description of the Neuwied Basin region and its localities is given in Part II, in which reference is also made to stratigraphy, absolute dating, results of sampling for pollen, mammalian microfaunas and molluscan faunas from these sites. Part III is the systematic description of the macrofaunal fossils including lists of identifiable material, discussion of the stratigraphic ranges of the various species and their palaeoecology, and comparing this with their presence in the Neuwied Basin assemblages. In Part IV, lists of the macrofaunas identified are given for each assemblage from each locality and these are discussed with reference to the age suggested for the deposits and the palaeoenvironment at the time of deposition of the assemblage. Changes in palaeoenvironment at the individual localities are also discussed. Finally the history of the Neuwied Basin Middle and Late Pleistocene macrofaunas is described.

PART ONE

LOCAL BIOSTRATIGRAPHICAL FRAMEWORKS

CHAPTER 1

AIMS AND METHODS

The aim of this study is to attempt to establish a local biostratigraphical framework for the macrofaunas recovered from Middle and Late Pleistocene assemblages in the Neuwied Basin region. The term »large mammals« describes here mammals varying in size from foxes (Genus *Vulpes* and *Alopex*) to elephants (Genus *Mammuthus* and *Elephas*).

As Lister (1986) has stated, the current state of Pleistocene research means that such frameworks are often based on localities well-dated by other means, such as established stratigraphies, absolute dating, or pollen. This is also the case in the Neuwied Basin region.

In order to establish a biostratigraphical framework within a particular geographical region, certain conditions, must be fullfilled.

1) The region is a well-defined geographical area.
2) It has a large number of localities covering a long time-span and, where possible, several fossiliferous horizons are located at each locality. The localities are situated close to one another, so that inter-site correlations based on marker horizons can be made.

3) The assemblages have been dated either by relative dating or absolute dating methods.
4) The assemblages recovered from these localities are large.
5) The assemblages have been excavated or recorded to a high standard, including sampling for pollen, mammalian microfaunas and molluscan faunas.
6) The origin of the assemblage can be established, that the assemblage has not been contaminated by the inclusion of older or younger material (taphonomy) and that other biases (due to the accumulation of the remains by man) have been eliminated.

Although the Neuwied Basin is considered to be a particularly promising area for a local biostratigraphic framework, there are limitations associated both with this approach, and with the localities and assemblages in the area itself. The points listed above are now discussed with reference to the study area.

1) The Neuwied Basin region is an area of about thirty square kilometres, well-defined by its geomorphology (see Chapter 2).

2) So far fifteen localities with deposits dating from the beginning of the Middle Pleistocene to the end of the Late Pleistocene have been recorded and investigated in the Neuwied Basin region. Many of these localities have up to five separate horizons in which macrofaunal remains have been recorded. The maximum distance between two of the outlying localities is between thirty and fourty kilometres (Fig 2, nos. 3 and 13). Marker horizons, particularly in the form of tephra deposits, are found at practically every locality described here (Chapter 4).

3) The importance of the stratigraphic succession in the Kärlich clay-pit (Fig. 2, locality 1), had already been recognised as early as the beginning of this century (Mordziol, 1913; Pohlig, 1913). The majority of the localities discovered since then also have good stratigraphical sequences.
However, recent Potassium-Argon dating of tephra horizons at some of the localities, such as Kärlich, has brought the age of these deposits and their assemblages, and ultimately the stratigraphy of the Neuwied Basin region into question. Some of the assemblages described in Chapter 4 are considered to be much older than previously thought. Unfortunately, the results of the various methods of absolute dating used at the localities in the Neuwied Basin region are, when compared with each other, inconsistent, and have confused the stratigraphical issues rather than solving them. Further, the age of some assemblages, such as those at Wannen and Schweinskopf (Chapter 4), are only tentative.
Due to the unexpected uncertainties regarding the age of some of the Neuwied Basin assemblages (the absolute dates in question were published as recently as 1987 and 1988), it was decided to use the macrofaunal remains as a means to »control«, if possible, the suggested age of the assemblage or deposit in which they occur. In order not to fall into »the hopeless muddle of circular argument now surrounding relative dating by faunal means« (Cook et al., 1982), this was attempted by comparing the known stratigraphic range of the species concerned, as proposed by Lister (1986) (first known occurrence of species in Pleistocene deposits in North-West Europe to time of extinction), with the suggested age(s) of the assemblage.
Unfortunately, there are also problems associated with the use of the known stratigraphic ranges of Pleistocene mammals in dating assemblages. Some species have extremely long stratigraphical records. For example, the extinct straight-tusked elephant (*Elephas antiquus*) first occurred during the latter part of the Early Pleistocene or beginning of the Middle Pleistocene and became extinct in North-West Europe at the beginning of the Late Pleistocene. This particular species occurs in assemblages in the Neuwied Basin region thought to date to the end of the Middle Pleistocene but which may now, on the basis of absolute dating, be older. The presence of *Elephas antiquus* in these assemblages thus falls within the known stratigraphic range of this species in North-West Europe, but cannot be used to date the assemblage further.
Attempts to age an assemblage by reference to the evolution of a species also meet with difficulties. Evolution can only be used for biostratigraphical purposes when the history of a species is known thoroughly (Lister, 1986). Some larger mammals, such as the extinct mammoths (*Mammuthus* spp.),

underwent a continuous evolution during the Middle and Late Pleistocene periods, which cannot be stratigraphically closely defined. On the other hand the Pleistocene horses (genus *Equus*), have been the subject of more intensive research (for example, Prat, in de Lumley, 1976), resulting in a plethora of named species, each with implicit biostratigraphical overtones.

4) Generally macrofaunal remains represent up to 90% of the total amount of finds recovered from assemblages in this region.
Whereas the student attempting to establish a biostratigraphical framework based on a particular species or family has access to large collections of material, choosing a limited geographical area means that the fossils found within this area are the only ones which can be used, regardless of their state of preservation or the size of the sample. Thus, despite the large amount of macrofaunal remains from the Neuwied Basin assemblages, many of the macrofaunal fossils were so poorly-preserved that they could only be identified as comparable (cf.) to species, and sometimes only to genus.
It was also neccessary, due to the continuing research at some of the localities, to restrict the amount of material identified in this study to that recovered during particular excavation campaigns. For example, only the macrofaunal remains from the 1986 excavation campaign at the Tönchesberg locality were studied (Chapter 4). Due to this, potentially stratigraphically important fossils may not have been seen, and sample size, particularly the minimum number of individuals per species (MNIs) were directly affected by this form of sampling.

5) The excavations at the site of Gönnersdorf from 1968 - 76, under the direction of Professor Bosinski, University of Cologne, initiated a multi-disciplinary approach used during the further investigations of other localities in this area. During excavation, all find categories are recorded three-dimensionally and their exact position can be reconstructed afterwards by horizontal or vertical plotting (see below: taphonomy). Sampling for pollen, and wet-sieving of sediment to recover mammalian microfaunas, and molluscan faunas are considered routine. The results of sampling for pollen, microfaunas and molluscan faunas can also provide supportive information about the age of the site or assemblage and the palaeoenvironment at the time of deposition. However, the palaeoenvironmental evidence from some assemblages is, due to the state of research in these fields in the Neuwied Basin region, still rather sparse. In some assemblages, the macrofaunas were the only palaeoenvironmental indicators available, and these are not considered to be particularly good indicators on their own (see, for example, Stuart (1982) for discussion of this). In such cases, two further factors were also considered:

a) the sedimentologic context of the assemblage. For example, loess is known to have been deposited during the cold glacial stages of the Pleistocene. Therefore an assemblage in primary context (see taphonomy below), located in a loess deposit, was probably deposited during a cold stage. The sedimentologic context of an assemblage is a factor which has been recorded at all the localities described here, the exception being some of the units at Kärlich where fossils were collected at the beginning of this century without being recorded in detail (Chapter 3).
b) the known occurrence of species in Pleistocene faunas in North-West Europe. For example, roe deer (*Capreolus capreolus*) has only been recorded in interglacial and interstadial faunas during the Middle and Late Pleistocene in North-West Europe (van Kolfschoten & Roebroeks, 1985; Lister, 1986). Its occurrence in an assemblage is therefore likely to be indicative of an interglacial or interstadial phase, at least in North-West Europe.

6) Taphonomy is the study of the processes by which fossil assemblages have accumulated (Efremov, 1940); and has been used increasingly to interpret mammalian faunas from Palaeolithic sites. It is not the aim of this study to obtain information on the behaviour of early man from the macrofaunal remains in the Neuwied Basin assemblages, despite the fact that the majority of them appear to have been accumulated by this agent (25 out of 30 assemblages in the Neuwied Basin region are associated with the stone tools or other cultural remains of early man). The goal of taphonomy is to strip away biases in the fossil assembla-

ges (Klein, in Behrensmeyer & Hill, 1980; Klein & Cruz-Uribe, 1984), and in this respect it is also an important tool in establishing a reliable local biostratigraphical framework.

Two aspects are of importance in this study:

a) The context of the assemblage and eliminating contamination by younger or older material within an assemblage.

b) Eliminating the biases within an assemblage caused by early man.

a) Assemblages are in a primary or in a secondary post-burial context. Burial context refers here to the factors, generally geological, affecting the assemblage after its incorporation (= burial) into the sediment.

An assemblage in primary context is one which has not been disturbed after burial, and where it can be assumed that the final location of the assemblage, as recorded during excavation, is more or less the one in which the assemblage was originally deposited. Such assemblages can also be described as being in situ.

Secondary context refers to those assemblages which have been disturbed after burial, so that the location of the fossils, as recorded during excavation, is not representative of the original place of deposition. Such assemblages can also be described as being redeposited.

The establishment of primary or secondary post-burial context is important when considering, for example, the age of an assemblage. Not recognising redeposited assemblages may mean that the fossils are dated or interpreted with regard only to their location as recorded during excavation.

Assemblages in secondary context are relatively easy to identify from the sedimentologic context in which the fossils are located. All of the localities described in this study are open sites, and the assemblages have been deposited in terrestrial sediments such as loess. Disturbance of assemblages in these situations has been caused by several agents, but solifluction resulting in the horizontal movement, or transportation of an assemblage especially when situated on a slope, or processes resulting in the vertical movement of material through the deposits, are the ones that appear to have affected assemblages at the Neuwied Basin localities. These processes are usually localised, i.e. the movement or transportation of fossils took place over a small area only.

Contamination of an assemblage is caused by the inclusion of fossils from older or younger deposits. This can take place at any time between deposition and burial and after burial as a direct result of the processes involved above, and often occurs at localities where a series of fossiliferous horizons are stratified directly above one another, such as at Wannen (Chapter 4).

The state of preservation (weathering, colouration) of the macrofaunal remains themselves can often be used to identify fossils which were not part of the original assemblage.

Conjoins (refitting back together) of macrofaunal remains can reconstruct the history of the fossils from the time of their arrival at the site to the time of excavation. Conjoining material can help to prove that the fossils in an assemblage belong to the same phase of deposition or, on the contrary, that assemblages originally thought (during excavation, for instance) to belong to separate depositional phases actually belong together.

Further, the integrity of the macrofaunal remains in an assemblage can be controlled by comparing the palaeoecology, as suggested by the microfaunas, molluscan faunas and pollen with that of the macrofaunas themselves. For example, the pollen assemblage and mammalian microfauna from an assemblage indicate a warm climate and forested conditions. The macrofaunas, on the other hand, indicate a cold climate and an open, steppe environment, which suggests that the components in the assemblage did not belong together originally.

b) The role of early man.

With the exception of some of the assemblages at Kärlich, the macrofaunal remains described in this study are all from archaeological fossiliferous horizons. Accumulation of macrofaunal remains by man can lead to biases in the representation of certain macrofaunal species in the assemblages. An example of this is the remains of red deer (*Cervus elaphus*) in assemblages such as those at the Tönchesberg and Hummerich localities. At these localities, red deer is represented in the sampled assemblages by a minimum of one individual only. However, large numbers of shed red deer antlers were also recovered (at Tönchesberg up to thirty specimens from the sampled assemblage), and suggest that red deer appear to have been more numerous in the fauna living at the time, than is indicated by the presence of the single individual in the assemblage.

Occasionally, man may have been directly responsible for the representation of a species which may not neccessarily have been a part of the living fauna. An example of this is the presence of red deer in the winter settlement phase at Gönnersdorf. This species is represented here only by canine teeth deliberately worked so that they could be worn as pendants. The presence of the canines of red deer in this settlement phase is, therefore, not direct evidence that this species was present in the living fauna.

Seasonal occupation of some of these localities by early man may also lead to biases in the faunal composition, particularly when it is considered that some mammalian macrofaunas undergo major or minor seasonal migrations themselves. Therefore, it was always attempted to establish in which season an assemblage had been deposited. This was based provisionally on the cycle of regeneration of antlers from red deer (*Cervus elaphus*) and reindeer (*Rangifer tarandus*) present in the assemblages. At the Gönnersdorf locality, F. Poplin (1976; in Brunnacker (ed.), 1978), used a combination of the cycle of reindeer antler regeneration, the presence of neo-natal bones of horse (*Equus* sp.) and the presence of certain species of bird (*Aves*) and fish (*Pisces*) at the site to identify a winter and a summer settlement phase.

PART TWO

THE NEUWIED BASIN REGION AND ITS LOCALITIES

CHAPTER 2

THE NEUWIED BASIN REGION

Situation

The Neuwied Basin region is situated in the Central Rhineland of West Germany. The term »Central Rhineland« refers to a particular stretch of the Rhine Valley where the river flows through the slate massif of the Rhenish Shield (Fig. 1a).

After flowing to the north and then to the west through the plains of the Mainz Basin, the Rhine enters the Rhenish Shield at the town of Bingen and continues northwards for about 120 kilometres, until it emerges into more open land near Bonn. South of Coblenz, the Rhine Valley opens suddenly into the Neuwied Basin, narrowing again immediately to the north of the town of Andernach (Fig. 1b).

Geomorphology

The Neuwied Basin was formed during the Tertiary and Quaternary periods by a combination of tectonic sinking, upthrust of the Rhenish Shield and downcutting by the Rhine. The geomorphological history of

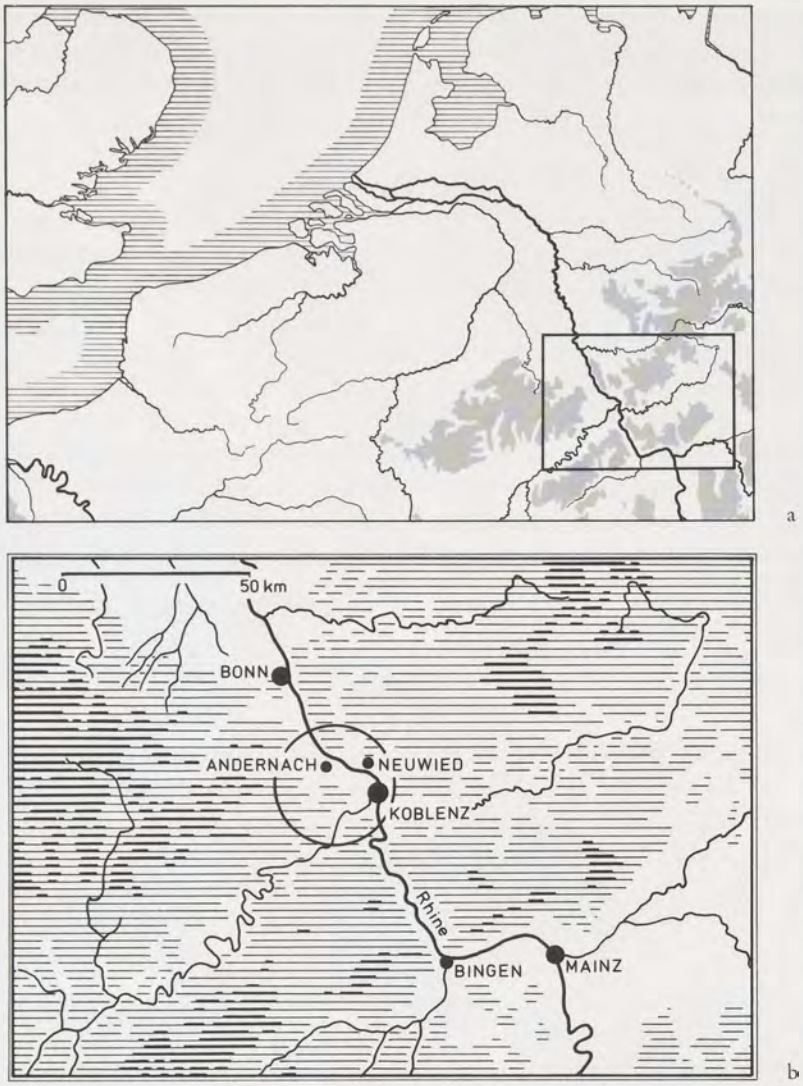


Fig. 1 Location of the Central Rhineland in North-West Europe (a) and of the Neuwied Basin region (b).

the basin was further marked during the Quaternary (=Pleistocene) period by the more active downcutting of the Rhine and the formation of the Rhine Terraces, by the deposition of loess and by tephra deposits (basaltic ash, pumice), marking the beginning of volcanic activity in the east Eifel region particularly around the Laacher Lake area (Fig. 2).

The Neuwied Basin today is somewhat elliptical in shape, stretching about 20 - 30 kilometres in a south-east to north-west direction. The basin is edged by plateaux of high-land (Fig. 2, >200). These include, to the south, the northern tip of the Hunsruck lying between the Rhine and Moselle Valleys, the edge of the Westerwald to the east and the Eifel to the west.

For the purposes of this study, the term »Neuwied Basin region« also includes to the west, the gently undulating plains of the Nette Valley, known locally as the Pellenz, the slightly higher land of the Maifeld beyond this and a stretch of the narrow Rhine Valley immediately to the north of the basin (Fig. 2).

The two major water-courses of the Neuwied Basin region are the Rhine and the Moselle rivers. The basin is further drained by a number of minor tributaries and streams, the most important of which are the Wied, Aubach and Sayn rivers on the east bank of the Rhine and the Nette on the west.

Three main Rhine terraces are present in the Neuwied Basin. The upper terrace is located at the edges of the basin between 180 and 200 metres above sea-level. The middle terrace or terraces are situated between 100 and 160 metres above sea-level and the lower terrace at 60 metres above sea-level, in the present-day Rhine Valley floor (Fig. 2).

Three local biotopes are formed by the terrace formation:

1. the valley-floor along the banks of the Rhine river and tributaries. Soundings along the present-day valley floor have shown that during the latter part of the Pleistocene, the river originally meandered in a broad flood-plain through the basin. Ox-bow lakes and islands of drier land existed, which are no longer to be seen today.
2. the sheltered slopes of the basin formed by the middle terraces.
3. the exposed highland plateaux of the upper terraces.

Despite canalisation of the Rhine itself, industrialisation along the valley sides and suburban expansion around the towns of Neuwied, Andernach and Koblenz, the character of this region has changed very little. The view from the Westerwald heights across the Neuwied Basin today would have looked much the same during the Middle and Late Pleistocene periods (Plate 15).

Climate

The Neuwied Basin has a relatively warm, dry climate today. Local climatic differences between the sheltered basin floor and the surrounding highland are very pronounced.
The following table compares recent climatic data taken in the towns of Neuwied and Hachenburg (Westerwald), which are about thirty kilometres apart (after Henrichs, 1981).

	Height above sea level	mean temp. °C	July temp.	Jan. temp.	rainfall mm per annum
Neuwied	67 m	9,5	19	1	559
Hachenburg	344 m	7,7	15	-1	939

Research history

The first macrofaunal remains to be recorded from the Neuwied Basin region were those collected by Professor Herman Schaaffhausen between 1879 and 1881 (Schaaffhausen, 1882; 1879). In 1883, Schaaffhausen was informed of the discovery of macrofaunal remains associated with the stone tools of early man, located below a volcanic pumice deposit on the so-called Martinsberg in Andernach (Fig. 2, locality 10). In his report about the results of the subsequent investigation at this site, Schaaffhausen 1888; 1884), described the finds as being the first evidence of mans presence in the Neuwied Basin prior to the cessation of volcanic activity in the east Eifel.
With the discovery of this locality, the interest of Palaeolithic archaeologists in the Neuwied Basin region began to increase. At the same time, the macrofaunal remains associated with the Andernach Palaeolithic inventary evoked, with the exception of those pieces worked deliberately by man, little interest.

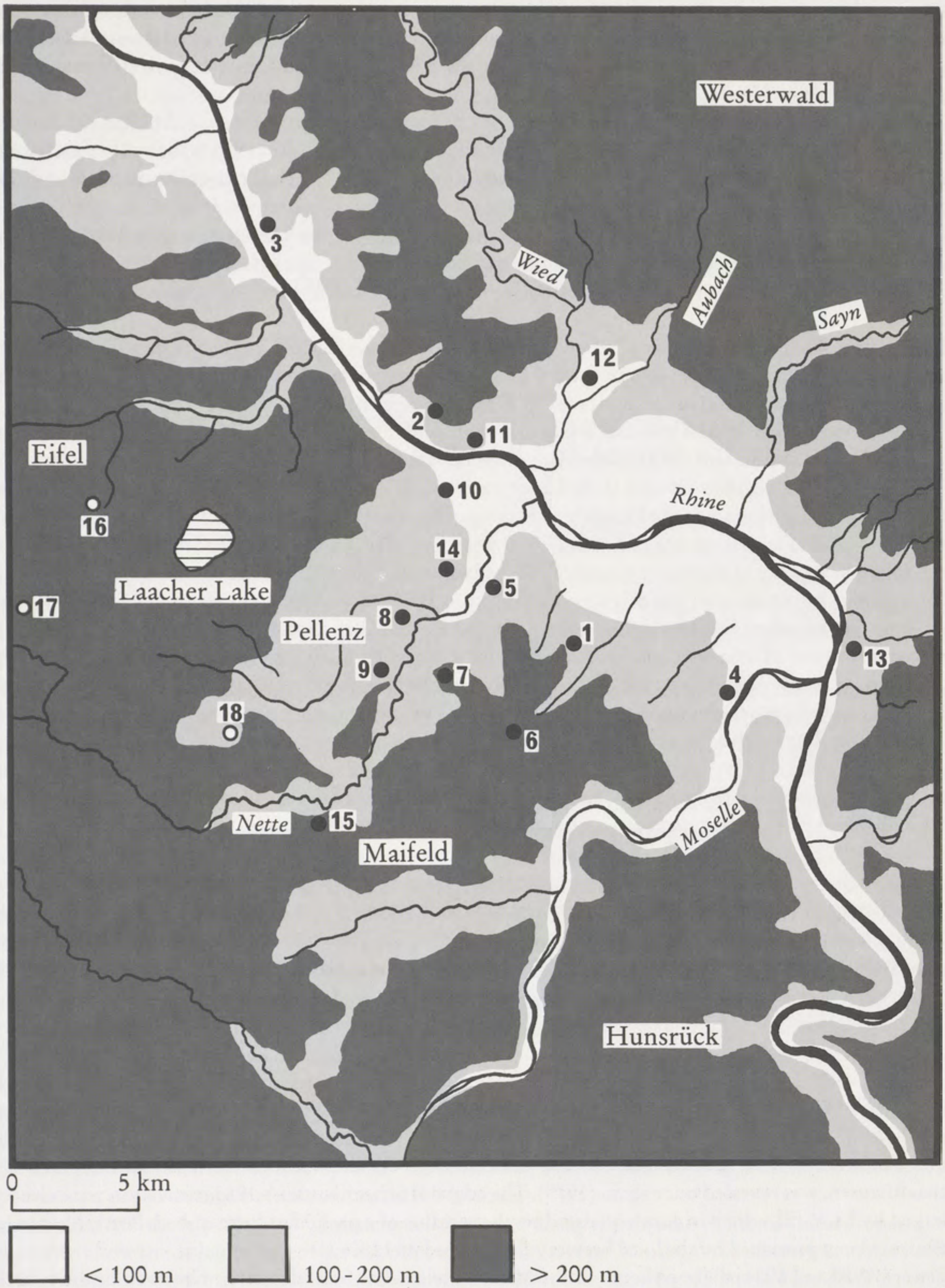


Fig. 2 Middle and Late Pleistocene localities in the Neuwied Basin Region: 1 Kärlich (Kä). – 2 Leutesdorf (Lt.). – 3 Ariendorf (Ar). – 4 Metternich. – 5 Miesenheim I (Mi). – 6 Schweinskopf (Sk). – 7 Wannen (Wa). – 8 Hummerich (Hu). – 9 Tönchesberg (Tö). – 10 Andernach (An). – 11 Gönnersdorf. – 12 Niederbieber. – 13 Urbar. – 14 Miesenheim II. – 15 Polch. – 16 Wehrer volcano. – 17 Rieden volcano. – 18 Thür. – (● Localities with macrofaunal remains. Letters in parentheses refer to the shortened form of the locality used in the text. ○ Other localities described in the text).

The work begun by Schaaffhausen was continued at the beginning of the 1900s by several other natural historians. Günther (1910; 1907), reported finding stone artefacts and isolated bone fragments from quarries in Metternich near Coblenz (Fig. 2, locality 4), and Rhens-Brey and Moselweiss, which are situated outside the Neuwied Basin.

Günther (*ibid.*), identified the faunal remains as being from woolly rhinoceros *Coelodonta antiquitatis*, horse *Equus*, red deer *Cervus elaphus*, bear *Ursus* and mammoth *Mammuthus*. He was also the first to note changes in the composition of the faunas occurring in the Pleistocene deposits in the quarries and that recovered from Andernach-Martinsberg (Günther, 1910).

At the same time, Pohlig (1909; 1913), described macrofaunal remains from a quarry in Mülheim (near Kärlich, Fig. 2, locality 1), in which he identified extinct elephant *Elephas* (*Mammuthus*) *trogontherii* and *hippopotamus*. Mordziol (1913), also identified hippopotamus remains from the neighbouring clay-pit in Kärlich.

Höfer (1937), undertook more detailed investigations of the loess deposits in the the now closed Weglau quarry at Metternich. He was able to record the location of horse *Equus* and red deer *Cervus elaphus* remains in loess beds dating to the Second and Last Cold Stages BP.

The majority of these faunal remains were, unfortunately, lost during bombing raids on the town of Coblenz during the Second World War. The material from Schaaffhausen's excavation at Andernach-Martinsberg, which had been stored at the Landesmuseum in Bonn, was the only original inventory from these early investigations into the Pleistocene history of the Neuwied Basin to survive.

In 1966, the Late Pleistocene site of Urbar (Fig. 2, locality 13) was discovered (Eiden & Löhr, 1973), and with this, a new phase of Pleistocene research in the Neuwied Basin region began.

The most important discovery at this time took place in 1968, when extensions to the cellar of a house in the Neuwied suburb of Feldkirchen, known earlier as Gönnersdorf, revealed bone fragments, stone tools and a rich horizon of other occupational debris from a settlement dating to the Magdalenian period (Fig. 2, locality 11). Excavations at the site of Gönnersdorf, undertaken by the Department of Prehistory at the University of Cologne under the direction of Professor Bosinski, began in 1968 and continued until 1976. This was the first locality in the Neuwied Basin region to be investigated using a multi-disciplinary approach (Bosinski, 1979; Brunnacker (ed.), 1978). The Gönnersdorf inventory included a large amount of bone, antler and teeth from several species of larger mammals and the archaeozoological interpretation of this material played an important role in the assessment of the site (Poplin, 1976; in Brunnacker (ed.), 1978).

In 1970, Nobis and Rothausen published remains of extinct horse *Equus (Allohippus) süssenbornensis* and *Equus* cf. *mosbachensis* (Nobis, 1970) and extinct giant deer *Praemegaceros* (Rothausen, 1970), from lower Middle Pleistocene deposits in the Kärlich clay-pit. In 1970 - 72 fossils were also recovered from loess deposits in the gravel quarry at Ariendorf (Brunnacker et al., 1975), and at the Leutesdorf locality (Brunnacker et al., 1974).

In the late 1970s, a new impetus in archaeological research began in this region. In 1977, Dr. S. Veil, University of Cologne, conducted a series of soundings on the Martinsberg in Andernach in an attempt to find traces of Schaaffhausen's earlier excavations (Veil, 1977 - 78). The breakthrough came in 1979 when, during rebuilding of a garden wall on the Martinsberg, the fossiliferous horizon, as described by Schaaffhausen, was revealed once again (1979). The edges of Schaaffhausen's 1883 excavation were clearly marked by back-fill, which in turn was dated by the remains of a particular form of beer bottle known to have only been produced by the local brewery during the late 1880s.

Between 1980 and 1986, the gaps between the Middle Pleistocene fossiliferous horizons at localities such as Kärlich and the Late Pleistocene localities such as Andernach-Martinsberg, began to close. In 1981 to 1983, several fossiliferous horizons dating to the upper Middle and Late Pleistocene periods were investigated at Ariendorf and in the Kärlich clay-pit. In 1982, the lower Middle Pleistocene locality Miesenheim I was discovered and excavations at this site began in the same year.

In 1983, fossiliferous horizons dating to the upper Middle and Late Pleistocene periods were discovered in loess deposits in the crater of the extinct east Eifel volcano Plaidter Hummerich. In the same year, fossiliferous horizons were also discovered in the crater of the Schweinskopf-Karmelenberg volcano, and in 1986 in the Tönchesberg and Wannen volcanoes. Late Pleistocene localities were also discovered at Niederbieber and Miesenheim II.

According to Brunnacker (1971), the macrofaunal record from the Neuwied Basin localities was too sparse to be of biostratigraphical use. The situation had changed by the end of 1986, whereby a total of fifteen localities, many of them having several superimposed fossiliferous horizons, were known to exist in this region. All of these localities have produced macrofaunal remains associated, for the most part, with the stone tool industries of fossil man. An attempt to establish a biostratigraphical framework based on the macrofaunal remains from the localities in this region could be undertaken.

CHAPTER 3

THE PLEISTOCENE STRATIGRAPHY OF THE NEUWIED BASIN REGION AND THE KÄRLICH LOCALITY

The Pleistocene period is usually divided into three main phases, referred to in this study as Early Pleistocene, Middle Pleistocene and Late Pleistocene. The Matuyama-Brunhes magnetic reversal boundary, dated to about 730.000 years before present (BP), is taken here as marking the beginning of the Middle Pleistocene as suggested by Brunnacker (in Butzer & Isaacs (ed.), 1975). The beginning of the Late Pleistocene is correlated with the beginning of the Last Interglacial at about 128.000 BP and ends at about 10.000 BP (Bowen 1978).

The Pleistocene deposits of the Neuwied Basin are by no means complete. The oldest Pleistocene deposits in this region probably date to a younger phase of the Early Pleistocene. Deposits older than these do not occur here. Middle and Late Pleistocene deposits are, however, recorded from several localities in the area (Fig. 3).

Towards the end of the last glaciation, the whole of the Neuwied Basin was covered by up to five metres of pumice from the eruption of the Laacher volcano, radiocarbon dated to about 10.950 - 11.050 BP. With this, the Pleistocene history of the region was brought to an abrupt and relatively early end.

The Middle and Late Pleistocene stratigraphy of the Neuwied Basin region is marked by a succession of cold and warm stages. During the long cold stages (= glacials), glaciers occasionally reached as far south as the town of Düsseldorf (Bosinski, 1983), about 200 kilometres to the north of the Neuwied Basin. The Neuwied Basin was a periglacial region during the cold stages, which were characterized by the deposition of loess and gravels, in which features indicative of permafrost, such as ice-wedges are present. Shorter cold stages (Stadials) have also been recorded in the Pleistocene stratigraphy of the Neuwied Basin.

The warm stages (interglacials and interstadials) are characterized by the development of fossil soils on loess. Interglacials are phases during which the maximum temperatures were as high or higher than those recorded during the post-pleistocene period (Holocene), and were characterized by the development of mixed oak forest in North-West Europe.

The interglacials are marked in this region by the remains of a soil formation. This is usually in the form of a red-brown or red-orange Bt horizon (textural B horizon).

Interstadials are short periods of climatic amelioration, during which time the temperatures increased enough to allow the development of boreal, but not mixed oak forest. During these phases less mature soils formed. Typical of these in this region are the so-called »Humuszonen« (see Chapter 4 for description of localities where these occur). The word »Humuszonen« has been translated here as »humic soil«, as a more definite term for this type of palaeosol has not been given by the German geologists working in the Neuwied Basin region. The humic soils are similar in appearance to chernozems (black soil of the steppes, Limbrey 1975), and there is evidence from the Tönchesberg locality (Chapter 4) to suggest grassland was

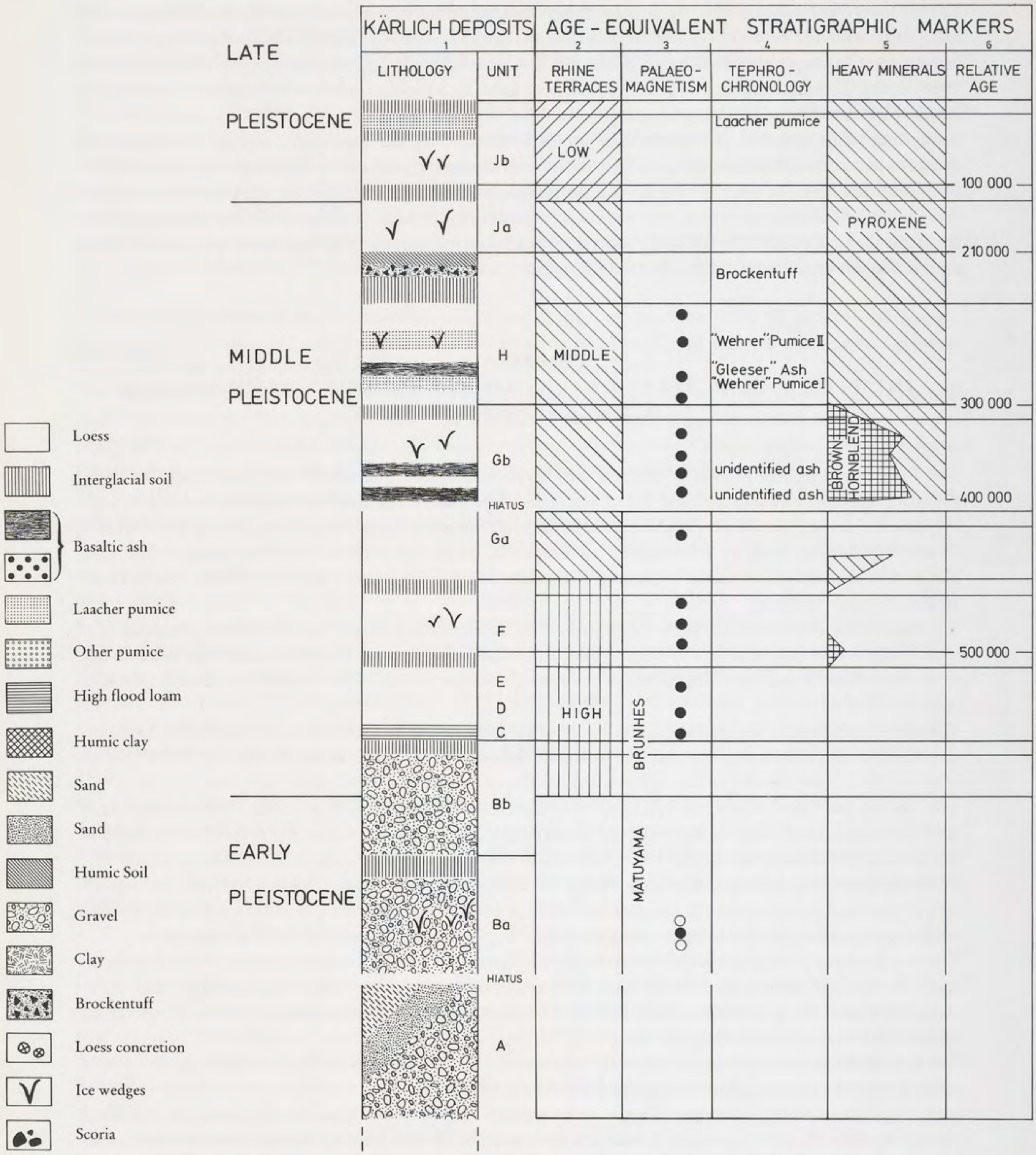


Fig. 3 Simplified section through the deposits in the Kärlich clay-pit: 1 Schmincke & Mertes 1979. – 2 Frechen & Lippolt 1965. – 3 v. d. Bogaard & Schmincke 1988. – 4 After Brunnacker (et al. 1976; in: Butzer & Isaacs eds. 1975; Windheuser, Meyer & Brunnacker 1982).

ABSOLUTE DATING (BP)			CORRELATIONS			
7	8	9	10			
POTASSIUM ARGON	THERMO-LUMINESCENCE	RADIOCARBON	STRATIGRAPHY (SUMMARY)	N-W EUROPEAN SYSTEM 4)	Brunnacker (1976)	MICROFAUNA van Kolfschoten (1988)
			HOLOCENE			
		11030	LAST COLD STAGE BP	WEICHSELIAN		
			LAST INTERGLACIAL	EEMIAN		
150000 ± 40000 2) 440000 ± 18 000 3)	152000 ± 15000		SECOND COLD STAGE BP	YOUNGER SAALIAN PHASE		
			KÄRLICH INTER.			
476000 ± 8000 3) 288000 ± 90000 1) 683000 ± 8000 3)	220000 ± 25000 232000 ± 28000		THIRD COLD STAGE BP	OLDER SAALIAN PHASE		
			ARIENDORF INTER.	HOLSTEINIAN		
			FOURTH COLD STAGE BP	ELSTERIAN		Cromer IV
			LEUTESDORF INTER.			
			FIFTH	CROMER COMPLEX		
			INTERGLACIAL			
			SIXTH		Cromer III	
			INTERGLACIAL			
			SEVENTH		Cromer II	
			INTERGLACIAL			
			EIGHTH	GLACIAL A		
730 000						

present at the time of formation. In the local stratigraphic system the interglacials are, as far as possible, given names referring to the locality at which they were first identified. The cold stages are simply given numbers and are referred to, for example, as Fifth Cold Stage BP, Third Cold Stage BP or Last Cold Stage BP.

The Standard Division of glacials and interglacials as proposed for North-West Europe is used for correlations between the local stratigraphy and a standard Pleistocene system. The Middle and Late Pleistocene periods are subdivided in North-West Europe into a number of stages (Fig. 3), beginning with the Cromer complex of warm and cold stages, followed by the Elsterian, a cold stage and the Holsteinian, an interglacial stage. The following cold stage, the Saalian, is subdivided by a further interglacial into an older and a younger phase in the Neuwied Basin region. The Saalian is followed by the Eemian, an interglacial, and the Weichselian, a cold stage. Exact correlations between the local stratigraphy and the European Standard division are difficult; tentative correlations are given in Fig. 3, column 10, based on Brunnacker (et al., 1976; in Butzer & Isaacs (eds.), 1975; Windheuser, Meyer & Brunnacker, 1982) and van Kolfschoten (1988).

Correlations between absolute dates from deposits in the Neuwied Basin region and the oxygen-isotope curves and stages have also been occasionaly made (Brunnacker et al., 1976; Conard, 1988; Lippolt et al., 1986). However, as workers are still having problems in placing even main events in the terrestrial sequence, with the exception of the Last Interglacial, more emphasis has been given here to the North-West European system of interglacials and glacials.

Occasionally, Pleistocene deposits from this region have been correlated with the Alpine system of Penck and Bruckner (1909). For example, Bosinski (1983), refers to terms such as Riss (Second Cold Stage BP), Riss-Würm (Last Interglacial) and Würm (Last Cold Stage BP). The Alpine system is not referred to in this study.

Alongside the archaeological study of the Neuwied Basin assemblages, research has concentrated upon:

1. The local stratigraphic succession based on the deposits at the various localities themselves and their correlation with one another using
   a) age-equivalent stratigraphic markers and
   b) absolute dating techniques.
2. The palaeoenvironment of the fossilliferous horizons at these localities, based on the results of sampling for pollen, molluscan faunas and mammalian microfaunas and the character of the deposits in which the assemblages are located.

The most complete sequence of Pleistocene deposits in the Neuwied Basin region are those in the Kärlich-clay-pit. These deposits form the basis of the Pleistocene stratigraphy of this region. Thus, the following description of the Kärlich sequence serves to introduce not only this locality and the local stratigraphic system, but also the possibilities and problems associated with multi-disciplinary Pleistocene research in the Neuwied Basin.

The Kärlich Clay-Pit

Introduction

Commercial exploitation of high-quality Tertiary clays for the ceramic industry began in the Kärlich pit in 1896 and are continuing today. The clays lie at a depth of 40 - 50 metres below the present-day surface and their exploitation neccessitates the removal of overlying Pleistocene gravel and loess deposits.

The Kärlich clay-pit was already known at the beginning of the 1900s as one of the most important Quaternary sections in the Rhineland (Pohlig, 1913), and various authors have since been involved in revising the stratigraphy of these deposits (Frechen, 1959; Frechen & Rosauer 1959; Mordziol, 1913, 1929a and b, 1930a and b, 1952; Mückenhausen, 1959; Remy 1959).

In the 1960s and 1970s, this locality became the focal point of investigations by geologists from the University of Cologne. The following description of the Kärlich deposits is therefore based upon work published by Professor Karl Brunnacker of this university (1971, 1978; Brunnacker et al., 1969, 1976, and in Butzer and Isaacs (eds.), 1975).

Situation

The Kärlich clay-pit is situated on the Kärlich hill on the south-western edge of the Neuwied Basin (Fig. 2, locality 1). The surface of the pit lies at about 135 metres above the present-day Rhine-valley.

Lithology

The base of the deposits is formed by Devonian slate of the Rhenish shield overlain by Tertiary (Oligocene) clay and weathered volcanic ashes (not shown in Fig. 3).
The Pleistocene deposits begin with a fluvial series overlain by loess beds with intercalated palaeosols and tephra horizons. The geological units are described following Brunnacker's system of letters of the alphabet (Fig. 3, column 1).

Fluvial deposits

Unit A: Fluvial deposits consisting of gravels and flood silts, usually occurring as a channel-fill. The remains of a palaeosol have been recorded in the uppermost part of this unit. A hiatus is present between this unit and unit Ba.

Unit Ba: A fluvial deposit consisting of gravels from the Rhine-river. Ice-rafted blocks and ice-wedges occur for the first time in the Kärlich sequence in this unit. A floodplain soil has developed at the top of this unit.

Unit Bb: Gravels of the river Moselle. The first occurrence of volcanic heavy minerals has been recorded in this unit. The Matuyama-Brunhes magnetic reversal boundary has been located in a silt lense in this unit.

Unit C: A weakly gleyed flood silt. This unit represents the transition from the fluvial series to the upper loess beds.

Loess deposits

Unit D: A loess deposit characterized by its green colouration. This unit has a weak-gleyed horizon at the top.

Unit E: This unit begins with a series of channel deposits containing rich molluscan faunas (the so-called »Schneckensand«), which are in turn overlaid by loess deposits. Traces of a palaeosol have been identified at the top of this unit. Units D and E are often classed together.

Unit F: This unit begins with a series of channel deposits filled with gravels and decalcified loesses, and overlain by soliflucted deposits and loesses. A palaeosol occurs at the top of this deposit. Thin tephra lenses and ice-wedges also occur in this unit.

Units Ga and Gb: Unit Ga has a series of humose, soliflucted deposits at its base. Tephra lenses and a palaeosol are present in the upper part of Gb. A major hiatus has been recognised between Ga and Gb. At Leutesdorf (Fig. 2, locality 2, and see Chapter 4 for description of site), interglacial deposits have been recorded between loess deposits correlated with units Ga and Gb. The palaeosol at the top of unit Gb has been correlated with interglacial deposits at Ariendorf (Fig. 2, locality 3, and Chapter 4 for description of site).

Unit H: This unit is also characterized by a channel deposit at its base. The channel has been filled with tephra, consisting of a thin pumice layer and a thicker basaltic ash. The pumice has been called originally the »Wehrer Pumice« I, due to its similarity to pumice deposits from the Wehrer volcano (Fig. 2, locality 16), and the ash has been called the Gleeser Ash. However, v. d. Bogaard and Schmincke (1988) are of the opinion that this tephra horizon bears no resemblance to pumice from the Wehrer volcano. A reworked loess lies between these and a younger tephra deposit, the »Wehrer pumice« II. In the uppermost facies of unit H is a calcareous palaeosol superimposed by a coarse, pumiceous tephra, the so-called »Brockentuff«. This tephra is probably of local origin, from a vent within the clay-pit itself.

Unit Ja: loess deposit. A palaeosol is present in the upper part of this unit.

Unit Jb: A further loess deposit. The unit begins with a series of three humose horizons superimposed by loess. The Laacher Pumice and a recent soil development complete this unit.

The main problems associated with the interpretation of the Kärlich sequence are the disconformities in the stratigraphy and the present state of the section itself.

Two major discontinuities between units A and Ba and units Ga and Gb, have been recognised in the Kärlich deposits. Brunnacker (1975), also notes that the majority of the loess beds have minor erosional phases at their bases.

The present state of the Kärlich section leaves much to be desired. Brunnackers descriptions are based on more complete sections found during the late 1960s and beginning of the 1970s, when the deposits were still being worked by Paternoster machines (Plate 16,1). Today, the deposits are removed by working down in certain areas from the present-day surface onto the Tertiary clays. This method results in a patchwork of partial sections which are difficult to correlate even within the pit itself (Plate 16,2).

Typical of this, is the situation regarding the archaeological assemblage (Kä 1) currently being investigated in the pit (see Chapter 4). Although previously considered to belong to unit H (Bosinski et al., 1980), an exact correlation within the Kärlich sequence is, due to the isolated position of the archaeological site in the clay-pit, very difficult.

Stratigraphy

Age-equivalent stratigraphic markers

Palaeosol stratigraphy

Palaeosols (fossil soils) play an important role in the local stratigraphy. In Kärlich, the remains of interglacial soils are found at the top of units A, B, E, F, G, H and Ja (Fig. 3, column 1). The recent soil development is at the top of Jb. On the basis of this, six different cold phases have been recognised above the fluvial series.

Occasionally a combination of palaeosol and another marker horizon has been tentatively used for correlative purposes. A good example of this are the marker horizons - red brown soil development overlain by Laacher pumice - which occurs at most localities and marks the Late Pleistocene Alleröd Interstadial phase in this region.

Deposits dating to the Last Interglacial and beginning of the Last Cold Stage are characterized at many localities in this region by interglacial soil remains with humic soils stratified above them, and can also be tentatively used for inter-site correlation.

The Rhine terrace

The correlations between the deposits at Kärlich and the sequence of Rhine terraces are shown in Fig. 3 column 2. It is possible to correlate terrace remnants in the Neuwied Basin region with those of the Lower Rhine, where the Matuyama-Brunhes reversal has been located in the upper part of the Main Terrace.

Palaeomagnetism

Magnetic or polarity reversal boundaries are important Pleistocene marker horizons, particularly as the deposits in which they occur can often be dated by the Potassium-Argon technique. Several localities in the Neuwied Basin have been sampled for palaeomagnetic direction. The most important result of these investigations was the identification of two polarity reversal events at the base of the Kärlich deposits (Fig. 3, column 3). The flood silt of unit A and a silt lense in unit Bb have reversed polarity (Koci et al., 1973), the palaeosol of unit Ba, flood silt of unit C and the loesses of units D, E, F and G all have normal polarity (Brunnacker et al., 1976).

Brunnacker has correlated the polarity reversal in unit Bb with the Matuyama-Brunhes boundary, an important event as it marks the beginning of the Middle Pleistocene. The older polarity reversal in unit A could be correlated with the Jaramillo event (Brunnacker et al., 1976).

Evidence of younger polarity reversal events, such as the Blake event, have not been found so far either in Kärlich or at other localities in this area.

Tephrochronology

Quaternary vulcanism plays an important role in the stratigraphy of the Neuwied Basin region (Fig. 3, column 4). Tephra deposits in the form of basaltic ashes, scoria or pumice occur at all of the localities described in this study. They originate from various eruptive centres in the east Eifel volcanic field, situated at the north-western edge of the Neuwied Basin in the vicinity of the Laacher lake (Fig. 2).

The tephra deposits are important for several reasons:

1) Once identified they are useful inter-site marker horizons. An example of this in the Neuwied Basin is the Laacher pumice, which occurs at several localities such as Kärlich, Gönnersdorf, Andernach, Niederbieber, Miesenheim I, Miesenheim II etc. and marks the Late Pleistocene Alleröd Interstadial phase in this area.
2) Tephra deposits can be absolute dated by the Potassium-Argon technique. Organic remains in younger tephra deposits, such as charcoal, can also be dated by Radiocarbon methods.
3) Volcanic minerals resulting from particular eruptive phases can be traced by heavy mineral analysis and also used as stratigraphic markers.

Heavy minerals

Investigations carried out by Razi Rad (1976) at Kärlich and other localities in this area have established a stratigraphic framework based particularly on the presence/absence of certain volcanic minerals (Fig. 3, column 5).

Important in the Kärlich sequence is the domination of brown hornblend at the top of unit Ga and in unit Gb, marking an intensification of the East Eifel vulcanism, and its replacement at the top of unit Gb and base of unit H by the mineral pyroxene (Fig. 3). These minerals can also be traced at various other localities in the Neuwied Basin region (Chapter 4).

Van Kolfschoten (1988), has also suggested correlations between some of the Kärlich deposits and pollen-dated localities in Holland, where brown hornblend also occurs (Fig. 3, column 10).

Stone artefacts

As the majority of the fossiliferous horizons described in this study are archaeological ones, that is the macrofauna is associated with the stone tool or lithic industries of fossil man, the possibility of using these as stratigraphic indicators was also considered.

Stone artefacts have been collected from several units in Kärlich (Bosinski, 1983; Kulemeyer, 1988; Würges, 1984, 1986) but, as with the majority of the lithics recovered from assemblages at the Neuwied

Basin localities, they are not particularly useful in dating a deposit. The only assemblages with stone tool industries which could be culturally, and therefore stratigraphically defined, were those dating to the latter part of the Late Pleistocene (Chapter 4).

Absolute dating

Potassium-Argon (40AR/39AR)

The Potassium-Argon method of absolute dating has been used on tephra deposits at several localities in the Neuwied Basin region. Originally, Schmincke & Mertes (1979) dated the Wehrer Pumice at source to about 283.000 ± 90.000 BP, and this date has been subsequently used for the »Wehrer Pumice« at Kärlich. Frechen & Lippolt (1965) obtained a date of 150.000 ± 40.000 BP for the Brockentuff in unit H (Fig. 3, column 7). Relative dates for local stratigraphic events were also given based on the results obtained by this method (Windheuser, Meyer & Brunnacker 1982). Thus, the Leutesdorf Interglacial was dated to about 400.000 BP, the Ariendorf Interglacial to about 300.000 BP and the Kärlich Interglacial to about 210.000 BP (Fig. 3, column 6).

Refinements in this method to detect or reduce the presence of older contaminating material in the sample have also been recently employed at localities in this area. Fuhrmann & Lippolt (1986) have used the 40Ar/39Ar stepwise degassing method and have shown that previous higher age values are false due to excess argon.

Van den Bogaard and Schmincke (v. d. Bogaard et al, 1987) have used the 40AR/39AR single grain laser fusion method on deposits in the Kärlich sequence. The dates resulting from this method are much older than those previously obtained (v. d. Bogaard & Schmincke 1988) and also contradict those obtained by other methods of absolute dating from deposits of similar age. With the laser method, the »Wehrer« Pumice I is dated to 683.000 ±8.000 BP. »Wehrer« Pumice II to 467.000 ± 4.000 and the Brockentuff to 440.000 ± 18.000 BP (Fig. 3, column 7).

Thermoluminescence (TL)

This method has been used at several localities. Wintle (1987a) has dated loess deposits at the Late Pleistocene locality of Niederbieber, but does not consider this method to be suitable for deposits older than 100.000 BP (Wintle, 1987b). Singvhi (et al., 1986), have dated loess deposits at the Hummerich locality, which have produced dates older than 100.000 BP.

Zöller (et al., 1987), has used this method at Kärlich on older deposits. Two samples from the loess directly below the palaeosol of unit H have produced dates of 222.000 ± 25.000 and 232.000 ± 28.000 BP. These results are much younger than those given by the Potassium-Argon-Laser mehod (Fig. 3, column 8).

Radiocarbon

Due to the age limitations associated with this method (Lowe & Walker, 1984) its use has been restricted to localities with assemblages dating to the end of the Late Pleistocene, such as Gönnersdorf and Andernach in this region, or to dating organic remains in the Laacher Pumice (Fig. 3, column 9).

Uranium-Series-Dating

Dating by this method has only recently been attempted by C. Tiemei (University of Peking), using fossil macrofaunal teeth from localities in the Neuwied Basin region. The problems associated with this method are discussed by Tiemei & Sixun (1988). So far this method has produced only a few dates from assemblages at the Neuwied Basin localities, and has not been used on fossils from Kärlich.

Ice-wedges

Ice-wedges occur frequently in loess and gravel deposits at the Neuwied Basin localities. These only occur today where the annual air temperature is around - 8 degrees centigrade or even lower (Lowe & Walker, 1984). Their presence is therefore indicative of very cold conditions. Ice-wedges occur in units F, Gb, H, Ja and Jb at Kärlich (Fig. 3, column 1).

Palynology

Pollen has been sampled from several interglacial and interstadial deposits at the Neuwied Basin localities. Sampling for pollen from loess deposits in which a large number of fossiliferous horizons are located, has only been attempted at Gönnersdorf (Chapter 4) so far. Local pollen zones have not yet been established, so that pollen assemblages cannot be used for inter-site correlation. Attempts to compare pollen assemblages from the Neuwied Basin localities with known Pleistocene floras have not been successful. For example, in the Kärlich clay-pit pollen has been sampled from the deposits thought to belong to the locally named Kärlich Interglacial by Urban (1983; in Bosinski et al., 1980), and recently by Bittmann (1988). Urban was of the opinion that the flora was not comparable to that from any of the known Pleistocene Interglacials, whereas Bittmann states that it is similar to floras recorded at localities dating to the Cromer complex on the Continent. However, despite problems of correlation, palynology still plays an important role as a further palaeoenvironment indicator.

Plant macrofossils

Plant macrofossils in the form of wood, charcoal, leaves and seeds have been recorded from assemblages at several localities in the Neuwied Basin. They often occur in, or are preserved beneath, tephra deposits. Macrofossils can provide evidence of plants and trees which, for reasons of preservation, do not occur in the pollen assemblage, and can often be identified to species instead of only to genus or family.

Occasionally plant macrofossils can be used as biostratigraphical indicators. In Kärlich, for example, impressions of Celtis (nettle tree) leaves have been found in the Brockentuff of unit H (Urban, in Bosinski et al., 1980). As Celtis is no longer found in North-West Europe after the Last (Eemian) Interglacial, this indicates that unit H should also be older than the Eemian.

Molluscan faunas

Molluscan remains are often found in deposits at the Neuwied Basin localities. Generally the molluscan faunas being of little use in dating deposits (Boscheinen et al., 1984) are, however useful environmental indicators (Lozek 1964).

Remy (1959), first identified molluscs from Kärlich, and Lozek (in Brunnacker 1971), sampled most of the units in this pit. The following faunal lists from Kärlich are after Lozek (in Brunnacker, *ibid.*).

Unit C: The fauna is dominated by species inhabiting a cold loess steppe environment, such as *Pupilla* sp. and *Trichia hispida* . Also present are species preferring a damp habitat, such as *Clausilia* cf. *pumila* and aquatic forms such as *Gyraulus laevis*, *Valvata pulchella* and *Lymnea peregra*. Fragments of interglacial species, representing older reworked fauna, are also present.

Elements indicative of a very cold climate are, however, absent in the primary fauna, which indicates a damp, cold phase.

Unit D: The fauna indicates a loess steppe environment; the presence of *Columella columella* indicates that the climate was rather cold with low winter temperatures and possibly permafrost conditions. Some reworked interglacial elements also occur in this fauna.

Unit E: The fauna indicates a cold loess steppe environment. Species found in the so-called »Schneckensand« indicate a cold damp environment.

Units F and G: The faunas from both these units consists of those species inhabiting a cold loess steppe environment.

Unit H: A full interglacial fauna has been identified from the palaeosol at the top of unit H.

Unit J: A sparse fauna with typical cold loess steppe elements.

Mammalian Microfauna

Mammalian microfaunal evolution, particularly of the genus *Arvicola* (voles), is an important biostratigraphic tool (Fejfar & Heinrich, 1981; v. Koenigswald, 1973; van Kolfschoten, 1988). Microfaunal assemblages can also be more reliable palaeoenvironmental indicators than macrofaunas. This is particularly true of archaeological assemblages, such as those in the Neuwied Basin, where possible biases due to the hunting activities of early man only appears to apply to larger »microfauna« such as beaver.

Heller (in Brunnacker, 1971), described microfauna from units F and G in Kärlich as being »post-Cromerian« in age. Van Kolfschoten (1988), has described a biostratigraphically important fauna from unit Gb.

Unit Gb: The fauna is dominated by *Pliomys* sp. and *Microtus*. *Arvicola terrestris cantiana* also occurs. This fauna has been placed within the *Arvicola terrestris cantiana Sorex* (*Drepanosorex*) sp. Concurrent - range-subzone, which in turn has been correlated with the Interglacial IV of the Dutch division of the Cromer complex, which also includes part of the Elsterian (van Kolfschoten, 1988) (Fig. 3, column 10).

Mammalian Macrofauna

Pohlig (1909, 1913), was the first to describe macrofaunal remains from deposits near to this locality. The fauna probably originated from an older Rhine terrace (Brunnacker, 1971). Mordziol (1913), mentions remains of hippopotamus *Hippopotamus major* from the fluviatile series (units A-C).

Nobis (1970), has described remains of horse *Equus süssenbornensis*, and Rothausen (1970) remains of giant deer *Praemegaceros* from units E or F. Remains of elephant, including fragments of a tusk and a molar have been identified by Adam (in Brunnacker, 1971) in unit F. Nobis (1970), also described remains of horse *Equus* cf. *mosbachensis* from unit H.

The macrofaunal material from Kärlich described in this study (see Part III) is from the Würges collection, presently exhibited as part of an exhibition of the history of the villages of Mülheim and Kärlich in the Rheinlandhalle, Mülheim-Kärlich. Preliminary identifications of this material have been undertaken by several palaeontologists, including F. Poplin, K. Lanser amongst others.

Although few in number and in some cases poorly preserved, these fossils are important as they represent the only known macrofaunal remains from deposits dating to the earlier part of the lower Middle Pleistocene in this region. The descriptions of the original location of the fossils, for example, »found in unit Ja«, as given by the present owner of this collection, were accepted. It was unfortunate that the exact location of the fossils within a particular unit was no longer known and could not, as many of the fossils were collected at the beginning of this century, be reconstructed.

Correlations with the North West European Standard systems

Attempts to correlate the older Kärlich sequence (units A to G) with the Dutch divisions of the Cromer complex as proposed by Zagwijn (1971, 1985), have been attempted by Brunnacker (et al., 1976, in Butzer & Isaacs (eds.), 1975) and van Kolfschoten (1988).

Correlations of the younger part of the Kärlich sequence with the Standard European Systems appeared to be more reliable, but have been recently brought into question by the results of absolute dating at this locality (Fig. 3, column 10).

Important, however, for this study is the Matuyama-Brunhes in unit Bb at Kärlich, which is used here to mark the beginning of the Middle Pleistocene. In the Dutch division, this boundary has been located between the Interglacial I and Interglacial II of the Cromer complex, so that unit Bb at Kärlich could be correlated with the glacial A stage of the Dutch division (Fig. 3, column 10).

The Last Interglacial is represented by the interglacial soil at the top of unit Ja, and this is taken as marking the beginning of Late Pleistocene. Thus in this study, Middle Pleistocene deposits range from the Matuyama-Brunhes boundary in unit Bb to the top of unit Ja. Late Pleistocene deposits from the interglacial soil of unit Ja to the base of the recent soil development (Fig. 3, column 1).

The Middle Pleistocene deposits are further divided here into two phases, lower Middle and upper Middle Pleistocene deposits range from the Matuyama-Brunhes boundary in unit Bb up to and including the interglacial soil at the top of unit Gb (=Ariendorf Interglacial). The upper Middle Pleistocene deposits range from the base of unit H to the base of the interglacial soil at the top of unit Ja (Fig. 3, column 1).

CHAPTER 4

LOCALITIES WITH MIDDLE AND LATE PLEISTOCENE FOSSILIFEROUS HORIZONS IN THE NEUWIED BASIN

Miesenheim I

Situation

Miesenheim I is situated on the east bank of the Nette river, on a small escarpment of land to the east of Miesenheim village (Fig. 2, locality 5).

Research history

This locality was discovered in 1982, after commercial exploitation of volcanic deposits had exposed underlying fossil-bearing sediments. Soundings were investigated in the same year (Boscheinen et al. 1984). Large-scale excavation began in 1984 (Turner, 1985) and continued in 1985 and 1986 (Bosinski et al., 1988). Excavations will be continuing at this locality.

The macrofaunal remains recovered during the 1982 - 1986 excavation campaigns are described in Part III. The material is stored in the collection at the Research Centre, Monrepos.

Lithology

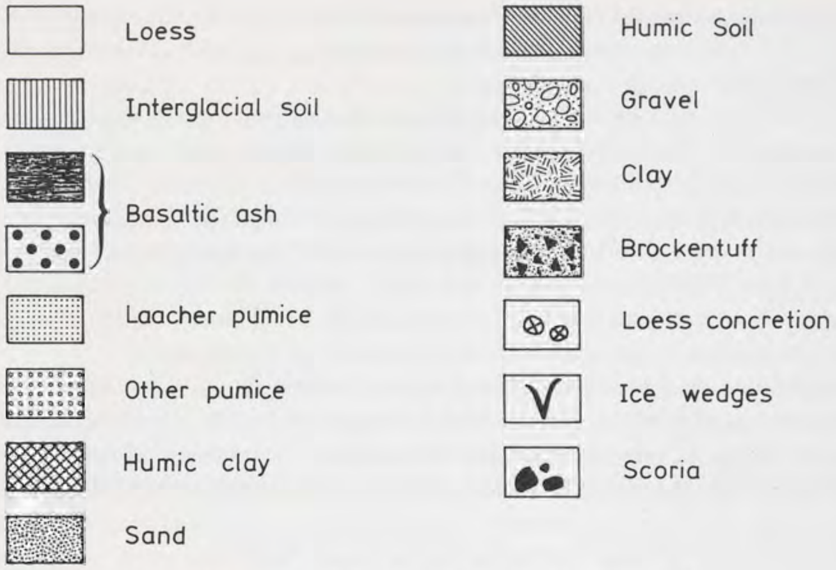
A simplified section through the Miesenheim I deposits is shown in Fig. 4. Units important for the chronostratigraphy of the deposits are underlined.

Fossiliferous horizons

Two fossiliferous horizons have been recorded (Fig. 4, nos. 1 and 2).

Mi 1: This horizon consists of sparse macrofaunal remains only, lying on the border between units L and K. The assemblage consists of two concentrations of post-cranial bone, and appears to be in primary context.

The macrofaunal material from this horizon is pale yellow in colour with some mineral deposits (manganese) on the outer surface. The material is poorly preserved and the outer surfaces are eroded.



Key to the symbols used to describe deposits in the figures 4 - 19.

Mi 2: This is the the main fossiliferous horizon consisting of mammalian macrofaunal and microfaunal remains and associated stone artefacts. The finds occur throughout unit J and in the uppermost part of unit K. Numerous conjoins between bone fragments indicate that the fossils occuring in both units belonged to the same phase of deposition. During excavation, it was noticed that the fossils were concentrated towards the base of the »Anmoor« deposit and were also found lying on the boundary between units K and J. According to Brunnacker, (in Boscheinen et al., 1984), the »Anmoor« of unit J formed during a break in deposition, and it may be that the original place of deposition of this assemblage was either on the surface of unit K or collected during the formation of the unit J. The subsequent movement of fossils into the upper part of unit K and throughout unit J is due to post-burial factors.

In comparison to the material from Mi 1, the macrofaunal remains recovered from both units J and K are extremely well-preserved. The outer surfaces show hardly any signs of weathering and fragments bearing traces of root-etching are rare. The macrofaunal material from unit K is pale yellow to pale brown in colour, whereas that from unit J is brown only. The conditions of deposition were certainly much better than those indicated by the state of preservation of the material found in Mi 1, and suggest that the fossils were deposited shortly before or during the formation of the »Anmoor« under anaerobic conditions. Conjoins between Mi 1 and Mi 2 have not been found so far.

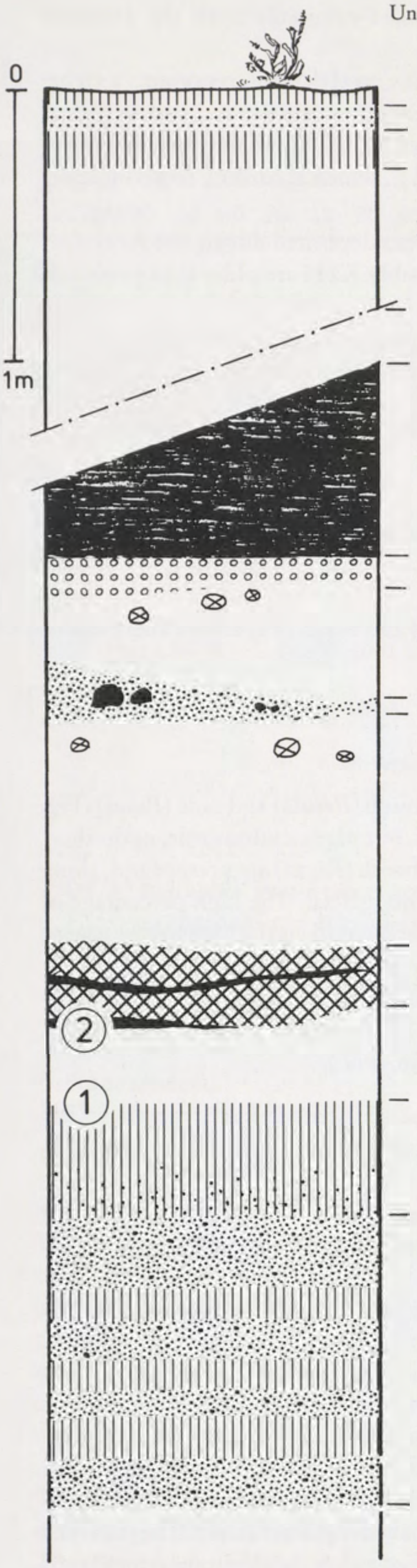
Chronostratigraphy

Brunnacker (Brunnacker, in Boscheinen et al., 1984), considered the palaeosol of unit L to be the equivalent of the Ariendorf Interglacial. This correlation was based on the following marker horizons at Miesenheim (Fig. 4):

i) Heavy mineral analysis of the older loess deposits show that the mineral pyroxene dominates. This volcanic mineral becomes dominant in deposits younger than the Leutesdorf Interglacial, and indicates that the fossiliferous horizons at Miesenheim I are also younger than the Leutesdorf Interglacial.

ii) The tephra deposits of units F and E are very similar to the »Wehrer« Pumice I and the »Gleeser« Ash located in unit H at Kärlich. According to the stratigraphy in the Kärlich clay-pit, these deposits are stratified in loess of the Third Cold Stage BP (Fig. 3).

The palaeosol of unit L was thus interpreted as belonging to a warm phase younger than the Leutesdorf Interglacial, but older than the Third Cold Stage BP which, according to the local stratigraphy is the



Unit	Description
A:	Recent plough soil
B:	Laacher Pumice
C:	Palaeosol of the Alleröd Interstadial phase
D:	A pale yellow, homogenous loess
	Hiatus
E:	A black-grey blocky ash, occasionally reaching a depth of about two metres
F:	A thin pumice band
G:	A homogenous pale-yellow loess with a Ca (calcium carbonate) horizon in its upper part
H:	A thin gravel horizon, including pebbles up to 10cms, in diameter and some weathered pumice. This unit is reworked: the gravels may be from a higher terrace of the Nette River
I:	A loamy gleyed colluvium. In its uppermost part calcium carbonate concretions are present
J:	A dark-brown, humic clay deposit. Brunnacker (in Boscheinen et al., 1984) describes this unit as a moor or Anmoor
K:	A calcareous, gritty colluvial horizon
L:	A calcareous, yellow brown loamy sediment. Brunnacker (in Boscheinen et al., 1984), describes this unit as being the Bt horizon of a palaeosol
M:	Alternating lenses of calcareous light yellow-brown sandy and yellow-brown loamy sediment
	Older loesses with two intercalated, but not identified tephra (ash) horizons. The volcanic mineral pyroxene dominates in the loess

Fig. 4 Simplified section through the deposits at Miesenheim I.

Ariendorf Interglacial. The Ariendorf Interglacial has been correlated originally with the Holstein Interglacial (Fig. 3).

However, there are problems associated with this correlation. Unit H, a gravel deposit, represents a vigorous erosional phase at the site. This unit has been recorded in other sections at the site and had, in places, cut into the fossiliferous deposits. It indicates a break of unknown duration in the stratigraphical sequence between the palaeosol of unit L and the tephra deposits of units F and E, which according to Brunnacker form a terminus ante quem for the fossiliferous horizons.

Recent absolute dating of both the tephra in unit H at Kärlich and tephra deposited during the Ariendorf Interglacial has indicated that both the Ariendorf Interglacial and possibly Kä H are older than previously thought (Fig. 3; Chapter 4).

The only other marker horizons in the Miesenheim I sequence are the units C - Alleröd Interstadial soil and B - Laacher Pumice, which mark the end of the Last Cold Stage in the Neuwied Basin region. Unit D is presumably loess of the Last Cold Stage. The hiatus between units D and E means that these younger deposits are of no further use in dating the fossiliferous horizons.

The fossiliferous assemblages

Mi 1

Palynology

Birch (*Betula*) dominates; oak (*Quercus*), alder (*Alnus*), lime (*Tilia*) and beech (*Fagus*) are also present (see Fig. 5, after Urban, in Boscheinen et al., 1984).

Mi 2

Palynology

In unit J, the tree pollen is dominated by a high percentage of both birch (*Betula*) and pine (*Pinus*) (Fig. 5, after Urban, in Boscheinen et al., 1984). Spruce (*Picea*) is present, but plays a minor role, as do thermophilous taxa such as hazel (*Corylus*). Hornbeam (*Carpinus*) and beech (*Fagus*) are present and, along with spruce, represent taxa usually found towards the end of an interglacial. The high percentage of non-tree pollen indicates a locally open, herbaceous vegetation. Characteristic is the high percentage of algae found in the samples, evidence that the pollen spectra was deposited in water.

The pollen assemblage as a whole belongs to the end of an interglacial (Urban, *ibid.*), characterized by open pine and birch woodland. This interglacial could not, on the basis of the pollen assemblage alone, be correlated with any of the known Pleistocene interglacials (Urban, *ibid.*).

Molluscan fauna

A very rich, but fragmentary molluscan fauna was recovered from units J and K. A provisional list has been compiled by J. Boscheinen (in Boscheinen et al.,1984).

The fauna is dominated by those species living in sluggish or stagnant waters with abundant plant-life, and those inhabiting damp, forested conditions. The fauna indicates a locally wet and damp environment. Species indicative of cold conditions are not present.

The absence of stratigraphically useful species or communities makes it impossible to give an age to this assemblage at present.

Microfauna

A complete microfaunal list is given by van Kolfschoten (1988). The majority of the species found are those associated with woodland or wooded areas, such as the wood mouse (*Apodemus sylvaticus*) and the dormouse (*Muscardinus avellanarius*). Aquatic species, such as beaver (*Castor fiber*), are also present, as are those species which inhabit open, dry grassland, such as hamster (*Cricetus* sp.). The presence of the dormice *Eliomys quercinus* and *Muscardinus avellanarius* indicate that the climate was similar to that today.

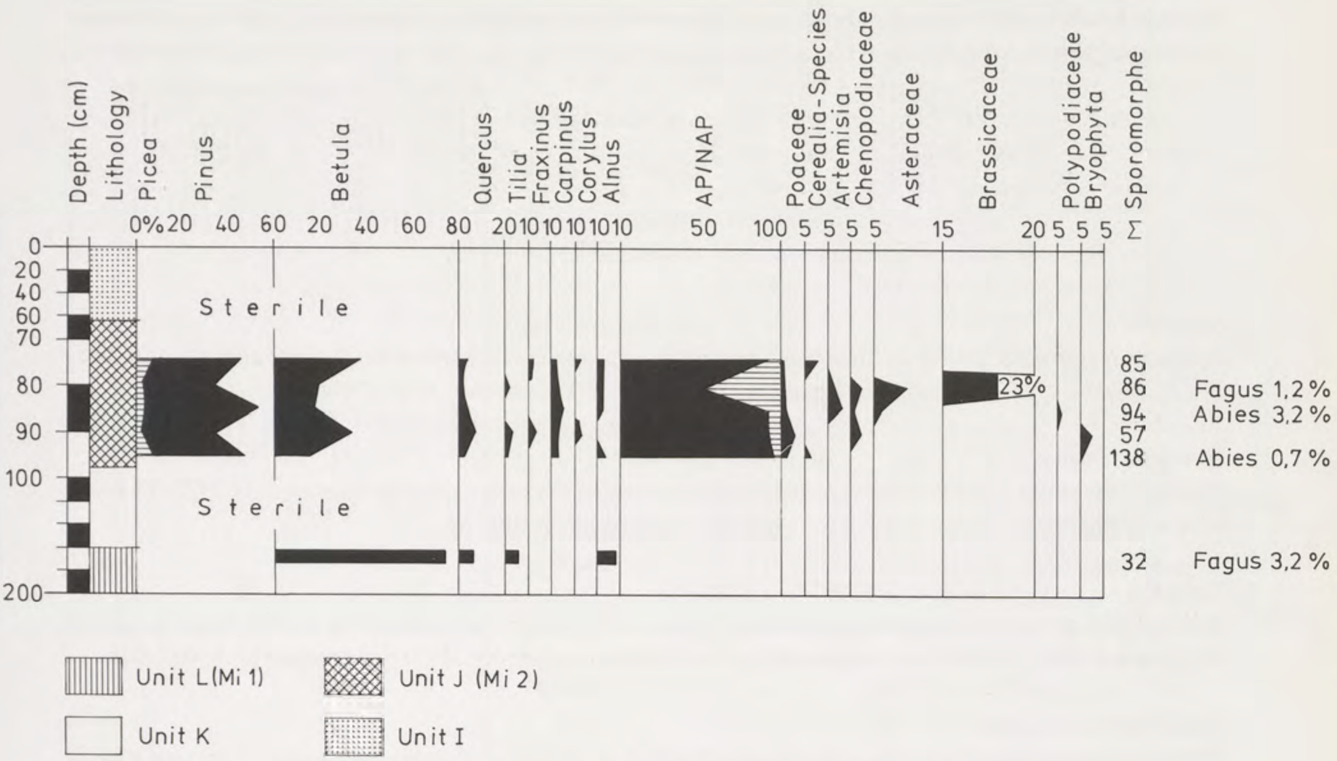


Fig. 5 Pollen diagram from Miesenheim I (after Urban in: Boscheinen et al. 1984).

Of stratigraphic importance are *Drepanosorex savini*, *Trogontherium cuvieri*, *Arvicola cantiana*, *Pliomys episcopalis* and *Microtus agrestris*. The occurrence of these species indicates that the assemblage belongs to the *Arvicola terrestris cantiana - Sorex (Drepanosorex)* sp. Concurrent - range - subzone, which is correlated with Interglacial IV of the Cromer complex and part of the Elsterian, according to the Dutch subdivision (van Kolfschoten, 1988 and see Fig. 3).

Stone artefacts

The stone artefacts in the Mi 2 assemblage consist mainly of flakes produced on locally-found raw materials and give no further information as to the age of the fossiliferous horizon.

SUMMARY

The pollen assemblages indicate that the units L and J are interglacial deposits, and they probably belong to the same interglacial phase. Unit J, is pollen dated to the end of this interglacial. The Mi 2 assemblage was probably deposited shortly before or during the beginning of the formation of the »Anmoor« in unit J. The palaeoenvironmental information from the mammalian microfauna and molluscan fauna associated with the Mi 2 assemblage is consistent with that suggested by the pollen in Unit J. The environment at this time consisted of pine and birch woodland, with locally open herbaceous vegetation near to the site. The environment at the site itself was rather damp, and may have consisted of marshland.

The palaeosol of unit L has been correlated with the Ariendorf Interglacial. The Mi 2 assemblage is located in a younger deposit, but appears to belong to the same interglacial phase.
The Ariendorf Interglacial has been previously correlated with the Holsteinian. According to van Kolfschoten (1988), the microfauna from Miesenheim I indicates that the interglacial represented at this

locality should be older than the Holsteinian. Likewise, absolute dating of interglacial deposits at the type-locality suggest that the Ariendorf Interglacial is probably older than was previously thought (see below).

Leutesdorf

Situation

Leutesdorf is situated to the north of the Neuwied Basin, on the east bank of the Rhine valley (Fig. 2, locality 2). It is the type-locality of the Leutesdorf Interglacial (Brunnacker et al., 1974).

Research history

The deposits at this locality were exposed during shoring of the valley sides for vineyards in 1972. The section no longer exists today. Excavations were not carried out at this site.

Lithology

A simplified section through the sequence of deposits at Leutesdorf is given in Fig. 6, after Brunnacker (in Brunnacker et al., 1974). Units important for the chronostratigraphy of the deposits are underlined.

Fossiliferous horizons

The sparse macrofaunal remains, mentioned in Part III, were collected during geological investigations of the exposures at Leutesdorf, and have been identified by F. Poplin (in Brunnacker et al., ibid).

The fossils were located in the upper part of the loess of unit G (Fig. 6, nos. 1 and 2). Fragments described as belonging to a large bovid located in an older horizon are not described further in this study. The fossils are stored in the Neuwied Museum and in the collection at the Research Centre, Monrepos.

With the exception of the molluscan fauna in the Leutesdorf Interglacial deposits, sampling for molluscs, microfauna and pollen was not undertaken at this locality. Information as to the deposition of the fossils (primary or secondary context) was not available.

Chronostratigraphy

Important for the chronostratigraphy of the Leutesdorf sequence are the following horizons:

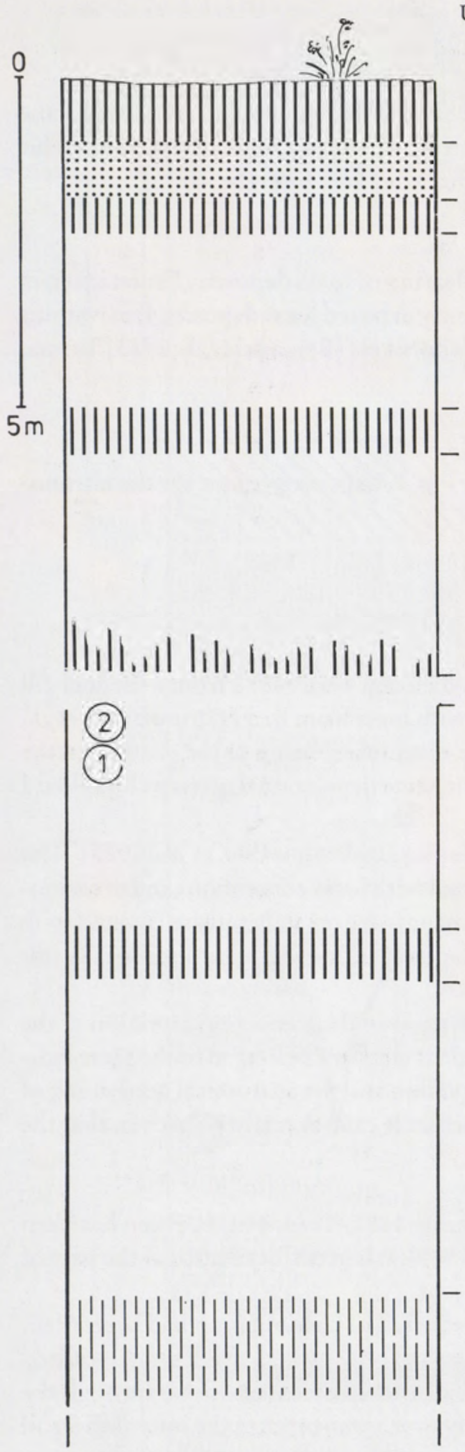
i) Unit J has been identified, on the basis of an interglacial molluscan fauna, as the Leutesdorf Interglacial. This deposit is overlain by four loess beds (Units I, G, F and D) with three intercalated interglacial soils or the remains of these (Units H, base of F and E). The Leutesdorf Interglacial is the Fourth Warm Stage BP at this locality.

ii) The heavy mineral brown hornblend has been identified in the Leutesdorf Interglacial deposits and in the loess stratified directly above this (Unit I). This allows a correlation with the sequence in the Kärlich clay-pit, where brown hornblend is dominant in the unit Kä Gb (Fig. 3).

SUMMARY

On the basis of the dominance of brown hornblend and the four loess beds stratified above the interglacial deposits at Leutesdorf, the Leutesdorf Interglacial has been correlated with a warm phase between Kä Ga and Gb. According to the local stratigraphy the Leutesdorf Interglacial is the Fourth Warm Stage BP and the loess beds above the interglacial deposits can be correlated as follows. Unit I is the loess of the Fourth Cold Stage BP, unit G loess of the Third Cold Stage BP, unit F loess of the Second Cold Stage BP and unit D the last.

The fossils are located in cold stage deposits in the upper part of unit G. This unit has been correlated with the Third Cold Stage BP, which in turn is correlated with an older phase of the Saalian (see Fig. 3).



Unit	Description
A:	Recent soil
B:	Laacher Pumice
C:	Soil of the Alleröd Interstadial
D:	Loess
E:	Palaeosol of the Last Interglacial
F:	Loess. The remains of a palaeosol are located at the base of this deposit
	Hiatus
G:	Loess
H:	A brown, loamy horizon, described as an interglacial deposit
I:	A loess deposit. Brown hornblend also occurs in this deposit
J:	A loamy ailuvial deposit. This is the Leutesdorf Interglacial horizon, identified by a warm molluscan fauna The deposit also shows a dominance of the heavy mineral brown hornblend

Fig. 6 Simplified section through the Leutesdorf deposits.

Ariendorf

Situation

The Karl Schneider gravel quarry at Ariendorf is situated about thirty kilometres to the north of the Neuwied Basin (Fig. 2, locality 3). This locality lies on a middle terrace on the east bank of the Rhine. This is the type-site, after Brunnacker (in Brunnacker et al., 1975), of the Ariendorf Interglacial.

Research history

The first fossils were recovered here in 1970 during mechanical clearing of loess deposits (Brunnacker, et al., 1975). In 1981, bone fragments were found eroding out of recently exposed loess deposits. Excavations carried out between 1981 and 1983 investigated three fossiliferous horizons (Bosinski et al., 1983; Turner, 1985) (Plate 17,1).

Lithology

A simplified section through the Ariendorf deposits is shown in Fig. 7. Units important for the chronostratigraphy of the deposits are underlined.

Fossiliferous horizons

Four main horizons have been recognised so far (Fig. 7, numbers 1 - 3 and Ch.).

Ar Ch: This assemblage consists of macrofaunal remains recovered during 1970 - 1972 from a channel-fill deposit in the sandy-loess of unit N. The channel itself was filled with loess from Bed I (Brunnacker et al., 1975), and the fossils may be derived from this loess deposit. The exact relationship of the channel to the present sequence of deposits is not clear. It probably belongs to the same depositional phase as loess bed I (unit L).

The macrofauna from this assemblage has been described by Poplin (in Brunnacker et al., 1975). The macrofaunal remains are white to yellow-brown in colour, encrusted with loess concretions and occasionally with gravel. The outer surfaces of the finds show deposits of manganese crystals and are covered with root-etching. This is typical of macrofaunal material from loess deposits at this and other localities in this region.

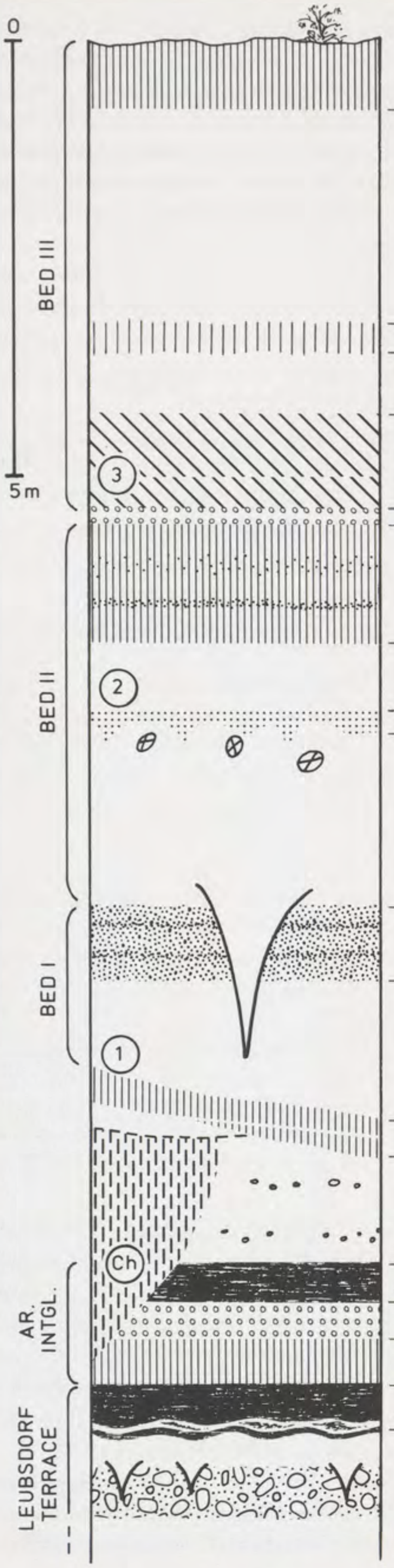
None of the material is rolled in appearance and there are no differences in the state of preservation of the individual fossils from this deposit. Some of the fossils from an extinct elephant belonged to the same individual (see Part III). However, despite the uniform state of preservation and the anatomical conjoining of some material, the depositional context of this assemblage means that it cannot really be proven that the fossils are all from the same depositional phase.

Ar 1: This is the oldest of the fossiliferous horizons excavated during 1981 - 1983. This horizon has been incorrectly described as being stratifed in unit M (Bosinski et al., 1983). It is actually situated at the base of unit L, directly above the palaeosol of unit M.

Ar 1 consists of macrofaunal remains in association with stone artefacts. The base of unit L had been affected by cryoturbation and solifluction processes after the assemblage had been buried, resulting in localised disturbance of the assemblage. The fossils have been displaced to a depth of up to one metre through the sediment, and have been moved downslope. The assemblage is, however, younger than the interglacial soil (unit M), and its position at the base of Bed I in Fig. 7 is probably correct.

The macrofauna is well-preserved, predominantly grey-white in colour. Root-etching occurs on only a few specimens. Conjoins between both the lithics (stone tools) and between the macrofaunal remains, and the state of preservation indicate that this assemblage belongs to the same phase of deposition.

Ar 2: This is the main fossiliferous horizon, discovered in 1981 in the uppermost part of the loess of unit H. The assemblage consists of macrofaunal remains in association with stone artefacts. The fossils were



Unit	Description
A:	Recent plough-soil
B:	Aeolian loess
C:	A weakly-developed palaeosol. Described as the Lohner soil
D:	Aeolian loess
E:	Humic soil development
F:	A pumice deposit. Previously called the Metternich Pumice. ^{40}Ar^{39} Ar (Laser) date of 223 000± 47 000 BP
G:	Last Interglacial palaeosol
H:	A calcareous aeolian loess. TL date of 199 000± 18 000 BP at top of unit
I:	A thin ash deposit. Has been called the Kriftel Ash
J:	Calcareous aeolian loess deposit. Extremely large ice-wedges length 2 + metres) have been formed at the base of this unit
K:	Alternating coarse sand and loamy lenses
L:	A sandy facies of a loess deposit
M:	The red-brown Bt horizon of a palaeosol
N:	A sandy loess deposit. A channel has cut through this unit (Ch). TL dates of 235 000 ± 42 000 BP and 300 000 ± 34 000 BP
O:	A frost-shattered ash deposit
P:	A reworked pumice and ash deposit. ^{40} Ar ^{39} Ar (Laser) date of 442 000 ± 3 000 BP ^{40} Ar ^{39} Ar (stepwise degassing) date of 420 000 BP
Q:	Soil of the Ariendorf Interglacial. ^{40}Ar^{39} Ar (Laser) date of 451 000 ± 6 000 BP
R:	An ash deposit ^{40}Ar^{39} Ar (Laser) date of 710 000 ± 28 000 BP
S:	Gravels from the middle terrace of the Rhine. Dominance of the heavy mineral pyroxene

Fig. 7 Simplified section through the Ariendorf deposits.

associated with, and occasionally laid upon a thin lense of slate fragments stratified within the loess. Lenses of slate fragments occur frequently in the loess deposits at Ariendorf, and are usually interpreted as breaks in sedimentation during which eroded bed-rock material, probably from outcrops on the upper terrace, had been reworked into the younger loess deposits. Conjoining of both lithics and macrofaunal remains, and bones lying in anatomical position, suggest only localised disturbance of the assemblage after burial. The macrofaunal material is pale yellow-brown in colour: root-etching occurs on most of the specimens. The conjoins between the macrofaunal material and between the lithics, and the uniform state of preservation indicates that the fossils belong to the same phase of deposition.

Ar 3: This horizon is located in the humic soil of unit E. Macrofaunal remains and some stone artefacts were recovered from unit E during mechanical removal of the deposits, but a more thorough investigation of this horizon has not been undertaken so far. The assemblage appears to be in primary context. The sparse macrofaunal remains are dark yellow-brown in colour and poorly preserved.

The macrofaunal material recovered during the 1981 - 1983 excavations from Ar 1, 2 and 3 is described in Part III. The material is stored in the collection at the Research Centre, Monrepos. The macrofauna from the channel assemblage is stored in the collection of the Naturhistorisches Museum in Mainz.

Chronostratigraphy

Brunnacker (et al., 1975), was the first to describe the Ariendorf section and recognised four main depositional phases (Fig. 7). Firstly, the Rhine gravels, called here the Leubsdorf Terrace (Fig. 7, Units S and R), superimposed by three loess beds (Fig. 7, Bed I = Units L and K; Bed II = Units J - G; Bed III = Units F - A) each representing a separate cold stage with intercalated palaeosols. The Ariendorf Interglacial deposits (Units Q - O) are stratified between the gravels of the Leubsdorf Terrace and the loesses. Recent dating of the Ariendorf Interglacial deposits and the appearance of a new sequence of deposits at the base of the loess beds suggest that at least the lower part of the Ariendorf sequence is older than previously thought.

– i) The Leubsdorf Terrace

Heavy mineral analysis of the Leubsdorf terrace gravels has shown a dominance of the mineral pyroxene (Brunnacker et al., 1975) As has been already stated (Chapter 3), this volcanic mineral only becomes dominant in the Neuwied Basin region after the Leutesdorf Interglacial (Fourth Warm Stage BP). This implies that the gravels and the loess deposits are all younger than the Leutesdorf Interglacial and Brunnacker (*ibid*) correlated the Leubsdorf Terrace with the Fourth Cold Stage BP.
The ash of unit R, also belonging to the Leubsdorf Terrace, and referred to in earlier literature as a »Selbergit« ash (Bosinski, 1983), has been dated to 710,000 +/- 28,000 BP by the 40/Ar39Ar (Laser method) (v.d.Bogaard & Schmincke, 1988). This date is considered to be too old for gravels of the Middle Terrace of the Rhine (Fig. 3) and needs revising.

– ii) The Ariendorf Interglacial deposits

Units Q, P and O form the Ariendorf interglacial sequence. Unit Q has been identified as the soil of this warm phase (Brunnacker et al., 1975). Bibus (1980), in his description of the Ariendorf section, rejected this idea. His arguments have however not been considered further (Brunnacker, in Bosinski et al., 1983). Leaf impressions from deciduous trees have been recovered from the volcanic ash of unit O. Elm (*Ulmus*), beech (*Fagus*), hornbeam (*Carpinus*) and thermophilous taxa, such as hazel (*Corylus*) have been provisionally identified (Poplin in Brunnacker et al., 1975; pers. comm. F.Bittman). The presence of hornbeam and beech may indicate that the ash of unit O was deposited during a later phase of the Ariendorf Interglacial, as these taxa are usually present towards the end of a warm phase (Urban, in Boscheinen et al., 1984).
The Ariendorf Interglacial sequence is stratified above the Leubsdorf Terrace, which is younger than the Leutesdorf Interglacial. This interglacial sequence was, according to Brunnacker (1975), superimposed by three loess beds, each representing a single cold stage, with two intercalated interglacial soils. The

Ariendorf interglacial was thus the Third Warm Stage BP at this locality and was tentatively correlated with the Holstein Interglacial (see Fig. 3).

Frechen and Lippolt (1965), obtained dates of 350,000 - 420,000 BP for the »Selbergit« ashes. Recently, units Q and P of the Ariendorf Interglacial sequence have been dated to between 420,000 - 450,000 BP by the 40AR/39Ar laser method (v.d.Bogaard & Schmincke, 1988) and by the 40Ar/39Ar stepwise degassing technique (Lippolt & Fuhrmann, 1986). The recent dates support the idea that the Ariendorf Interglacial and the underlying gravels of the Leubsdorf Terrace are older than has been previously considered.

Deposits at Miesenheim I (Chapter 4), correlated by Brunnacker (in Boscheinen et al., 1984) with the Ariendorf Interglacial, also, on the basis of mammalian microfauna (van Kolfschoten, 1988), represent an older warm phase.

– iii) Loess beds I and II

Brunnacker (et al., 1975), originally dated the deposition of these beds to the Third and Second Cold Stages BP respectively, which are correlated with an older and a younger phase of the Saalian (Fig. 3). The interglacial soil separating these beds was represented only by a Cc (calcium carbonate) horizon (Brunnacker, ibid). The dating of these beds was obviously based upon their relation to the Ariendorf Interglacial, which was thought at the time to represent the Third Warm Stage BP. During the excavation of Ar 1, the palaeosol (unit M), described originally as belonging to the Ariendorf Interglacial (Brunnacker, in Bosinski et al., 1983), and the loess of unit N were revealed. These deposits appear to represent an older cold and warm cycle which was not present when Brunnacker described the section (Haesaerts, pers. comm.), and also indicate, as above, that the Ariendorf Interglacial is a stage older. This does not, however, appear to change Brunnackers original description of loess Beds I and II. A TL date of about 199,000 +/- 18,000 BP has been obtained for the uppermost part of the loess of bed II (Zöller et al., 1987), which correlates with its proposed late Saalian age. However, TL dates for the loess of unit N of about 244,000 +/- 25,000 and 300,000 +/- 34,000 BP (*ibid.*), are rather young for a loess which was probably deposited, according to the revised stratigraphy, during the Fourth Cold Stage BP.

The so-called Kriftel Ash of unit I has not been dated so far. Its identification is also rather provisional, being compared to the Kriftel Ash of the Rhine-Main area (Semmel, 1967, 1974; Bibus, 1973), only because of its physical appearance.

– iv) Loess bed III

Units G, F and E represent a younger marker horizon at this locality. The sequence - interglacial soil overlain by humic soil - also occurs at the base of loess deposits dating to the Last Cold Stage at other localities in the Neuwied Basin region, such as Hummerich and Tönchesberg. Despite slight differences in this sequence between localities, for example presence of intercalated tephra at Ariendorf (Unit F), or multiple humic soils at Tönchesberg (Chapter 4.) these units are usually interpreted as marking the Last Interglacial and interstadial(s) at the beginning of the Last Cold Stage BP (see further discussion on page 189).

The pumice of unit F has been identified earlier as the Metternich pumice (Brunnacker et al., 1975; Löhr & Brunnacker, 1974). Schmincke and v.d.Bogaard (1988), have identified this as the Huttenberg phase of the Wehrer volcanic eruption (Fig. 2, locality 16). According to the stratigraphy at Ariendorf, this tephra was deposited at the beginning of the Last Cold Stage BP and therefore a 40Ar/39Ar (Laser method) date of 223 000 +/- 47 000 BP for this pumice (the Last Interglacial begins at about 128 000 BP) is rather old.

The remains of a younger soil formation in the loess of Bed III, has been identified as the Lohner soil, a minor warm phase in the Last Cold Stage BP (Bibus, 1980; Bibus & Semmel, 1971).

Palaeomagnetism

Samples taken through the section from the recent soil of unit A to the the ash of unit O all showed normal polarity (Brunhes epoch), with no evidence of Events (Schnepp, 1985).

Ar Ch

Molluscan fauna
The following description is based on Puissegur (Table 2, page 112, in Brunnacker et al., 1975).
The fauna is dominated by cold loess steppe species, such as *Pupilla muscorum* and *Pupilla loessica*, and members of the slug family *Limacidae*, which are usually associated with woodland. Also present in the fauna are species such as *Arianta arbustorum* which inhabits open woodland and *Succinea oblongata* which is associated with damp conditions. The presence of *Columella columella* indicates very cold conditions, possibly accompanied by permafrost.
The molluscs from the channel deposit indicate a typical cold loess steppe fauna as found, for example, in the Kärlich loess horizons (Chapter 3). Species indicative of humid conditions are also recorded in these faunas. The presence of the *Limacidae* and *A. arbustorum* either indicates that part of the fauna is derived from other deposits, or could reflect a habitat local to the Ariendorf site itself, such as woodland (copses ?) growing in the more sheltered Rhine Valley.

Ar 1

Microfauna
The data is taken from Steensma and Kolfschoten (in prep.); a summary of the results is given in Kolfschoten (1988). The fauna is dominated by those species typical of a cool, steppe-tundra environment. Species associated with woodland only are not present. Kolfschoten (1988), has correlated this fauna with the *Arvicola terrestris* Partial-range-zone, which in turn is correlated with the Saalian.

Stone artefacts
The stone artefacts associated with this horizon are mainly flakes produced on local raw materials and are not of use in dating the assemblage further.

Ar 2

Molluscan fauna
A provisional faunal list has been compiled by Boscheinen (in Bosinski et al., in prep.).
The fauna is very similar to the one found in the channel deposits. Typical cold loess steppe species occur with some elements indicating humid conditions. The presence of *Clausilia* sp. indicates that there may have been some woodland in the vicinity of the site.

Microfauna
Only *Arvicola terrestris* has been recovered from this deposit. This species has a wide range of habitats and is therefore not a good environmental indicator. Van Kolfschoten (1988), places this species in the *Arvicola terrestris* Partial-range-zone, which is correlated with the Saalian.

Stone artefacts
A small amount of flakes were recovered during the excavations. These finds are not of further use in dating the assemblage.

Ar 3

Molluscan fauna
The following data is taken from Puissegur (in Brunnacker et al., 1975). The fauna indicates a cool cli-

mate with alternating humid and dry phases. The presence of *Chondrula tridens* in the uppermost sample (border of unit E to unit D) indicates the transition to more glacial conditions.

SUMMARY

The Ariendorf sequence consists of fluvial deposits and loess beds. The Rhine gravels of the Leubsdorf Terrace and the Ariendorf Interglacial were dated originally to the Fourth Cold and Third Warm Stages BP. The Ariendorf Interglacial was thus correlated with the Holsteinian. Recent dating of the interglacial deposits and the appearance of an older loess deposit above the interglacial sequence, certainly suggest that the lower part of the Ariendorf sequence is older than was previously thought.

The fossil assemblages are located in the upper loess beds and have been tentatively correlated as follows. The oldest assemblage (Ar Ch.) is located in a channel-fill and is probably derived from Bed I. This loess bed was deposited during the Third Cold Stage BP and has been tentatively correlated with an older Saalian phase.

Ar 1 is located at the base of loess bed I, which was deposited during the Third Cold Stage BP, which in turn has been correlated with an older phase of the Saalian. Ar 2 is located at the top of loess bed II, deposited during the Second Cold Stage BP, which in turn has been correlated with a younger Saalian phase. The mammalian microfaunas from Ar 1 and Ar 2 are also consistent with a Saalian age. The youngest assemblage, Ar 3, is located in a humic soil at the beginning of the Last (=Weichselian) Cold Stage.

The Ar 1 and Ar 2 assemblages are located in cold stage loess deposits. The occurence of ice-wedges in unit J indicate that these conditions could be extreme at times. The molluscan fauna from Ar 2 indicates a cold loess steppe environment with locally humid conditions and possibly sparse woodland. The microfauna from Ar 1 indicates a steppe-tundra environment. The palaeoenvironmental evidence from these faunas is consistent with the nature of the deposits in which they are located.

The molluscan fauna from Ar Ch. also indicates an extremely cold, loess steppe environment. Species associated with woodland are present, but it is not sure here whether these represent derived elements or are representative of wooded conditions in the locality.

Ar 3 is located in a humic soil thought to have developed under interstadial conditions. The molluscan fauna from this assemblage indicates a cool climate with alternating humid and dry phases.

Kärlich assemblage 1

Situation

The deposits in which this assemblage is located are situated in the Kärlich clay pit (see description of Kärlich clay-pit, Chapter 3). As there are problems with the stratigraphical position of Kä 1 (see below, chronostratigraphy), this assemblage has been described separately from the main Kärlich section.

Research history

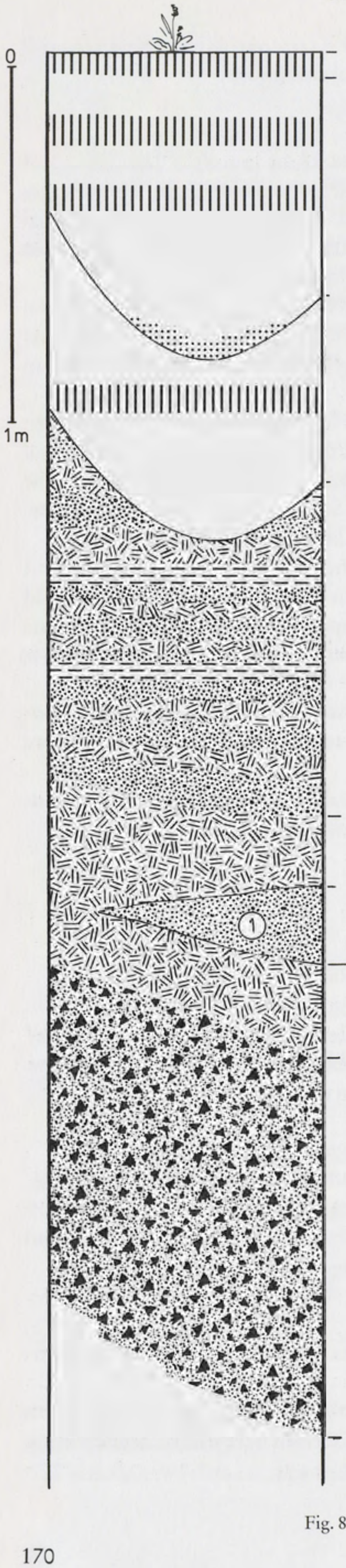
The Kä 1 assemblage was discovered in 1980, when Konrad Würges found a stone hand-axe and bone fragments eroding out of recently exposed deposits. The results of the first excavations were published by Bosinski and others in 1980. Excavations were carried out between 1980 and 1981 (Kulemeyer, 1985), and again between 1987 and 1988 (Kröger, in press). Excavation is continuing at this site.

Lithology

A simplified section through the Kä 1 deposits is shown in Fig. 8. Units important for the chronostratigraphy of the deposits are underlined.

The recent investigations at the site (1987 and 1988) have revealed sections with sequences different to those described by Brunnacker (Brunnacker et al., 1980). The section described here was recorded during the 1988 excavation campaign (Kröger 1988 and pers. comm.).

Unit Description



A: Recent plough soil

B: A channel-infill deposit. The fill consists mainly of loess. At the base of the channel is a pumice deposit, thought to be the Laacher pumice. Two further soil formations occur in this unit, possibly of Atlantic (?) and Holocene (?) age

Hiatus

C: A channel-infill deposit. The fill consists of loess with an intercalated palaeosol

Hiatus

D: A mixed sand and clay deposit. Two gleyed horizons occur in this unit

E: A sand and gravel deposit. This unit occurs as a lense of sediment in unit F

F: A clay horizon with organic remains

G: A partly reworked pumiceous tephra horizon. This horizon is known as the Brockentuff

H: A loess deposit

Fig. 8 Simplified section through the Kärlich 1 deposits.

Fossiliferous horizons

A single fossiliferous horizon has been identified (Fig. 8, no. 1).

Kä 1: This is the main fossiliferous horizon excavated between 1980 and 1988. Kä 1 is located in the sandy lense of unit E. The horizon consists of macrofaunal remains associated with stone artefacts and plant macrofossils (Kröger, 1988).

The macrofaunal remains, with the exception of the tusks and molars of fossil elephant, are very fragmentary and weathered. In contrast to this, the outer surfaces of all the macrofaunal fossils are remarkably well-preserved, so that traces of root etching or surface marks (probably resulting from the natural scraping of the stony matrix in which these finds are embedded) are still clearly visible.

Conjoins between the macrofaunal material and between the lithics recovered from this assembage are not known so far. The state of preservation of the fossils is, however, very uniform and it is likely that they are from the same depositional phase. The extremely well-preserved branches and stems of trees (occasionally reaching lengths of up four or more metres) associated with this material, and the discovery of some of the macrofaunal remains still in anatomical position indicates that this assemblage is probably in primary context.

The macrofaunal remains from the 1980 - 1987 excavations have been described in Part III. The fossils are stored in the Monrepos Collection. Fossils described by Lanser (in Brunnacker et al., 1980), and possibly belonging to this assemblage, are stored in the Würges collection.

Chronostratigraphy

The section at the Kä 1 site itself (Fig. 8), is of little use in dating the assemblage. The truncation of the upper part of the section and the complicated system of channels below the recent plough soil means that these younger deposits are of no further use in dating the fossiliferous horizon. The palaeosol of unit C indicates that at least one interglacial phase had occurred between the deposition of the fossiliferous horizon and the formation of the recent plough soil.

The isolated position of the Kä 1 assemblage in the clay-pit (the site is situated at least 300 metres away from the present-day working face of the quarry) and the lack of direct correlation between the deposits at the site itself and the Kärlich section as described in Chapter 3, mean that the exact stratigraphic position of Kä 1 is still not clear.

However, correlations have been made between Kä 1 and the main Kärlich section, based firstly upon the similarity of the partly-reworked pumiceous tephra below the fossiliferous assemblage (Fig. 8, Unit G) and the »Brockentuff« at the top of Unit H in the main section (Fig. 3), and secondly, the fact that both the Kä 1 assemblage (see palynology below) and the Brockentuff in the main section were deposited during interglacial phases (Brunnacker, et al., 1980). The Brockentuff is stratified directly above the interglacial soil of the locally-named Kärlich Interglacial (Fig. 3) and, due to the correlations described above, the Kä 1 assemblage has also been referred to this interglacial. Likewise the pollen assemblage identified at the Kä 1 site and the one identified in a series of humic horizons stratified above the Brockentuff in the main section have been combined together to form the »Kärlich Interglacial«. Thus, by a series of circular arguments, the Kä 1 assemblage has been drawn into the confusion surrounding the age of the Kärlich Interglacial deposits in the main section, despite the fact that the Kä 1 assemblage and the deposits at this site have not been sampled for dating so far.

If, however, the correlations between the Kä 1 assemblage and the Kärlich Interglacial as identified in the main section are correct, then two possibilities can be considered.

i) The Kärlich Interglacial is the Second Warm Stage BP according to the local stratigraphy, which in turn has been correlated with an inter-Saalian warm phase (Fig. 3). Zöller (et al., 1987) has obtained TL-dates of 222,000 +/- 25,000 BP and 232,000 +/- 28,000 BP for loess below the soil formation of the Kärlich Interglacial (Fig. 3).

ii) 40Ar/39Ar date of about 440,000 BP have been obtained by v. d. Bogaard and Schmincke (1988), for the

Brockentuff. These dates are comparable to those given for the Ariendorf Interglacial deposits and, if correct, indicate that the Kärlich 1 assemblage is older and compares with the Ariendorf Interglacial.

The fossiliferous assemblages

Kä 1

Palynology

Fig. 9 shows the pollen assemblage described by B. Urban (in Bosinski et al., 1980; Urban, 1983) from the Kä 1 site. The position of the fossiliferous horizon is marked with an arrow. A more detailed study of samples for pollen from the 1986 excavations has been undertaken by F. Bittman (1988), but his pollen diagram did not differ from that of Urban. The whole of the pollen assemblage from this interglacial has not been recorded at the Kä 1 site.

The Kä 1 horizon was deposited at the beginning of zone K 4 (zonation after Urban). Zone K 4 is the hornbeam - birch (*Carpinus* - *Betula*) zone (Urban, 1983; in Bosinski et al., 1980) or, according to Bittman (1988), the hornbeam - mixed oak forest - fir zone. The sudden increase in birch pollen indicates that the vegetation became more open during this phase. The upper boundary of this zone shows an increase in pine (*Pinus*), indicating the spread of coniferous forest. The pollen assemblage suggests that the Kä 1 assemblage was deposited towards the end of an interglacial phase, during the late temperate to post temperate phase.

Urban came to the conclusion that this pollen assemblage was pre - Eemian (Last Interglacial) (in Bosinski et al., 1980), but that it could not be correlated definitely with any of the known Pleistocene interglacial floras and suggested that it may represent an unknown inter-Saalian warm phase (Urban, 1983). Bittman (1988), sees similarities between the Kä 1 pollen assemblage and those from Voigtstedt and Bilshausen (G.D.R.), which have been correlated with a warm phase in the Cromer complex.

Plant macrofossils

The majority of the fossil fruits, seeds and spores identified so far are from plants growing in damp habitats or from waterside taxa.

A few fragments of wood have been identified as oak (*Quercus*) and poplar (*Populus*), although the majority of these fossils belong to fir (*Abies*).

Stone artefacts

A single hand-axe, some chopping tools and simple flakes made of local raw materials have been found. Although this assemblage cannot be stratigraphically defined, it is more typical of a Lower than a Middle Palaeolithic assemblage (K. Kröger, pers. comm.).

SUMMARY

The pollen assemblage shows that the Kä 1 assemblage was deposited towards the end of an interglacial phase. At this time, the environment at the site itself was very damp and there was probably a pond or some kind of water-course in the vicinity. The vegetation consisted predominantly of pine, birch, hornbeam, a few surviving elements of mixed oak woodland, wing-nut (*Pterocarya*) and nettle tree (*Celtis*).

Because of the isolated position of the site where the Kä 1 assemblage is located, and the lack of identifiable marker horizons at the Kä 1 site itself, the chronostratigraphy of this assemblage is still not clear. Attempts made to correlate the Kä 1 deposits with those of the Kärlich Interglacial in the main section are rather speculative.

If, however the correlations between Kä 1 and the main section are correct, then the Kä 1 assemblage could belong to either an inter-Saalian warm phase or a Cromerian one. A third possibility also exists, that the Kä 1 assemblage represents an interglacial of unknown age. The presence of one interglacial soil in the deposits

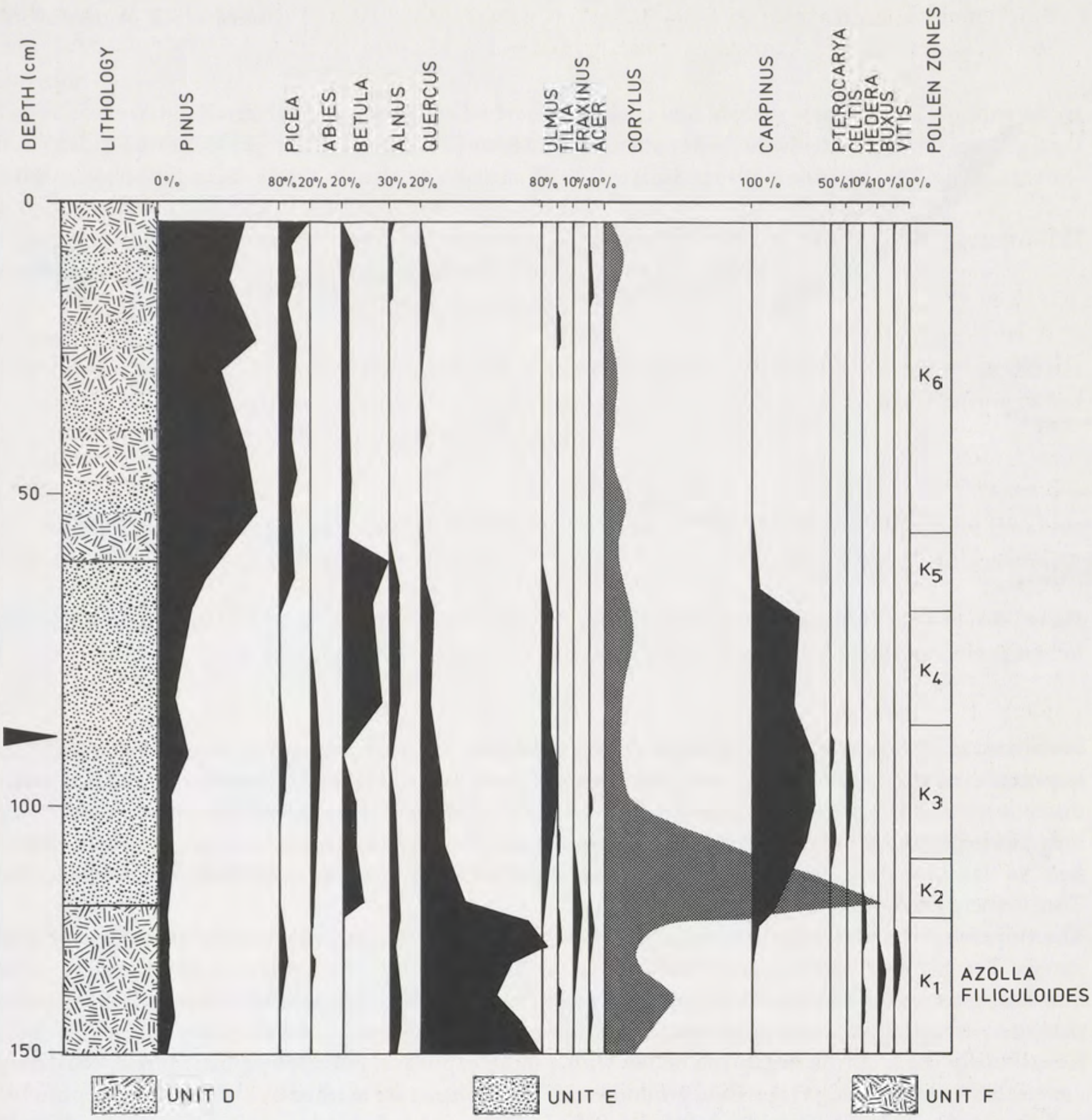


Fig. 9 Pollen diagram from the Kä 1 deposits (after Urban in: Bosinski et al. 1980). Corylus value expressed extra.

at the Kä 1 site above the fossiliferous horizon indicates that this is a Middle Pleistocene interglacial rather than a Late Pleistocene one.

The Volcano Localities

Not only are the volcanoes of the East Eifel important in that they erupted material useful as marker horizons and suitable for absolute dating, but they also feature in this area as archaeological sites in their own right (Bosinski et al., 1986).

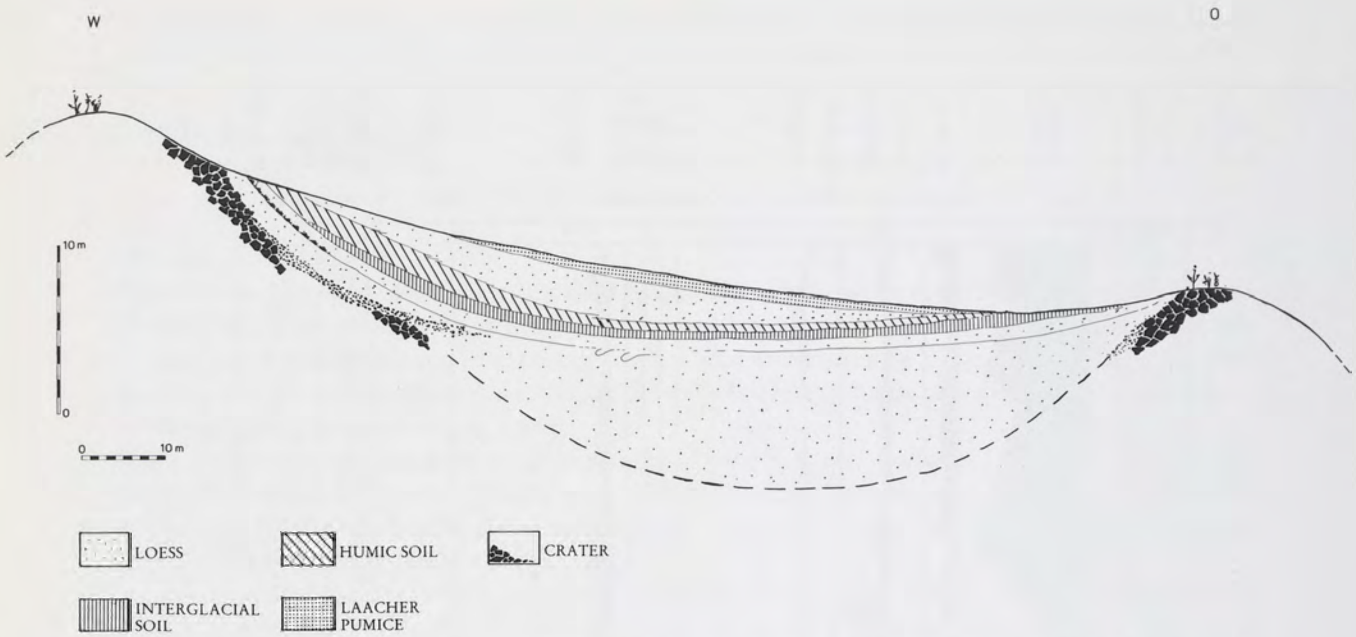


Fig. 10 Simplified section through the deposits in the crater of an East Eifel volcano using the Plaidter Hummerich as an example.

Fossiliferous horizons in the loess-filled craters of extinct East Eifel volcanoes have become such an important and, at the same time, problematic focal point for Palaeolithic research in this area, that an interdisciplinary group of scientists was established in 1987 to study these sites. The results of these studies are only just beginning to be published. Seven volcano localities with fossiliferous horizons have been identified so far, and four of these, Schweinskopf-Karmelenberg, Wannen, Plaidter Hummerich and Tönchesberg are described here.

The volcanoes themselves are all basaltic scoria cones, formed by subaerial activity confined to the land surface. Fragments of lava (a literal translation of the German word »Schaumlava«= »foamy lava«, is the best description of this material) are erupted in a lava fountain, cool in the air and fall back more or less on the place of eruption, forming a cone with a central, or slightly off-centre crater (Lorenz, 1982). Occasionally the eruption began and ended with a more explosive, phreatomagmatic phase, caused by contact between the rising magma and groundwater. These phases are marked by characteristic deposits of tephra mixed with bedrock material (Brockentuff) brought up by the explosion and found at the base of the scoria cone, and by ashes deposited at the base of the crater as the eruption was ceasing (Schmincke, 1986).

Often several such eruptions took place at one locality, so that the craters cut into one another. These are referred to as groups, for example, the Wannen Group and the Karmelenberg Group.

The craters were subsequently filled with sediment, particularly loess and also tephra from other vulcanic eruptions. A typical crater-fill is shown in Fig. 10, using the Plaidter Hummerich volcano as an example.

The depositional sequences within the craters are characterized by erosional and redepositional phases such as hill wash and deflation zones. Scoria rubble horizons represent the erosion of material from the crater walls into the crater itself.

The East Eifel scoria cones were formed mainly during the Middle Pleistocene period (Windheuser and Brunnacker, 1978; Windheuser, Meyer and Brunnacker, 1982).

The majority of the localities described here probably erupted during or shortly before the Second Warm Stage BP and their crater deposits consist of two loess beds with a single intercalated interglacial soil (Windheuser, 1977).

Schweinskopf - Karmelenberg

Situation

The Schweinskopf-Karmelenberg is situated between the Nette and Moselle rivers (Fig. 2; locality 6). At this locality a group of eight to ten eruptive centres have been identified, of which the Karmelenberg itself is the only one not to have been quarried for scoria. The Schweinskopf site is situated on a hilly ridge running down from the flanks of the Karmelenberg to the north-east.

The commercial extraction of scoria in this area is so advanced that only the truncated loess crater-fill of the Schweinskopf remains; the crater walls have been dug away (see Plate 17,2).

Research history

The Schweinskopf site was discovered in 1983. Soundings were investigated in the same year but did not reach the fossiliferous horizon (Weissmüller, 1985). Excavations began again in 1984, after the deposits had been recut by the machines, and continued until the end of 1988 (Schaefer, 1987a and b).

Lithology

A simplified section through the Schweinskopf deposits is shown in Fig. 11. Units important for the chronostratigraphy of the deposits are underlined.

Fossiliferous horizons

Four horizons have been identified so far (Fig. 11, 1 - 4). Only one horizon, Sk 4, has been investigated in any detail.

Sk 1: Sparse macrofaunal remains associated with stone artefacts. These finds are located at the base of the section, directly above the scoria of the crater in the redeposited loess of unit I. This horizon is in secondary context, but is younger than the loess of unit H.

The macrofaunal remains consist only of teeth from horse (see Part III). As teeth are usually well-preserved, a description of the state of preservation of the material is not given here.

Sk 2: Macrofaunal remains only located in unit H, below the ash deposit of unit G. The remains appear to be in primary context.

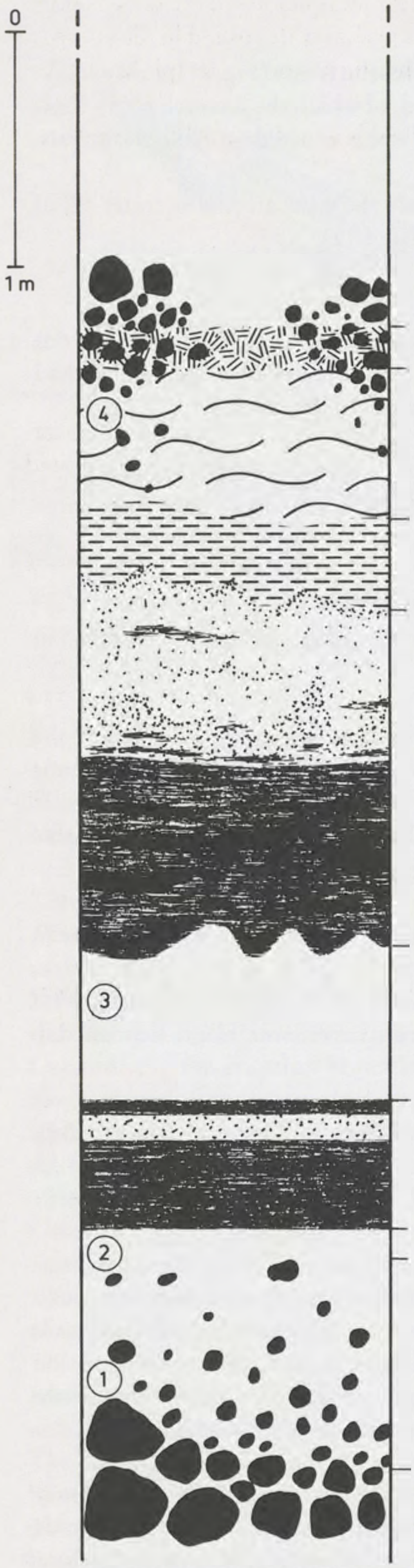
The material is grey-white in colour and rather weathered. The outer surfaces of the bone are covered with root-etching as is typical for the material from this locality and those from other assemblages deposited in loess.

Sk 3: Sparse macrofaunal remains only located in the redeposited loess of unit F. The horizon is probably in secondary context, but is younger than the tephra of unit E. The material is white-grey in colour and the outer surface is very weathered.

Sk 4: This is the main fossiliferous horizon consisting of mammalian macrofauna, microfauna and associated stone artefacts. This horizon is located in units C and D. The vertical distribution of the fossils through units C and D is the result of localised bioturbation and cryoturbation processes after burial. The fossils are also located in units characterized by scoria rubble indicating a phase of weathering and redeposition of material after burial, and it may be that there has also been some horizontal movement of the fossils. However, some of the macrofaunal remains were still laid in anatomical position, which indicates that this assemblage had only been locally disturbed.

The macrofaunal material is predominantly grey-white in colour and the outer surfaces are usually very weathered or covered with root-etching. Some fossils, where the outer surface is still preserved, are brown and it may be that all the macrofaunal remains had this colouration before weathering took place. The finds show the typical state of preservation occurring on macrofaunal material deposited in loess.

Unit Description



A: A thick loess deposit. The upper part of this horizon has been recently truncated

B: A clay-like horizon

C: A pale red-brown non-calcareous weathered loess. Contains some scoria rubble

D: A pseudogley

E: A volcanic ash deposit. This deposit shows the effects of either cryoturbation or loading. The upper part of this deposit consists of a more mixed ash, sand and loess matrix. The ash has been provisionally named the »Schweinskopf Ash«

F: Redeposited loess

G: A volcanic ash deposit

H: A homogenous loess

I: Redeposited sandy loess with some scoria rubble representing material eroded in from the crater walls

J: Primary scoria of the Schweinskopf crater

Fig. 11 Simplified section through the Schweinskopf deposits.

The conjoins between macrofaunal remains and between lithics from this assemblage, and the uniformity of the state of preservation of the macrofaunal remains indicate that these finds belong to the same depositional phase. The assemblage is younger than the ash of unit E, and was probably deposited in a loess upon which the pseudogley (unit D) and clay (unit B) formed, and the weathering of unit C took place.

The macrofaunal material from the 1983 to 1986 excavations is described in Part III. The finds are stored in the Monrepos Collection.

Chronostratigraphy

The chronostratigraphy of the Schweinskopf deposits is difficult to define. The sequence shows no evidence of identifiable marker horizons (the tephra deposits have not been identified) and the truncation of the youngest loess (unit A) means that younger marker horizons, such as the Alleröd Interstadial soil or the Laacher Pumice have been lost.

The following horizons are important for the proposed chronostratigraphy of the Schweinskopf.

i) Windheuser (1977), has suggested, on the basis of crater fills with two loess beds and a single intercalated interglacial soil, that the oldest loesses in the craters of the Karmelenberg group were deposited during the Second Cold Stage BP. Unfortunately, none of the original sections described by Windheuser can be correlated with the one at the site.

ii) The gleyed and weathered horizons (units D, C and B), are more characteristic of loess of the Second Cold Stage BP (Bibus 1973; Schäfer, 1987b; Semmel, 1967), and are not usually found in loess of the Last Cold Stage BP.

According to this, the whole of the sequence at the Schweinskopf, with the exception of unit A, appears to have been deposited during the Second Cold Stage BP. The fossiliferous horizons would also belong to this cold stage, which has been correlated with a younger phase of the Saalian (Fig. 3).

A fossil from Sk 2 has been provisionally dated to 165,000 BP by the Uranium-series method (Tiemei, pers. comm.). A TL date of 199,000 +/- 18,000 BP has been given for the upper part of loess deposited during the Second Cold Stage BP at Ariendorf. The date for Sk 2 is thus consistent with the proposed age for the loess deposit.

The fossiliferous assemblages

The results of sampling for pollen and molluscs are not available for any of the assemblages. Some microfaunal remains have been identified from Sk 4.

Sk 1

Stone artefacts

Quartz artefacts have been found in this assemblage. They are not of further use in dating the horizon.

Sk 2 and Sk 3

Macrofaunal remains only from both assemblages.

Sk 4

Stone artefacts

Stone artefacts made from local raw materials, such as quartz and quartzites and from imported materials such as flints and chalcedony occur in Sk4. Artefacts described as being worked in the Levallois technique also occur in this assemblage (Schäfer, 1987a and b). The stratigraphic range of this technique is however so long that it cannot be used to give a more definite age to the assemblage.

Microfauna

Species indicating a steppe environment such as *Spermophilus* sp. and those indicating cold conditions, such as arctic lemming, *Dicrostonyx torquatus*, are present in the microfauna from this assemblage.

SUMMARY

The fossiliferous horizons Sk 1 - 4 are located in loess horizons thought to have been deposited during the Second Cold Stage BP, which in turn has been correlated with a younger Saalian phase. A provisional Uranium-series date of 165,000 BP has been obtained from the Sk 2 assemblage and is consistent with a Saalian (younger phase) age.

Sk 1 - 4 are all located in cold stage loess deposits. The microfauna from Sk 4 indicates a cold climate with an open steppe environment.

Wannen

Situation

The Wannen site is situated in one of several small craters known as the East Wannen group (Fig. 2, locality 7).

Research history

The excavated site lies in the crater of the »In den Wannen« (translation: »in the tubs«) volcano. This crater was first quarried for scoria at the turn of the century. The first fossils were discovered in 1985 in the northern part of the quarry. In January 1986, bone fragments were again exposed and excavations to investigate these fossiliferous horizons began in the same year and continued until the end of 1987 (Justus et al., 1987).

Lithology

Fig. 12 shows a simplified section through the Wannen deposits. Units important for the chronostratigraphy of the deposits are underlined.

Fossiliferous horizons

Six horizons have been identified so far, five of which are described here (Fig.12, 1 - 5), of which at least the two youngest, Wa 4 and Wa 5 represent a single phase of deposition.

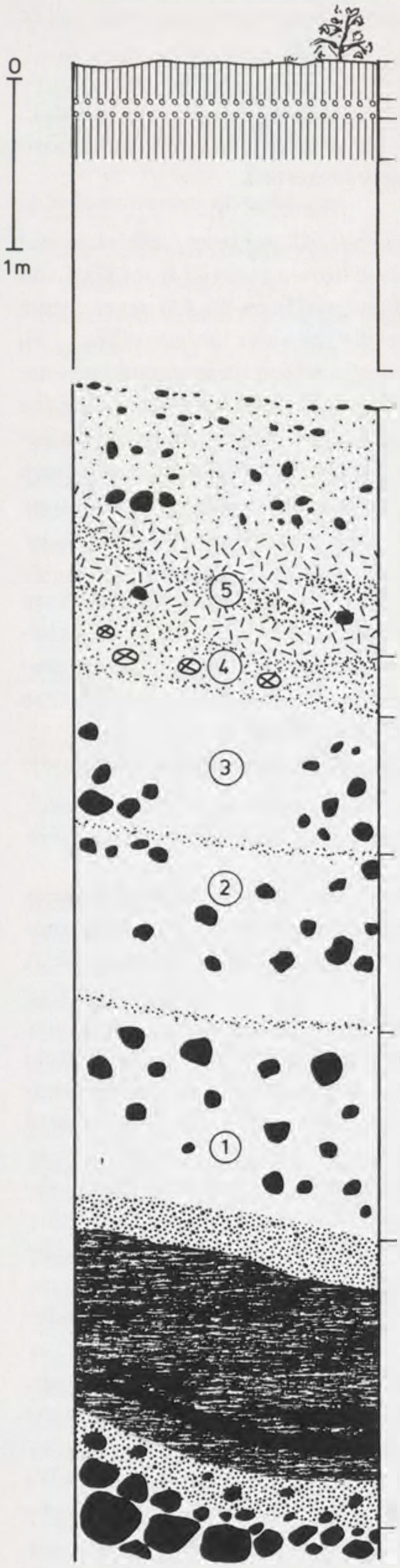
During excavation, fossils were also recovered from a neighbouring crater. The macrofauna from these deposits is also described in part III and the finds are called Wa Pr. (Profile) III. A description of the lithology of these deposits is not given as they had already been cut by the machines before the finds were discovered.

Wa 1: Macrofaunal remains with associated stone artefacts in unit I.

The macrofaunal material from this horizon is dark-brown in colour, occasionally having a lighter colouration where the outer surface has been exfoliated. Some finds are well-preserved with smooth, outer surfaces showing hardly any signs of weathering or root-etching; others are very weathered and covered with root-etching.

Wa 2: Macrofaunal remains with associated stone artefacts, located in unit H. The macrofaunal material is very similar in preservation to that of Wa 1. Conjoins between fragments of macrofaunal remains from Wa 1 and Wa 2 are known and indicate that some of the material from these two assemblages belongs to the same depositional phase.

Wa 3: Macrofaunal remains and associated stone artefacts, located in unitG. The macrofaunal material is



Unit Description

A: Recent soil development

B: Laacher Pumice

C: Soil of the Alleröd Interstadial

D: A homogenous loess deposit

Hiatus

E: A redeposited loess horizon with scoria rubble

F: A redeposited loess horizon, containing some scoria rubble

G: A loess horizon with scoria rubble. The unit is also truncated by a stony horizon

H: A second sandy loess with scoria rubble. The reddish colouration seen in unit I intensifies in unit H. This unit is likewise truncated by a stony horizon

I: A reddish, coarse-grained, sandy loess with scoria rubble. This unit is truncated by a thin, stony horizon

J: An ash deposit. Sandy lenses mixed with ash are stratified above and below the ash. This is the last phreatomagmatic phase of the eruption of this volcano

K: Primary scoria of the volcano

Fig. 12 Simplified section through the Wannen deposits.

paler in colour than that of Wa 1 and Wa 2, being grey-brown and occasionally grey-white in colour. The preservation of the material is otherwise the same as in Wa 1 and Wa 2.

Wa 4/5: Macrofaunal remains and associated stone artefacts in the redeposited loess units F and E. Conjoins between material from both units show that the fossils were all from the same phase of deposition. The macrofaunal material is a pale grey-yellow in colour and poorly preserved.

The exact relationship between the fossiliferous horizons at the Wannen has still not been established and the descriptions given here are only provisional. Generally, the very dark brown material from Wa 1 and Wa 2 never occurs in the younger horizons and the very pale-coloured material from Wa 4/5 never occurs in the oldest horizons. As to how far the individual assemblages, especially the older horizons (Wa 1 - 3), can be separated from each other is difficult to say. All of the loess units, in which these assemblages are located, show evidence of erosion in the form of scoria rubble, and it is reasonable to assume that the assemblages are no longer in primary context, however the appearance of bones lying in anatomical position in all of the assemblages indicates that this disturbance was localised. The macrofaunal remains from Wa 1, 2 and 3 are all similar in their state of preservation, and may be from the same phase of deposition. Wa 4/5 appears to represent a separate phase.

Wa Pr. III: Macrofaunal remains associated with some stone artefacts were recovered from this site. As to whether these finds are associated with each other is because of the recent disturbance of the deposits before discovery,not possible to reconstruct. The state of preservation of the macrofaunal remains is uniform, which indicates that they may belong to the same phase of deposition. The material is grey-white in colour and very well-preserved, with little outer surface weathering or root-etching.
The macrofauna from the Wannen locality described in Part III is from the 1986 excavation campaign only. The finds are stored in the Monrepos Collection.

Chronostratigraphy
As with the Schweinskopf-Karmelenberg, the lack of marker horizons in the Wannen sequence makes a chronostratigraphic interpretation of the deposits difficult. The Wannen deposits are by no means complete. Several breaks in sedimentation are shown by the stony horizons separating units I, H, G and F. A hiatus has also been recorded at the base of unit D.
The following horizons are important for the proposed chronostratigraphy of the deposits:

i) Windheuser (1977), suggests that the oldest horizons at the Wannen were deposited during the Second Cold Stage BP. The same problem arises here, as at the Schweinskopf-Karmelenberg, in that the original sections described by Windheuser can no longer be correlated with those exposed at the excavated site.
ii) The only marker horizons in the Wannen sequence are the Alleröd Interstadial soil (unit C) and the Laacher Pumice (unit B), which mark the end of the Last Cold Stage BP in this region. Following this, unit D is probably the loess of the Last Cold Stage BP. This younger sequence is, however, separated by a hiatus from the lower deposits and is not useful in dating the fossiliferous horizons.
iii) It has been suggested that the reddish colouration of the loess in units I and H represents a weakly-developed interglacial soil, possibly dating to the Last Interglacial.

If a date of the Second Cold Stage BP is accepted for the oldest deposits at the Wannen, and as deposits belonging to the Last Cold Stage BP are also present at this locality, then the fossiliferous horizons at the Wannen could belong to the Second Cold Stage only, to the Last Cold Stage or to both.
If the reddish colouration of units H and I do represent the soil formation of the Last Interglacial, then Wa 1 and 2 and possibly 3 (if these three assemblages are all from a continuous phase of deposition) were probably deposited during the Second Cold Stage BP and Wa 4/5 during the Last Cold Stage BP.
Absolute dates (Uranium-series) from these assemblages are only provisional, but support the latter argument. A date of 246,000 +/- 18,000 BP for Wa 3 and 210,000 +/- 15,000 BP for fossils from Wa 2 have been

obtained. A date of 94,000 +/- 22,000 / 16,000 BP has been obtained for the Wa 4/5 assemblage. The dates from Wa 3 and Wa 2 are broadly consistent with that from Ariendorf for loess of the Second Cold Stage BP (199,000 +/- 18,000 BP). The date from Wa 4/5 indicates that this assemblage is younger, and is consistent with the proposed Last Cold Stage age.

The fossiliferous assemblages

The results of sampling for microfauna, molluscan fauna and pollen are not available for any of the fossiliferous assemblages.

The stone artefacts from the Wannen assemblages consist of simple flake material only and are therefore not of further use in dating the deposits.

SUMMARY

The fossiliferous horizons Wannen 1 - 4/5 are all located in cold stage loess deposits. Wa 1 - 3 could all belong to the same depositionary phase, whereas Wa 4/5 appears to be a separate horizon. Provisional dating of fossils from the assemblages suggests that Wa 1, 2 and 3 belong to the Second Cold Stage BP (= younger Saalian phase) and Wa 4/5 to the Last Cold Stage BP (=Weichselian). The age of the Wa Pr. III deposits is uncertain; it is unlikely that they are much older than the main site deposits.

Plaidter Hummerich

Situation

The Plaidter Hummerich, or Hummerich for short, is situated in the Pellenz the valley plain between the East Eifel and the Maifeld (Fig. 2, locality 8). The Hummerich rises about 150 metres above the surrounding countryside and originally had two summits, its crater being situated between them (Plate 18,1).

Research history

This locality was discovered in 1983. At this time, loess was already being cleared from the east summit; the west summit no longer existed. A series of soundings was investigated in 1983 (Bosinski, Kulemeyer and Turner, 1983). Further excavations were undertaken between 1984 and 1986 (Kröger, 1987 a and b). Excavations at this locality were brought abruptly to an end in 1986 by the quarry owners, and the remaining loess deposits in the crater have since been removed (Plate 18,2).

Lithology

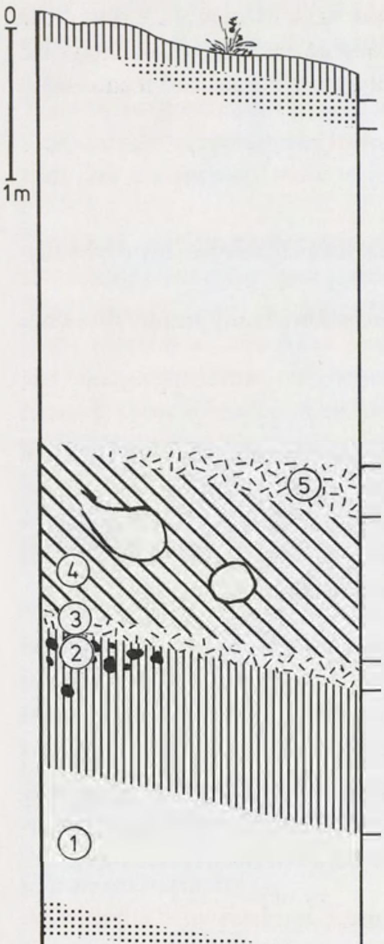
Fig. 13 shows a simplified section through the Hummerich deposits. Units important for the chronostratigraphy of this locality have been underlined.

Fossiliferous horizons

Five horizons have been identified so far (Fig. 13, 1 - 5), of which four, Hu 2 - 4, have been excavated.

Hu 1: Sparse macrofaunal remains only, located in unit H. The horizon is probably in secondary context (scoria rubble in deposit indicates period of weathering and movement of material downslope) but is older than the Last Interglacial soil. The macrofaunal remains have not been described in detail and a description of the state of preservation of the material is not given here.

Hu 2: Fragmentary macrofaunal remains and some associated stone artefacts. The finds were recovered from the scoria rubble horizon at the top of unit G, and are in secondary context. The exact origin of this small assemblage is not known, although it appears to have been deposited after the truncation of the interglacial soil.



Unit	Description
A:	Recent soil development
B:	Laacher pumice
C:	A loess deposit. A series of TL dates give an age of 22.230, 22.850 and 22.560 BP for this unit
D:	A soliflucted weathered loess
E:	A dark red-brown humic soil. Animal burrows filled with younger loess are also present in this horizon
F:	A pale-brown, calcareous, loessic deposit
G:	A palaeosol horizon. The upper part of this unit is marked by a calcareous scoria rubble horizon
H:	A loess deposit, with some scoria rubble indicating a phase of erosion of this material from the crater walls. A TL date of 134.000 BP has been given for this deposit
I:	A weathered pumice horizon. This deposit has been named the Kretz pumice
J:	A homogenous loess deposit. A TL date of 135.000 BP has been given for the upper part of this deposit, directly below the ash of unit I
K:	Primary scoria of the Hummerich volcano. An absolute date of 240.000 BP has been given for this deposit by the $^{40}Ar^{39}$ Ar method

Fig. 13 Simplified section through the Hummerich deposits.

The macrofaunal material is grey-yellow in colour and generally covered with root-etching. Some of the material is encrusted with a thin calcareous layer, resulting from leaching of calcium carbonate from the overlying loesses (pers. comm. K. Kröger). The sparse remains are from the same phase of deposition.

Hu 3: Fragmentary macrofaunal remains and associated stone artefacts located in the upper part of unit F. The macrofaunal remains are too fragmentary to be described further and a description of the state of preservation of this material is not given here.

Hu 4: This is the main fossiliferous horizon consisting of macrofaunal remains with associated stone artefacts located in the humic soil of unit E. The remains of marmot, found in burrows in this unit, are derived from the upper loess (unit C).
The macrofaunal remains are pale orange-red in colour. The outer surfaces are usually covered with root-etching and calcareous concretions. Post-burial disturbance has been confined to localised downslope movement of the material and to some reworking of the fossils through the humic soil. Conjoins between the macrofaunal remains and between the lithics indicate that the fossils are from the same phase of deposition.

Hu 5: Sparse macrofaunal remains with associated stone artefacts located in the soliflucted loess of unit D. The macrofaunal remains are grey-white in colour and well-preserved. The outer surfaces are covered in root-etching but are free from calcareous concretions. The fossils appear to be from the same depositionary phase, but are in secondary context.

The macrofaunal remains described in Part III are from the 1983 - 1986 excavations. The material is stored in the Monrepos Collection.

Chronostratigraphy

In comparison to the Schweinskopf and Wannen, the Hummerich has a more complete sequence of deposits. Even so, the typical erosional features and breaks in the sedimentary sequence are also present at this locality. The crater-fill of the Hummerich is typical for the East Eifel volcanoes consisting of two loess beds with a single intercalated interglacial soil (Fig. 10; Fig. 13).
Important for the stratigraphy of the Hummerich deposits are the following horizons:

i) The primary scoria of the volcano. 40AR/39Ar date of about 240,000 BP has been obtained for this deposit (Schmincke & Mertes, 1979).

ii) The marker horizons - interglacial soil of unit G and humic soil of unit E. These horizons are stratified at the base of the youngest loess bed (unit C) and are usually interpreted in this region as representing the palaeosol of the Last Interglacial and humic soils from an interstadial(s) at the beginning of the Last Cold Stage. Following this, and considering the date obtained for the scoria, units J and H probably date to the Second Cold Stage BP. TL dates of about 135,000 BP and 134,000 BP (Singvhi et al., 1986) have been obtained for the loesses of units J and H and are consistent with the proposed age of deposition. The loess of unit C has been dated to between 22,850 - 22,000 BP (ibid) .

iii)The Hummerich sequence is completed by the younger marker horizon of the Laacher Pumice (Unit B). The Laacher Pumice marks the end of the Last Cold Stage BP in this region and supports the conclusion that unit C is the loess of the Last Cold Stage.

Thus, the oldest fossiliferous horizon, Hu 1, was deposited during the Second Cold Stage BP; Hu 2 - 5 during the Last Cold Stage BP.

The fossiliferous assemblages

The results of sampling for microfauna, molluscan faunas and pollen are not available for any of the fossiliferous horizons at the moment. Microfaunal remains, with the exception of the marmots found in

Hu 4, have only been investigated in unit J (see reports from van Kolfschoten, in Kröger, 1987a and b). The microfauna from unit J indicates a predominantly steppic biotope.

The stone artefacts from the fossiliferous horizons are mainly simple flakes made from local raw materials and are of no further use in dating the deposits. In the Hu 4 assemblage, some stone artefacts described as being characteristic of the Micoquian industry occur.

SUMMARY

Five fossiliferous horizons (Hu 1 - 5) have been recorded at the Hummerich locality. According to the stratigraphy at this locality and absolute dating of the loess deposits, the following chronostratigraphy has been proposed. Units J and H were deposited during the Second Cold Stage BP. The oldest assemblage, Hu 1, is stratified towards the end of this stage, which has been correlated with a younger phase of the Saalian. Units G and E are the palaeosol of the Last Interglacial and interstadial soils at the beginning of the Last Cold Stage respectively (see also description of these soil(s) at the Tönchesberg locality). The deposition of Hu 2 - 5 post-dates the formation of the soil of the Last Interglacial, and belong to the beginning of the Last Cold Stage BP, which in turn has been correlated with the Weichselian.

Hu 1, Hu 3 and Hu 5 are located in cold stage deposits. Hu 2 is in a scoria rubble horizon and its origin of deposition is not known exactly. Hu 4 is located in a humic soil thought to have developed under interstadial conditions.

Tönchesberg

Situation

The Tönchesberg is situated on an elevated position on the western edge of the Nette Valley (Fig. 2, locality 9). The Tönchesberg is a complex of at least three volcanoes (Ahrens, 1932).

Research history

Quarrying began here in the 1930s and large-scale exploitation started in the 1970s, resulting in the removal of most of the central part of this volcano. The first fossils were recovered in 1986 in the north-east face of the quarry and a series of sondages were investigated here in the same year. In autumn 1986, during quarry extensions to the east, further finds were discovered. Excavations were carried out here between 1986 - 87 (Tinnes, 1987).

Lithology

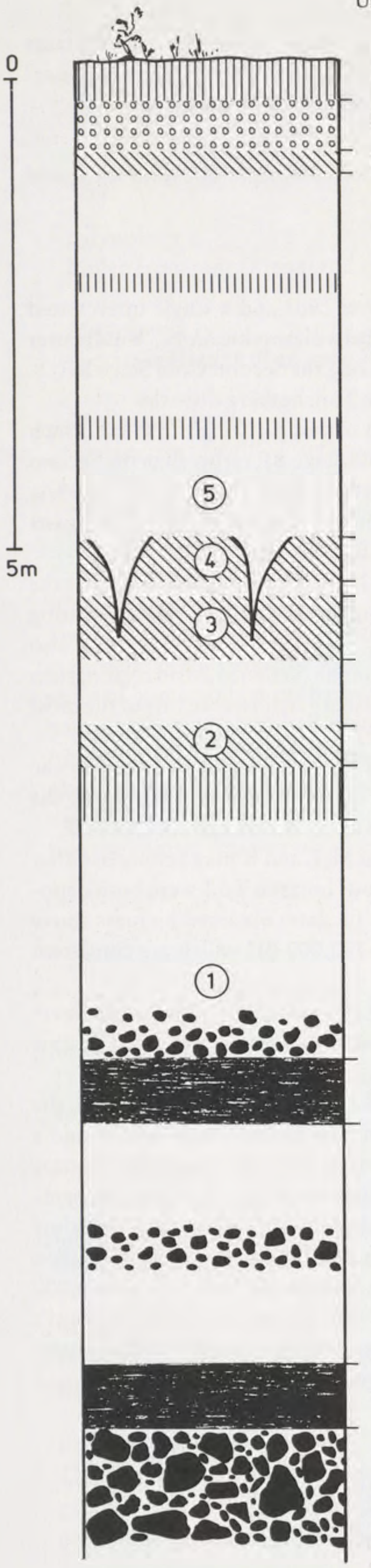
Fig. 14 shows a simplified section through the Tönchesberg deposits. Units important for the chronostratigraphy of these deposits are underlined.

Fossiliferous horizons

Five fossiliferous horizons have been identified so far (Fig. 14, 1 - 5). Only the main horizon, Tö 2, has been excavated, and the macrofaunas from the assemblages Tö 1 and Tö 2 are the only ones described here.

Tö 1: Sparse macrofaunal remains and associated stone artefacts located at the base of unit K, directly above the tephra deposit of unit L. The assemblage is probably in secondary context, but is younger than the ash of unit K. The macrofaunal remains are well-preserved and fresh in appearance. The material is white-grey in colour.

Tö 2: This is the main fossiliferous horizon. The finds consist predominantly of macrofaunal remains with associated stone artefacts. This assemblage is located in the humic soil of unit H. The fossils have been distributed vertically into the base of the loess of unit G by localised bioturbation processes. The state of pre-



Unit	Description
A:	Recent soil development
B:	Laacher pumice
C:	Soil of the Alleröd Interstadial
D:	A loess deposit. Two weakly developed soils are stratified wihin thit unit. The upper one has been correlated with the Lohner soil
E:	A reddish-brown humic soil with a thin calcium carbonate band at its base. Ice-wedge casts are present in this unit and unit F. A TL date of 65 000 ± 5500 BP has been given for this unit
F:	A reworked grey-brown humic soil. A TL date of 95 300 ± 11 200 BP has been given for this horizon
G:	A loess deposit
H:	A dark brown, occasionally red flecked humic soil. TL dates give an age of 114 000 ± 9000 and 108 000 ± 17 000 BP for this horizon
I:	An orange-brown interglacial soil
J:	A loess deposit with a scoria rubble horizon at its base
K:	A volcanic ash deposit. A ^{40}Ar^{39} Ar date of 260 000 ± 50 000 BP has been given for this ash
L:	A loess deposit containing some redeposited scoria rubble
M:	A volcanic ash deposit. This may be the phreatomagmatic phase of the eruption
N:	Primary scoria of the Tönchesberg volcano

Fig. 14 Simplified section through the Tönchesberg deposits.

servation of the macrofaunal material is good. The material is dark orange-red in colour. The outer surfaces show traces of root-etching and gnawing by carnivores and rodents. Conjoins between the macrofaunal material and between the lithics, indicate that the fossils belong to the same phase of deposition.

The macrofaunal material described in Part III is from the 1987 excavation campaign. The finds are stored in the Monrepos Collection.

Chronostratigraphy

Windheuser (1977), describes sections from this locality with two loess beds and a single intercalated palaeosol which can be correlated with the present one. As with the other volcano localities, Windheuser suggests that the oldest horizons at the Tönchesberg were deposited during the Second Cold Stage BP. The following horizons are important for the chronostratigraphy of the Tönchesberg deposits.

i) 40Ar/39Ar date of 260,000 - 50,000 BP has been obtained for the ash of unit K (Conard, 1988a), which suggests that the oldest units N, M and L may belong to the Third Cold Stage BP, rather than the Second Cold Stage BP. However, the primary scoria of the volcano has been recently dated by the 40/Ar39Ar (Laser method) to 202,000 +/-14,000 BP (pers. comm. v.d.Bogaard, in Conard, 1988b), which suggests that the oldest loesses were deposited during the Second Cold Stage BP after all.

ii) The marker horizon – interglacial soil (unit I) overlain by a humic soil (unit H) located at the base of the upper loess bed. As has already been stated, these horizons are interpreted in this region as representing the soil of the Last Interglacial and interstadials(s) at the beginning of the Last Cold Stage (see also below). These marker horizons are also known from other localities in the Neuwied Basin region, such as Hummerich and Ariendorf. The sequence of humic soils at Tönchesberg is, however, one of the most detailed found so far in this region.

iii) The marker horizons – soil of the Alleröd Interstadial and Laacher Pumice – are characteristic for the end of the Last Cold Stage in this region. The loess of unit D appears to have been deposited during the Last Cold Stage BP. The Lohner soil in the upper part of this unit has an estimated age of 30,000 BP.

Thus, the deposits at Tönchesberg can be correlated as follows. The units M, L and K may belong to either the Third or Second Cold Stage BP. The loess of unit J and the fossiliferous horizon Tö 1 were both deposited during the Second Cold Stage BP, a younger phase of the Saalian. TL dates obtained on loess above and below the fossiliferous horizon provided minimum ages of about 130,000 BP, which are consistent with a younger Saalian phase.

The interglacial soil was formed during the Last Interglacial (=Eemian) and the humic soils during interstadials at the beginning of the Last Cold Stage (Tinnes, 1987). The main fossiliferous horizon (Tö 2) is located in the oldest humic soil.

Conard (1988a and b) has attempted to correlate the more detailed sequence of humic soils at the Tönchesberg with the oxygen isotope stages. He suggests (1988b), that the humic soil of unit H and a »bleached horizon« stratified directly below the humic soil (not shown in Fig. 14) correlate to isotope stage 5d and represent the initial cooling stage after the Last Interglacial and not an interstadial at the beginning of the Last Cold Stage, as has been assumed for the other localities where humic soils occur (Ariendorf and Hummerich). The series of humic soils at the Tönchesberg have been dated (TL, pers. comm. L. Zöller, 1988) to between 114,000 - 65,000 BP. The bleached layer below unit H yielded a TL date of about 114,000 +/- 9,000 BP and the loess above unit H a date of 108,000 +/- 17,000 BP, which is consistent with Conard's suggestion. However, fossils from the Tö 2 assemblage have been provisionally dated by the Uranium-series method to about 72,000 and 67,000 BP, and if correct, suggest a younger date for the deposition of the assemblage.

The fossiliferous assemblages

Only provisional results from sampling for pollen, molluscs and microfauna are available.

Tö 1

Stone artefacts
Only a few simple quartz flake artefacts have been recovered from this assemblage to date.

Tö 2

Palynology
Pollen from pine (Pinus) and spruce (Picea) has been provisionally identified from unit H.

Microfauna
Species indicative of an open and locally damp environment have been identified to date.

Molluscan fauna
The species identified so far indicate an open environment and a warm climate.

Stone artefacts
The lithic assemblage consists of simple flakes made from local raw materials and flints.

SUMMARY
The assemblage Tö 1 is located in cold stage loess deposits dating during the Second Cold Stage BP, which in turn has been correlated with a younger Saalian phase. The assemblage Tö 2 is located in the oldest of a series of humic soils at the base of the loess of the Last Cold Stage. Conard (1988b), has suggested that this humic soil correlates with oxygen isotope stage 5d, and represents the initial cooling after the Last Interglacial. This contradicts the usually-held view that the formation of the humic soils in this region took place during one of the interstadials at the beginning of the Last Cold Stage BP. The environment at the time of deposition of Tö 2 was open vegetation with some coniferous trees. The molluscan fauna indicates that the climate was warm.

Metternich

Situation
The now closed Weglau loess quarry is situated in the southern part of the Neuwied Basin, in the Moselle Valley (Fig. 2, locality 4).

Research history
Fossils from this quarry were first recorded by Schaafhausen in 1882. Günther (1910), and later Höfer (1937), also collected macrofaunal remains and lithics from this quarry. Remy and Paas (1959) described the sequence of deposits and these were briefly revised by Hahn (1969).

Lithology
A simplified section through the Metternich deposits is shown in Fig. 15, taken after Höfer (1937) and Remy and Paas (1959). Units important for the chronostratigraphy of the deposits are underlined.

Fossiliferous horizons
The sparse macrofaunal remains from this locality mentioned in Part III, were recovered from the youngest loess deposit at the site (Fig. 15, 1 and 2). Excavations have not taken place here. The original finds were destroyed during the Second World War; apparently there are casts of the material, but these were not seen

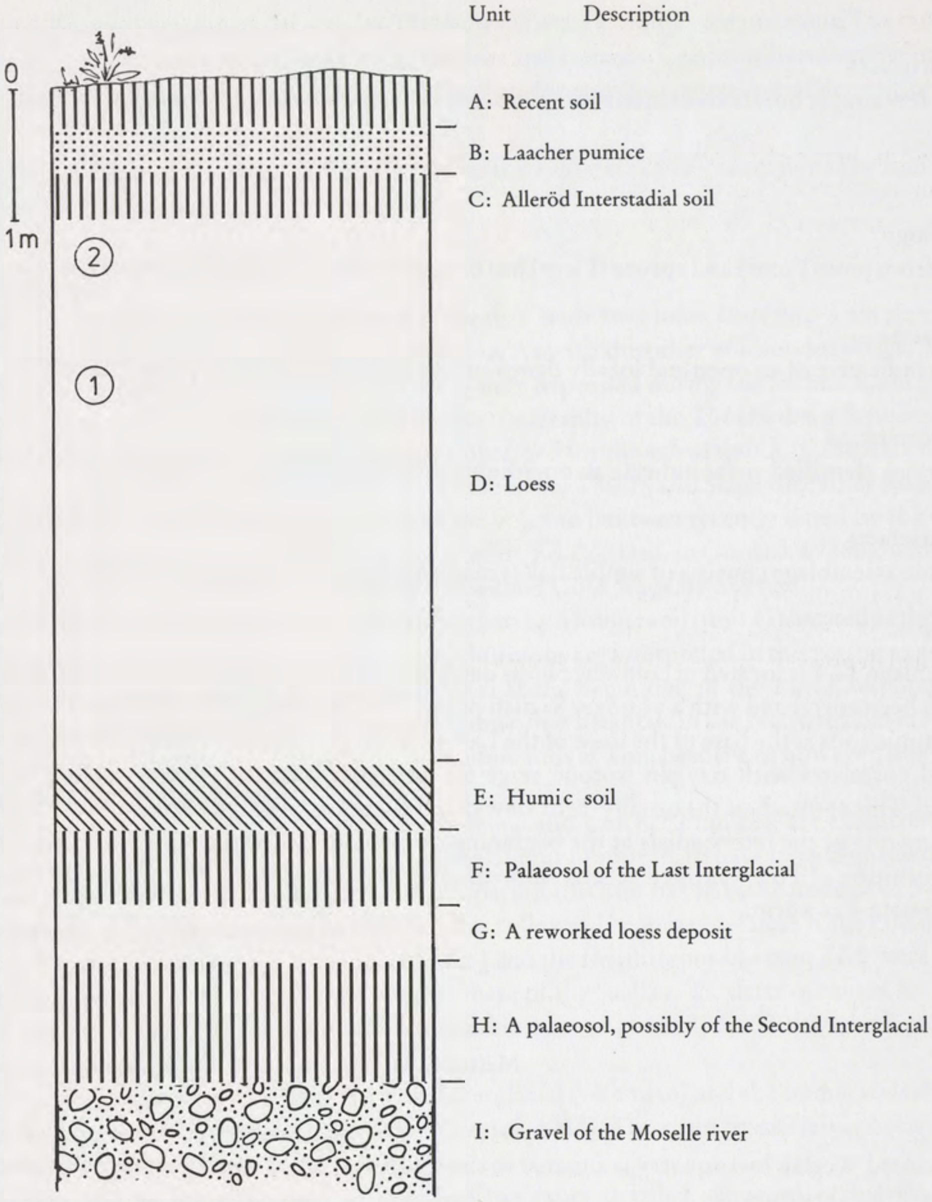


Fig. 15 Simplified section through the Metternich deposits.

during the course of this study. The description of the material is therefore based upon Höfer (1937). Details about the context of the fossils were not given.

Chronostratigraphy

Important for the stratigraphy of this locality are the following horizons:

i) The soil formation in unit F is the soil of the Last Interglacial.
ii) The marker horizons - soil of the Alleröd Interstadial (unit C) overlain by the Laacher Pumice (unit B) - mark the end of the Last Cold Stage BP.

Unit D, in which the fossils were found, is stratified between these and represents loess deposited during the Last Cold Stage BP, which in turn has been correlated with the Weichselian.

SUMMARY
The fossils found at the Metternich locality were deposited during the Last Cold Stage BP (=Weichselian). Sampling for pollen, molluscan faunas and microfauna has not been undertaken at this locality. The macrofaunal remains were located in cold stage loess.

Polch

Situation
This locality is situated in the Nette Valley (Fig. 2, locality 15).

Research history
This locality was discovered in 1936, during shoring of the valley sides (Mauz, 1939; Mordziol, 1939). Bones, teeth and tusks of a single old individual of mammoth (*Mammuthus primigenius*), were recovered in a loess-filled depression at the base of the quarry.
The various publications about this locality were very much concerned with trying to prove that this animal had been hunted by fossil man. Marks on the fossils, described as being deliberate, have been shown to have natural origins (Bosinski, 1979).
Only the teeth from this mammoth are described in Part III. The material is stored in the Palaeontological Department of the University of Bonn.

Chronostratigraphy
A simplified section is not given for this locality. The fossils were described as lying in a loess-filled depression at the base of the quarry. Sketches of the quarry walls made by Mauz (1939), show a single loess horizon overlain by hillslope deposits and a mixed horizon of Laacher pumice and recent plough-soil, stratified above the depression.

SUMMARY
The mammoth remains were located in cold stage loess deposits. According to the stratigraphy at this locality, the fossiliferous horizon was deposited during the Last Cold Stage BP, which in turn has been correlated with the Weichselian.

Localities with assemblages dating to the Late Weichselian

The assemblages described in this section all date to the end of the Last Cold Stage BP, which has been correlated with the Late Weichselian.
The Late Weichselian was characterized in this region, as in other areas of North-West Europe, by a series of climatic oscillations. The classical succession for the Late Weichselian in Continental Europe, and the generally accepted Radiocarbon dates for these stages, is as follows (based on several authors):

Younger Dryas Stadial (cold stage) - begins 11,000 BP
Alleröd Interstadial (major temperate stage) - begins 11,800 BP

Older Dryas Stadial (cold stage)
Bölling Interstadial (minor temperate stage) - ca. 12,500 BP
Oldest Dryas Stadial (cold stage) - before 13,000 BP

The picture is, however, more complicated than this. Evidence from Coleopteran (beetle) assemblages indicate that, in England at least, the temperature had already begun to rise before 13,000 BP (Coope & Pennington, 1977). The Older Dryas Stadial, although recorded in pollen assemblages from some Neuwied Basin localities, is often not recognisable, for example, in the microfaunal assemblages.

However, changes from cold stages with a predominantly open, herbaceous vegetation to temperate phases with boreal forest have been recorded in pollen assemblages from some of the Late Weichselian localities in the Neuwied Basin. Thus, in the pollen assemblage from Gönnersdorf (see Fig. 17), the classical sequence Bölling Interstadial - Older Dryas Stadial - Alleröd Interstadial has been recognised.

The Late Weichselian phase was brought to an early end in the Neuwied Basin region by the eruption of the Laacher Volcano. Deposits recognisable as belonging to, for example, the Younger Dryas Stadial do not occur in the Neuwied Basin.

Assemblages dating to the Late Weichselian in the Neuwied Basin region can be divided into two groups, those dating to the end of the Bölling Interstadial, such as Gönnersdorf and the older assemblage at Andernach (An 1), and those dating to the Alleröd Interstadial, such as the upper assemblage at Andernach (An 2), Niederbieber, Urbar, Miesenheim II and Thür.

The assemblages at Gönnersdorf and An 1 are both associated with Magdalenian cultural remains. The Magdalenian stone tool industries are characterised by long blades, end scrapers and burins. The assemblages dating to the Alleröd Interstadial are associated with typical »Federmesser« industries, consisting of backed points and small scrapers.

All of these localities were discovered during commercial extraction of pumice deposited during the Laacher volcanic eruption.

The eruption of the Laacher Volcano must have been one of the most dramatic events to have taken place in the East Eifel volcanic field. Up to five cubic kilometres (dense rock equivalent) of tephra was discharged from this volcano during three main eruptive phases lasting about ten days (v. d. Bogaard & Schmincke 1985).

The eruption consisted of alternating phreatomagmatic and Plinian phases, and has often been compared to recent eruptions, such as that of Mount St.Helens. The mass of the erupted material can be seen today in the form of thick pumice beds (up to fifty metres in depth near source (Plate 19,1,) with bands of darker-coloured co-ignimbrite ash cloud deposits (»Britz«), and solid ash banks (»Trass«) resulting from base-surge flows.

Pumice was deposited to the north-east, south-west and south of the Neuwied Basin. In the basin region alone these deposits can be found for twenty to thirty kilometres around. Laacher Ash horizons have also been found as far afield as Southern Sweden, Switzerland and Northern Italy (v.d. Bogaard and Schmincke, 1985).

The Laacher eruption took place in the second half of the Alleröd Interstadial. Usually a loamy, dark red-brown soil can be seen directly below the pumice, being the remains of the soil development which had begun to form during this interstadial. Together, these deposits form an important marker horizon for the end of the Last Cold Stage (=Late Weichselian) in the Neuwied Basin region. Charcoal fragments found embedded in the ash banks, and organic remains in the distal ash layers have been Radiocarbon dated to between 10,950 and 11,050 BP (v. d. Bogaard & Schmincke, 1985), and a date of about 11,030 BP for the eruption is usually considered to be accurate (Street, 1986).

The commercial exploitation of pumice began in the 1870s in the Neuwied Basin, although its use as a building material was already known before this time. Pumice deposits were exploited during the 1900s and are still being extracted today.

BÖLLING INTERSTADIAL

Gönnersdorf

Situation
This locality is situated at the northern end of the Neuwied Basin, on the east bank of the Rhine (Fig. 2, locality 11; Plate 19,2). The site is situated on a spur of land formed by a middle terrace of the Rhine, at about 40 metres above the present-day level of the Rhine river.

Research history
This locality was discovered in 1968 during extensions to the cellars of a house in the Neuwied suburb of Feldkirchen. Bone fragments, stone artefacts and other occupational debris were revealed in loess deposits below the Laacher Pumice. Excavations began in the same year and continued until 1976 (Bosinski, 1979).

Lithology
Fig. 16, a) shows a simplified section through the Gönnersdorf sequence of deposits, based on Bosinski (1979, Fig. 8b) and Brunnacker (1978 (ed.), Fig.13).

Fossiliferous horizon
The rich fossiliferous horizon is located in loess at the base of unit D. The fossils from the assemblage extend into and onto the surface of unit C (cf. the description of the processes involved here by Bosinski in Brunnacker (ed.), 1978). The loamification of the loess, as found for example in unit D, may be due to weathering which took place during the Holocene and penetrated through the Laacher Pumice.

Chronostratigraphy
The chronostratigraphical problems associated with the older assemblages at localities in the Neuwied Basin region no longer apply to the ones described in this section. The Late Weichselian localities fall into the range of the Radiocarbon absolute dating method, which gives more reliable dates, at least for these younger sites, than other dating methods used at older localities.
Important for the chronostratigraphy of the Gönnersdorf fossiliferous horizon are the following:

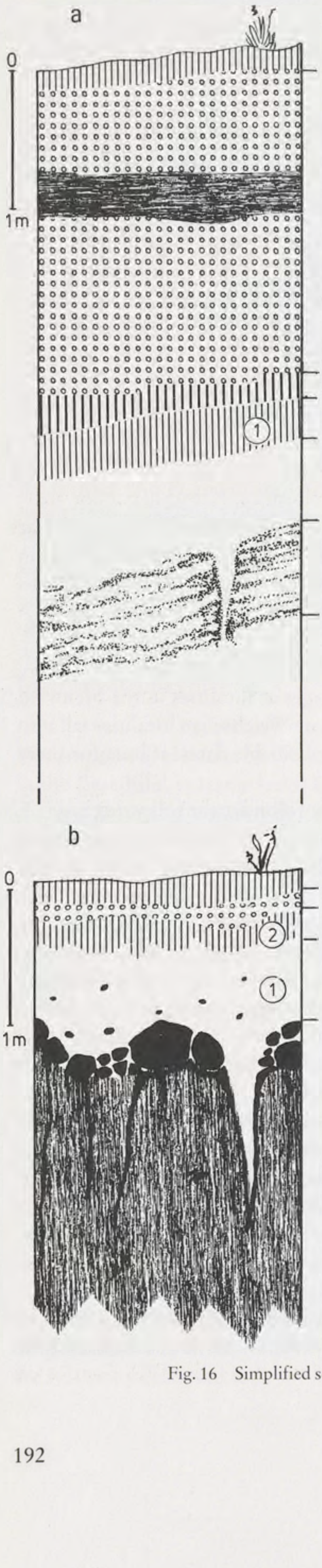
i) The two tephra deposits, Eltville ash (unit F) and the Laacher Pumice (Unit B) provide a terminus post quem of about 20,000 BP and a terminus ante quem of 10,950 - 11,050 BP respectively for the fossiliferous horizon.

ii) In a depression towards the west of the site itself, a weakly-developed soil (»Naßboden«), representing an amelioration in the climate, had formed on the loess of unit E. Soliflucted loessic material was stratified directly above this, in which fossils derived from the fossiliferous horizon were found. At the site itself a soil contemporary with this oscillation had not formed (Fig. 16a), however, molluscan faunas stratified below and associated with the fossiliferous horizon also indicate a change in climate from cold, glacial conditions to a more temperate phase (see below, molluscan faunas). Thus the settlement at Gönnersdorf was either contemporary with, or slightly younger than, the climatic amelioration.

iii) Bones from the fossiliferous horizon have been dated to 12,380 +/- 230, 12,660 +/- 370 and 11,100 +/- 650 BP (Radiocarbon Laboratory, University of Lyon, in Brunnacker (ed.) 1978). Mollusc shells found above and below the fossiliferous horizon have been Radiocarbon dated 10,540 +/- 210 BP and 12,910 +/- 105 BP respectively (Institute of Prehistory, University of Cologne, in Brunnacker, *ibid.*).

The fossiliferous assemblage

The lithics and other cultural remains from this assemblage have been described by Bosinski (1979), as belonging to the Magdalenian cultural phase. Interesting is the occurrence at this site of engravings of larger mammals on slate slabs.



Unit	Description
A:	Recent soil development
B:	Laacher pumice. Dated to 11 050-10 950 BP
C:	Soil of the Alleröd Interstadial
D:	A brownish loamy loess
E:	A calcareous, soliflucted loess deposit. Reworked slope deposits in this unit have been identified as the soil of the Bölling Interstadial
F:	Lenses of fine volcanic ash material in a silty matrix. Identified as the Eltville Ash, dated to about 20 000 BP Ice-wedge casts are present in this deposit
G:	A loess deposit

A:	Recent top-soil
B:	Truncated Laacher pumice. Dated to between 11 050-10 950 BP
C:	The Alleröd Interstadial soil
D:	A loess deposit with weathered lava fragments
E:	Remains of a Middle Pleistocene lava-flow with cooling fissures

Fig. 16 Simplified section through the Gönnersdorf (a) and the Andernach (b) deposits.

Palynology

A series of samples for pollen were taken from the base of the Eltville Ash deposit (Unit G) to the base of the Laacher Pumice (Unit B). The following description and Fig. 17 are after Leroi-Gourhan (in Brunnacker (ed.), 1978).

Pollen was only found in the upper part of the section in units F to C, and can be divided into four main stages.

i) The pollen spectra begins with a Mediterranean flora in unit F, including taxa such as the holm oak (*Quercus ilex*), oak, pistachio (*Pistacia*), the haploxylon pine (*Pinus haploxylon*) and *Cistus*. These taxa represent reworked Tertiary material; a similar situation was found in the Alleröd assemblage at the Niederbieber locality, where pollen from Tertiary species were the only ones identified (see below).

ii) Primary pollen appears about twenty centimetres below the fossiliferous horizon in unit E, with a pine dominated tree pollen. Alder (*Alnus*) and hazel (*Corylus*) are also present. Oak (*Quercus*), hornbeam (*Carpinus*), lime (*Tilia*), ash (*Fraxinus*), elm (*Acer*), holly (*Ilex*), walnut (*Juglans*) are also present. Three conifers are represented juniper (*Juniperus*), fir (*Abies*) and spruce (*Picea*). This stage indicates a temperate phase.

iii) Above the find-horizon, in unit D, a change to colder and dryer conditions are indicated by the reduction of alder, birch (*Betula*) and hazel, and an increase in non-tree pollen (*Artemisia*).

iv) Pollen from the base of unit C, shows an increase in forested conditions. Pine is again dominant, juniper is represented by a high percentage of pollen, although true thermophilous species are rare.

Ignoring the reworked material from unit F, the pollen stages are as follows. Firstly a temperate phase (unit E) correlated to the Bölling Interstadial, secondly; a cold stage in unit D, representing the Older Dryas Stadial and finally, pollen from unit C, which represents the beginning of the Alleröd Interstadial. The fossiliferous horizon is correlated with the very end of the Bölling Interstadial, associated with the opening up of the wooded conditions that had characterized this warm phase and the encroachment of the open steppe which characterized the Older Dryas Stadial.

Molluscan fauna

Samples taken in the loess of unit E, below the fossiliferous horizon, contained a sparse *Pupilla* fauna indicative of steppe conditions. At the level of the fossiliferous horizon the fauna changes, and species indicative of a more temperate climate and humid conditions, such as *Arianta arbustorum* and *Vallonia costata*, become dominant.

Microfauna

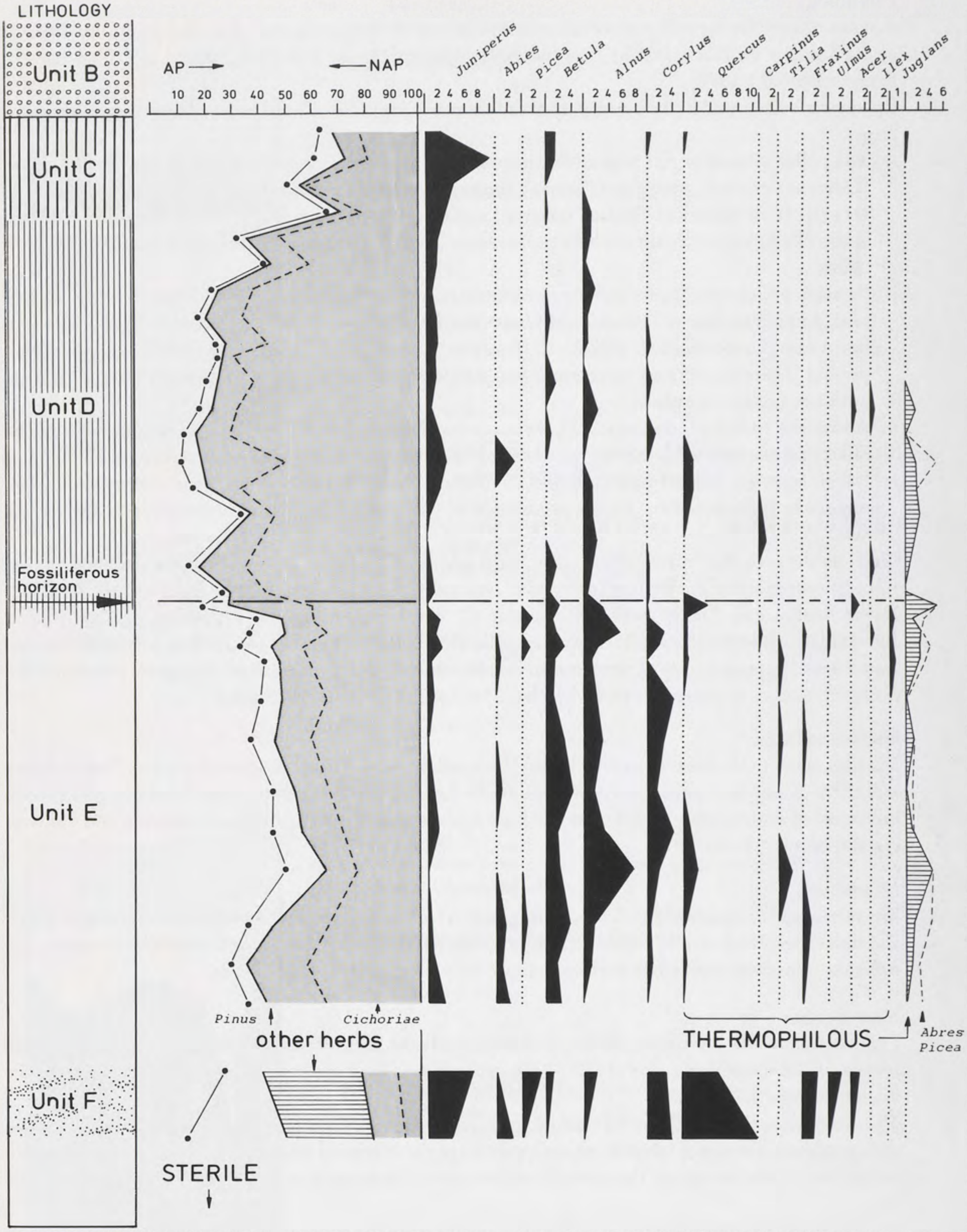
The microfauna consists of species indicating steppe conditions, such as *Ochotona pusilla* (steppe pika), and those species inhabiting closed vegetation along river-sides such as *Arvicola amphibius* (water vole) or banks or marshy areas close to rivers today (Malec, in Brunnacker (ed.) 1978).

Macrofauna

The macrofauna has been identified by F. Poplin. Only the fauna from the 1968 excavation and a short review of the remaining fauna (1970 - 1976 excavations) has been published so far (Poplin 1976; in Brunnacker (ed.), 1978).

The macrofaunal remains from this locality mentioned in Part III are only intended as a comparison for the unpublished material from the other localities in the Neuwied Basin, and to complete the macrofaunal history of this region. The state of preservation of the material is therefore not described in detail here.

Poplin (1976), has described the macrofaunal remains from the concentration excavated during 1968 as belonging to a winter settlement phase. He based this primarily on the antler from reindeer found in this concentration, in which the female antlers were all from animals that had been hunted and killed at the time when antler was being carried, that is between September and June (Schmid, 1972). Bones from


LITHOLOGY
Unit B
Unit C
Unit D
Fossiliferous horizon
Unit E
Unit F
AP →
← NAP
10 20 30 40 50 60 70 80 90 100
Juniperus
Abies
Picea
Betula
Alnus
Corylus
Quercus
Carpinus
Tilia
Fraxinus
Ulmus
Acer
Ilex
Juglans
2 4 6 8
2
2
2 4
2 4 6 8
2 4
2 4 6 8 10
2
2
2
2
2
2
1
2 4 6
Pinus
Cichoriae
other herbs
THERMOPHILOUS
Abres
Picea
STERILE

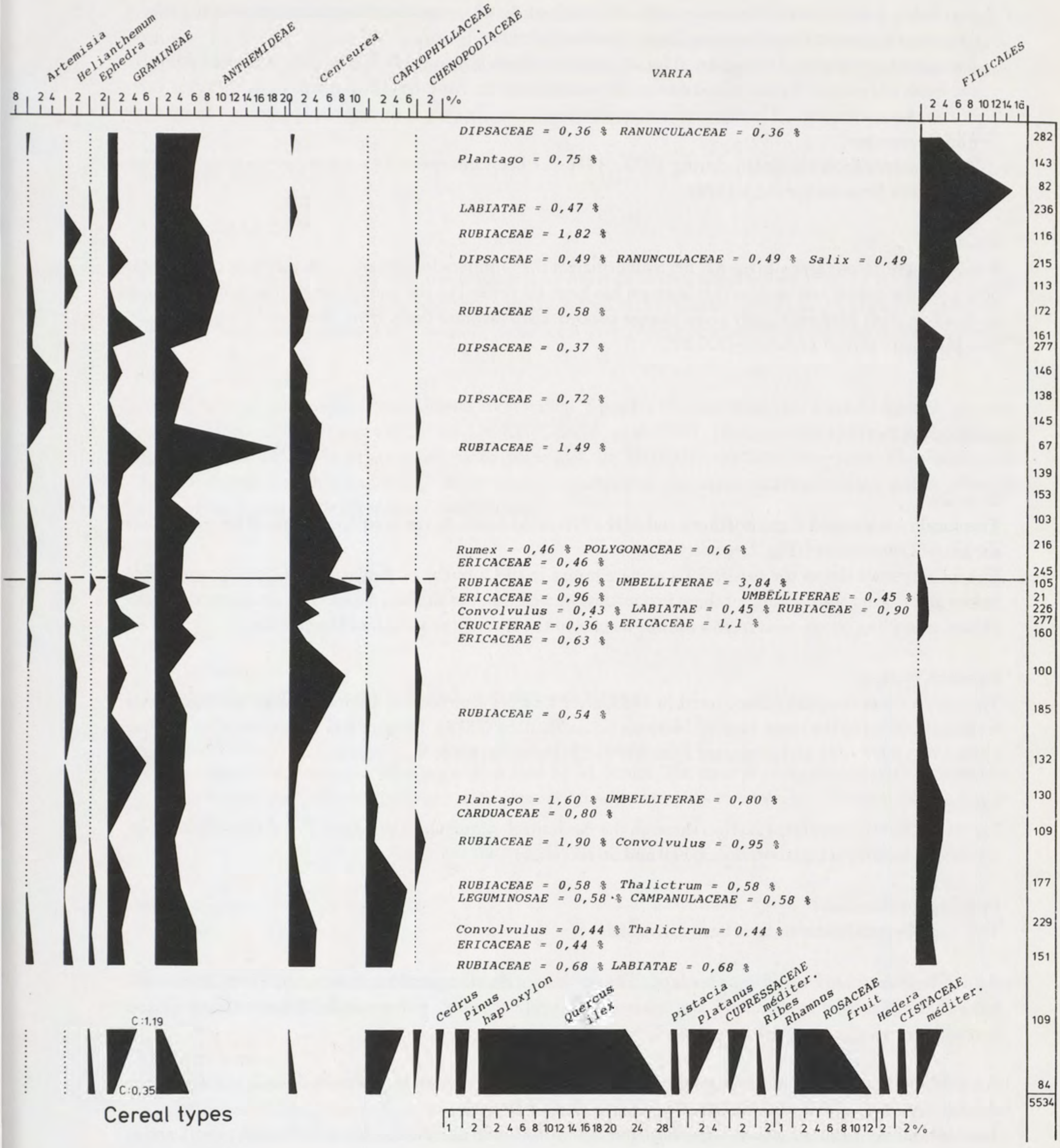


Fig. 17 Pollen diagram from Gönnersdorf (after Leroi-Gourhan in: Brunnacker ed. 1978). Values expressed as % of all pollen, except the fern (Filiaceen).

two horse foetuses were also recovered. The state of development of these indicates that the mares carrying them were killed between December and February.
Amongst the remains of birds (*Aves*) found in this concentration, a gull (*Larus*) was identified. Usually sea-birds only occur this far inland during the winter months. Amongst the remains of fish (*Pisces*), burbot has been identified. This species is a bottom-feeder, easily caught during the spawning season after mid-November.
The concentration excavated during 1970 - 1976 has been interpreted as a summer settlement phase (Poplin, in Brunnacker (ed.), 1978).

SUMMARY
A single fossiliferous assemblage has been identified at the Gönnersdorf locality. On the basis of stratigraphy, absolute dating and pollen, this horizon has been correlated to the end of the Bölling Interstadial in association with predominantly open steppe conditions. Absolute dates from the fossiliferous horizon give a pooled value of 12,520 +/- 300 BP.

Andernach (An 1)

Situation
This locality is situated at the northern end of the Neuwied Basin on the west bank of the Rhine, opposite the site of Gönnersdorf (Fig. 2, locality 10).
The locality now lies in the garden of a private house in the suburbs of Andernach. Observations made before and during the building of these properties showed that the site was situated on an exposed tongue of land extending north-west from a middle terrace of the Rhine (the so-called Martinsberg).

Research history
The locality was originally discovered in 1883, after Laacher Pumice had been exploited. Investigations were carried out in the same year by Herman Schaaffhausen (1888). The site was rediscovered in the late 1970s (Veil, 1977 - 78), and excavated from 1979 - 83 (Bolus, Street & Veil, in prep.)

Lithology
Fig. 16 b) shows a simplified section through the Andernach sequence of deposits. The following description of the locality is based on Bolus, Veil and Street (*ibid.*).

Fossiliferous horizons
Two fossiliferous horizons have been identified.

An 1: The is the main fossiliferous horizon. The remains of dwelling structures associated with stone artefacts of the Magdalenian industry and macrofaunal remains were recovered in the loess of unit D and spreading vertically into the base of unit C.

An 2: Macrofaunal remains associated with a Federmesser stone-tool industry in unit C, the soil of the Alleröd Interstadial. This fossiliferous-horizon is described later.
The taphonomy of these assemblages has been described by Street (Bolus, Street & Veil, in prep.), and is not discussed further here.

Chronostratigraphy of An 1
The position of An 1, in loess below the Alleröd soil, is very similar to that of the fossiliferous horizon at Gönnersdorf.

Radiocarbon dates (Oxford Accelerator Unit) obtained on bone fragments from An 1 have given a pooled value of 12 980 +/- 60 BP (Hedges et al., 1987) (for details see Street, in prep.). The An 1 assemblage is slightly older than that from Gönnersdorf. Both assemblages are associated with the Magdalenian culture.

ALLERÖD INTERSTADIAL

Andernach (An 2)

The situation of this locality and the fossiliferous horizon is described above (Fig. 16 b). Macrofaunal remains in association with stone artefacts were recovered in the Alleröd soil of unit C. Details of the deposition of the assemblage and post-burial disturbance will be given elsewhere (Bolus, Street & Veil, in prep.).

Chronostratigraphy
An 2 is located in the soil of the Alleröd Interstadial. Samples of bone from this assemblage have given a pooled Radiocarbon date of 12,010 +/- 110 BP (Gowlett et al., 1987; Hedges et al., 1987). A Radiocarbon date of 12,000 BP has been given for the beginning of the Alleröd in the classical system. The dates from An 2 indicates that this assemblage dates to the beginning of this interstadial and is the oldest Alleröd assemblage found in the Neuwied Basin to date.

The fossiliferous assemblage

An 2

Stone artefacts
The artefacts are of the typical »Federmesser« industry.

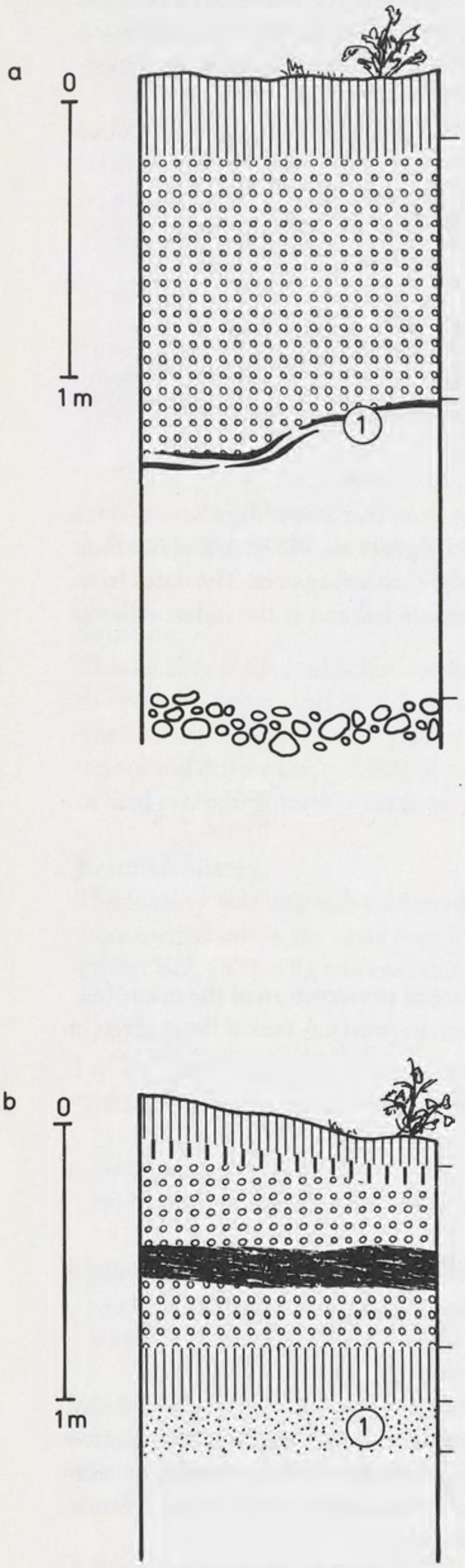
Macrofauna
The macrofaunal remains have been identified by M. Street. The state of preservation of the macrofaunal material from this assemblage is also given by that author (Street, in press). A faunal list is given in Part IV.

Niederbieber

Situation
This locality is situated on the 100 metre terrace of the eastern bank of the Rhine river, between the valleys of the Aubach and Wied rivers (Fig. 2, locality 12).

Research history
The locality was discovered in 1980, after Laacher pumice had been removed on the outskirts of Niederbieber village. The first excavations were undertaken in 1981, and the site has been investigated since then by prehistory students of the University of Cologne. The following description of this locality is taken from several sources, including Bolus, M. & Loftus, R., in press; Bosinski et. al., 1982, and several unpublished Master's dissertations from students of the University of Cologne.

Lithology
Fig. 18 a) shows a simplified section through the Niederbieber deposits, after J. Loftus (1985).



Unit Description

A: Recent plough soil

B: Laacher pumice

C: A red-brown reworked loess. This is the equivalent of the Alleröd soil. Iron-pan deposits occur at the top of this unit

D: Gravel of the 100 metre Rhine terrace

A: Recent top-soil

B: A hill-wash deposit consisting of reworked pumice and loess

C: Laacher pumice

D: Soil of the Alleröd Interstadial

E: A grey-brown loamy loess horizon

F: A loess deposit

Fig. 18 Simplified section through the Niederbieber (a) and the Urbar (b) deposits.

The fossiliferous horizon

A single fossiliferous horizon has been identified so far. An older horizon has been revealed in the soundings, but as this has not been investigated, the following description has been restricted to the main horizon.

The main horizon (Fig. 18 a, no. 1) consists of several concentrations of material, such as macrofaunal remains, stone artefacts and other cultural remains. The macrofaunal material is weathered and covered with root-etching. Some pieces are very eroded on the outer surfaces. Despite vertical movement of the material, conjoins between macrofaunal remains and between lithics suggest that the concentrations excavated to date belong to the same phase of deposition.

Chronostratigraphy

The fossiliferous assemblage is located in the soil formed during the Alleröd Interstadial. The cessation of loess deposition at this site has been TL dated, on a sample taken directly below the Laacher Pumice, to about 13,000 +/- 1,100 BP (Wintle, 1987a).

The fossiliferous assemblage

Stone artefacts

A typical »Federmesser« industry.

Palynology

Only reworked Tertiary pollen has been identified to date.

Plant macrofossils

Schoch (in Bosinski et al., 1982), has identified willow (*Salix*) and birch (*Betula*) from charcoal fragments.

Microfauna

Only a vole (*Arvicola* sp.) and beaver (*Castor fiber*) have been identified.

Macrofauna

The macrofauna has been identified by the present writer and others (Prof. Nobis, Museum Alexander Koenig, Bonn; Th. van Kolfschoten, Utrecht and M. Street, Neuwied).

Miesenheim II

Situation

This locality is situated in the Nette Valley on the south-eastern slope of a plateau between the Rhine and Nette rivers (Fig. 2, locality 14).

Research history

This locality was discovered after extraction of Laacher Pumice had revealed organic remains (wood, charcoal) lying on and in the underlying sediment. Soundings were investigated between 1982 and 1984 and more extensive excavations were carried out from 1985 (Street (ed.), 1986) to 1987.

Lithology

Fig. 19 shows a simplified section through the Miesenheim II deposits. The following description is based on Street (*ibid.*).

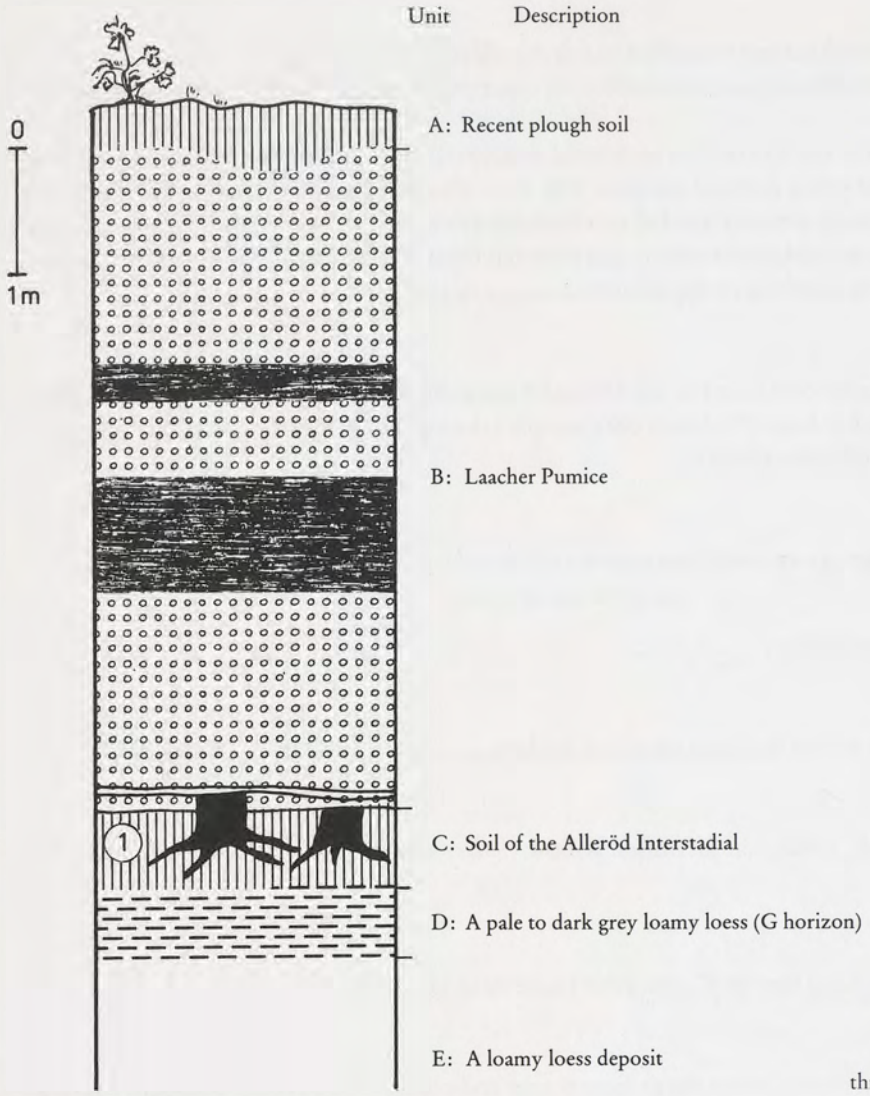


Fig. 19 Simplified section through the Miesenheim II deposits.

Fossiliferous horizon

Sparse macrofaunal remains associated with a few stone artefacts located in and on the surface of the remains of the Alleröd soil of unit C. The site of Miesenheim II is waterlogged, and the finds here are primarily organic ones, such as fossil wood and seeds. The fossiliferous horizon is in primary context and the fossils appear to be from the same depositional phase. This locality has, however, been included in this study as it provides elements of environmental information often missing at localities of the same period with abundant archaeological and macrofaunal finds (eg. Niederbieber).

Chronostratigraphy

The fossiliferous horizon is situated in the Alleröd soil. The results of samples taken for palaeomagnetic dating can be correlated with the H-I swing of Creer and Tucholka's secular variation curve (1982), which in turn has been dated to 11,440 BP by the Radiocarbon method.

Radiocarbon dates on samples of wood (Cologne university) have given a pooled value of 11,264 +/- 124 BP for this assemblage. These dates are only slightly older than those given for the Laacher eruption (about 11,030 BP), and Miesenheim II appears to be one of the youngest Alleröd sites in this area.

The fossiliferous assemblage

Stone artefacts

The stone tools are of the typical »Federmesser« industry.

Plant macrofossils

The remains of trees from this assemblage have all been identified as aspen (*Populus tremula*). This species is indicative of wet or damp conditions. Plant remains (seeds), from species indicative of open woodland such as fly honeysuckle and traveller's joy, have also been recovered.

Palynology

Only provisional results from pollen can be given so far.The assemblage is dominated by pine (*Pinus*). Birch (*Betula*), alder (*Alnus*) and willow (*Salix*) also occur. The non-tree pollen is dominated by *Artemisia*.

Molluscan fauna

A molluscan fauna dominated by *Vallonia* sp. has been identified.

Microfauna

The microfauna includes elements indicative of a steppe biotope, and species indicative of woodland and damp meadows.

Macrofauna

The macrofauna has been identified by M. Street, and a faunal list is given in Part IV.

Urbar

Situation

This locality is situated on the east bank of the Rhine, in the suburbs of Urbar, near the town of Coblenz. The site lies on a spur of land, between the Rhine and the Vallendar stream, at about 150 metres above sea-level and 80 metres above the level of the present-day Rhine (Fig. 2, locality 13).

Research history

The site was discovered in 1966 in a private garden. Excavations were undertaken in 1966, 1972 and 1980 - 81 (Eiden & Löhr, 1973). The following description of the locality is based on Eiden & Löhr (1973).

Lithology

Fig. 18 b) shows a simplified section through the deposits at Urbar.

The fossiliferous horizon

Macrofaunal remains associated with stone artefacts (no. 1 in Fig. 18 b). This horizon is located in the loamy loess of unit E, below the Alleröd Interstadial soil of unit D. Details about the depositional context are not known. The macrofaunal material is grey-yellow in colour and very weathered. The outer surfaces are eroded and covered with root-etching. The fossils appear to belong to one phase of deposition.

Chronostratigraphy

The fossiliferous horizon is grouped with the other Alleröd localities because of its location under the Laacher Pumice. A Radiocarbon date of 11 350 +/- 120 BP (pers. comm. R. Housley, Oxford Accelerator Unit) has been given for this assemblage.

The fossiliferous assemblage

Stone artefacts
A typical late Palaeolithic industry.

Macrofauna
The macrofauna from this assemblage has been provisionally identified by K.Lanser, but not published.

Thür

Situation
The locality of Thür is also situated in the Nette Valley (Fig. 2, locality 18). This locality is comparable to Miesenheim II in its stratigraphy and finds (see page 199).
Organic remains and a few stone artefacts were found here (Brunnacker et al., 1982). Macrofaunal remains are not known from Thür, but it has produced a more detailed pollen assemblage for the Alleröd than other localities of this period in this region and is therefore briefly discussed here.

Palynology
Figure 20 a, shows the complete pollen diagram with samples taken to a depth of one metre below the surface under the Laacher pumice. Figure 20 b, shows the results of more intensive sampling of the first twenty-five centimetres below the pumice (Urban, in Brunnacker et al. *ibid.*). Three phases have been identified.

i) Figure 20 a), shows a tree pollen dominated by pine (*Pinus*) and birch (*Betula*) between 100 - 50 centimetres. The presence of *Artemisia*, *Helianthemum* and *Rumex*, amongst the non-tree pollen indicate a steppe or tundra environment.
ii) Between 50 and 40 centimetres below the pumice birch begins to dominate, with a corresponding increase in the non-tree pollen, indicating a deterioration in the climate.
iii) The upper part of the pollen diagram shows a return to a milder climate, with pine dominating, a reduction in birch and an increase in the *Rosaceae*.

In figure 20 b, the tree pollen is dominated by pine and birch between 13 and 24 centimetres. Species such as *Artemisia* and *Rumex* amongst the non-tree pollen indicates the presence of some open vegetation. At about 9 centimetres, an increase in non-tree pollen indicates a change locally to shrubland.
Radiocarbon dates on fragments of wood found at a depth of between five and fifteen centimetres have given a pooled value of 11, 136 +/- 101 BP (Fig. 20 b, marked with an arrow) (Institute of Prehistory, University of Cologne).
The colder conditions indicated in phase ii), during the first half of the Alleröd interstadial, have also been recorded in other pollen assemblages in southern Scandinavia and north Germany (Urban, in Brunnacker (ed.), 1982).

SUMMARY
The assemblages at Andernach (An 2), Niederbieber, Urbar and Miesenheim II are all located in the soil formed during the Alleröd Interstadial. Loess deposition appears to have ceased at about 13,000 +/- 1,100 BP at Niederbieber, and pumice deposits from the Laacher eruption, dated to about 11,030 BP, post-date the soil formation at all these localities. The following dates were obtained from fossils from these assemblages. The oldest assemblage is the one at Andernach (An 2), which has been dated to about 12,010 +/- 110 BP. When compared to the classical date given for the beginning of the Alleröd (12,000 BP), this assemblage must have been deposited at the very beginning of the Alleröd Interstadial. It is also possible that the Alleröd Interstadial began earlier in this region. The assemblage at Urbar has a single date of 11,350 +/- 120 BP. The assemblage at Miesenheim II has been dated to about 11,265 +/- 124 BP, and is the »youngest«

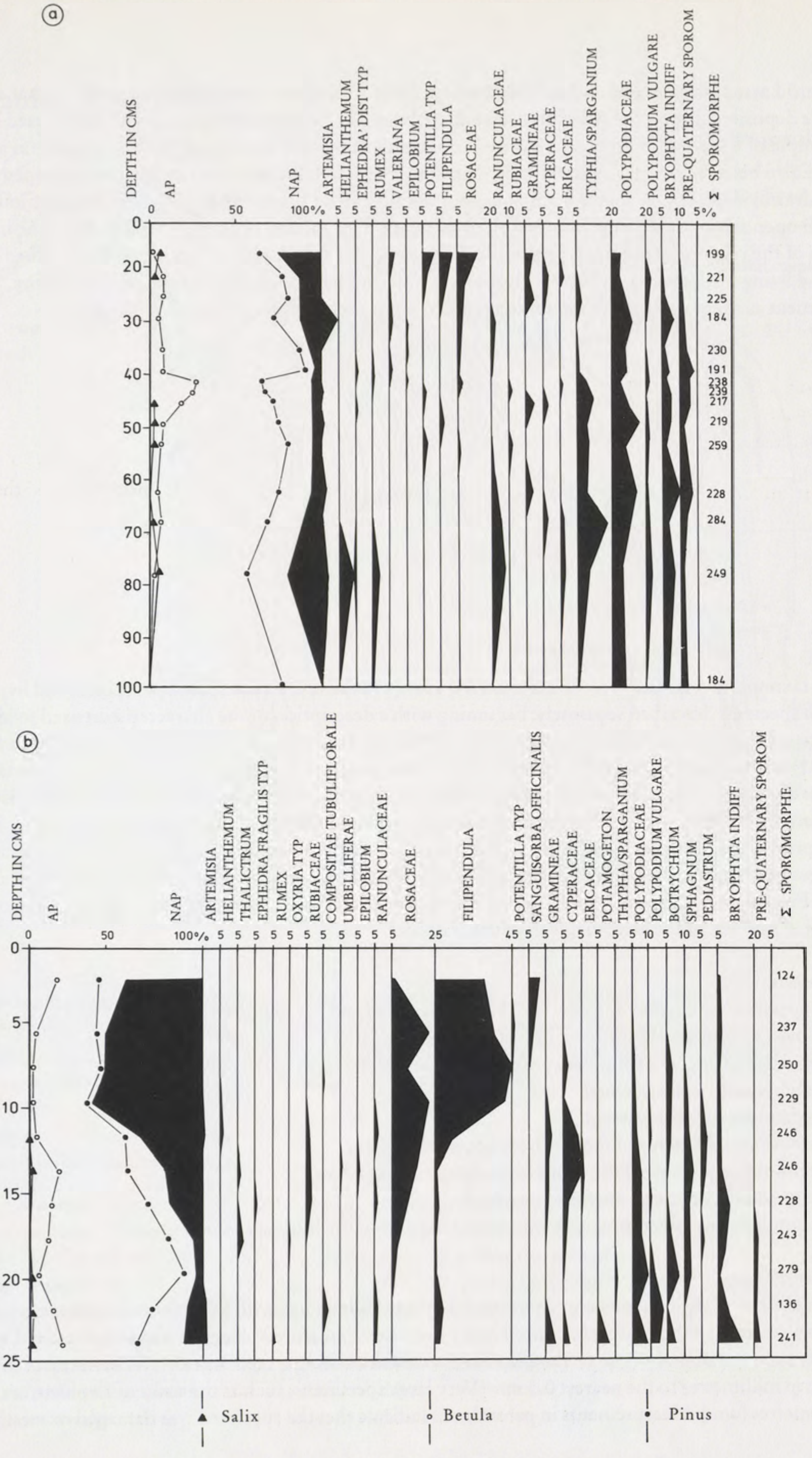


Fig. 20 a.b Pollen diagram from Thür.

Alleröd assemblage found so far. The absolute dates from these assemblages all indicate that the fossils were deposited during the Alleröd Interstadial phase. The pollen assemblage from Thür is used here as an example of the Alleröd flora, and indicates open pine and birch woodland. Willow, aspen and alder trees have also been recorded at Alleröd sites. The non-tree pollen includes taxa indicative of an open steppe or tundra environment. A sparse mammalian microfauna from Miesenheim II contains species indicative of both open steppe and damp, wooded environments. This mixing probably resulted from the incorporation of the remains of species living in the damp, wooded conditions at the site itself, with the remains of those living in a more open habitat close to the site, and being deposited at the site by raptors. The environment as suggested by this microfauna is consistent with the one indicated by the pollen.

PART THREE

SYSTEMATIC DESCRIPTIONS

The taxonomic classification of Anderson & Jones (1984) has been used for those species still living today. Each species is described separately, beginning with a description of the characteristics used to identify to species, based on information in Cornwall, (1956), Hillson (1986), Lavocet (ed., 1966), Pales & Garcia (1981) and Schmid (1972). A list of the material identified and a description of the more important specimens are given. Fragmentary macrofaunal remains were not usually included in the material lists, unless these were the only evidence of the presence of a particular species at the locality concerned, or indicated the presence of a higher number of individuals of a species in an assemblage. The known stratigraphic ranges of the species are described and compared with their occurrences in the Neuwied Basin assemblages. Finally the known palaeoecology of the species is discussed and compared with the palaeoenvironment, if known, of the assemblage in which it occurs.

Terminology

The terminology used to describe the skeletal elements and the dentition is given in Fig. 21. The terminology used to describe the morphology of the dentition (after Osborn, 1907) and the antlers of deer are given in separate figures. The following are used to describe the form of the cheek teeth:

brachydont - low-crowned
hypsodont - high-crowned
bunodont - the cusps of the tooth are rounded in form
secodont - the cusps of the tooth form sharp cutting edges
selenodont - the cusps are fused into folds
lophodont - as selenodont, but where the long axis of the folds are bucco-lingual

Measurements

The majority of the specimens were measured using a slide-gauge with a vernier scale and are given in millimetres (mm.), to the nearest 0.1 mm. Larger finds were measured using a measuring box, and measurements such as circumference of the diaphysis were taken using a tape measure. These measurements are given in millimetres to the nearest 0.5 mm. Very large specimens, such as the tusks of elephant, are given in centimetres (cm.). Measurements in parentheses indicate that the specimen was damaged or weathered.

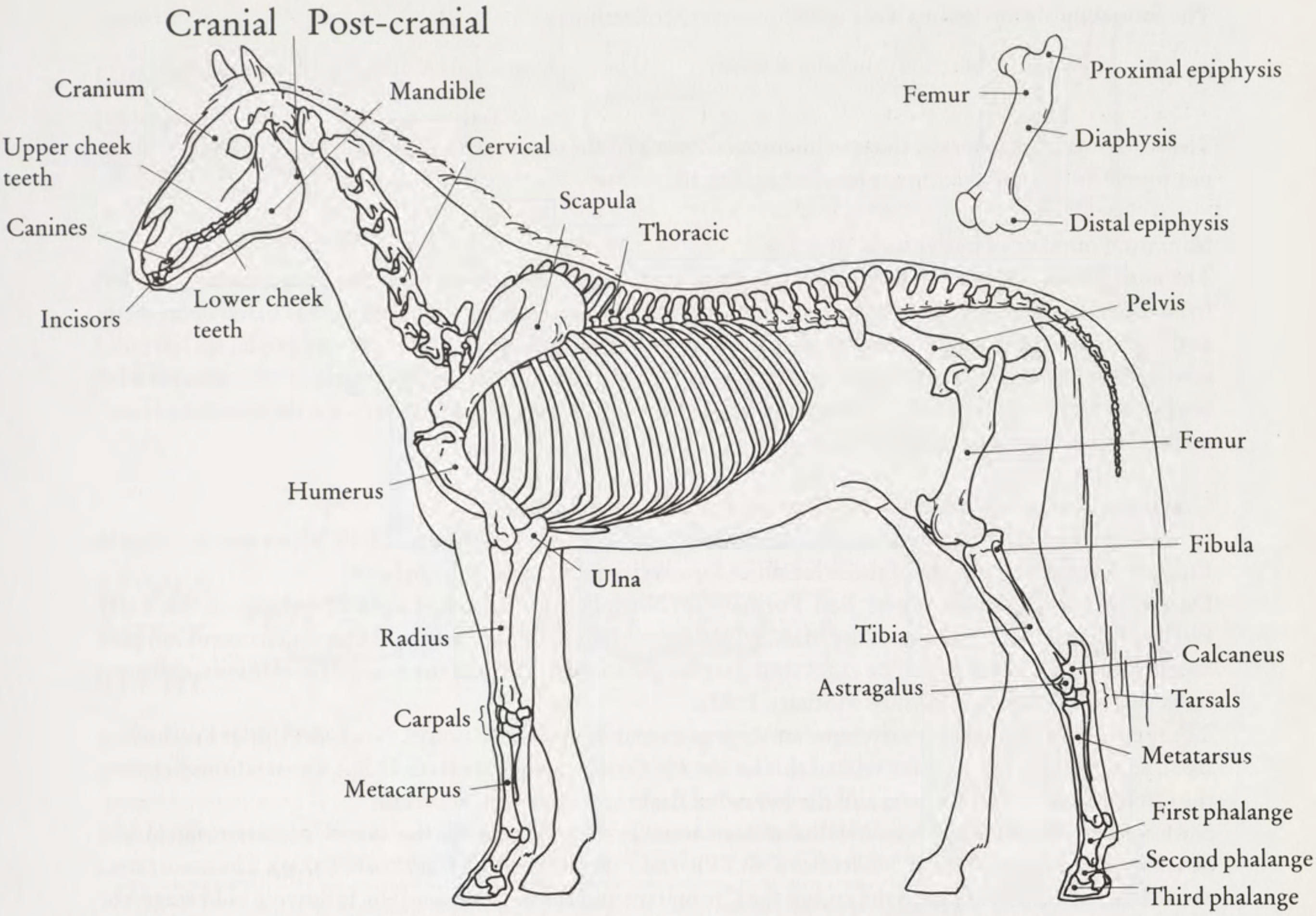


Fig. 21 Terminology used to describe the skeletal parts of larger animals.

The methods used to take the measurements on the upper and lower cheek teeth are given in the same figures along with the terminology used. The same applies to the measurements taken on the antlers. Post-cranial bone was measured following v. d. Driesch (1976), unless stated otherwise in the text. Absolute measurements not included in tables in the text are given in Appendix III.

Abbreviations

The following abbreviations are used:

ant.	anterior	dp	decidous cheek teeth
post.	posterior	I	permanent incisor
ant/post	anterior or posterior	P	permanent premolar
sin.	sinistra (left)	C	permanent canine
dex.	dextra (right)	M	permanent molar
s/d	sinistra or dextra		
		Mc	metacarpus
n	number of specimens	Mt	metatarsus
x	mean value	artic.	articulation

The following abbreviations were used for private collections:

KW	Würges Collection (Mülheim-Kärlich)	Urm	Urmersbach Collection (Weissenthurm)

The registration numbers of the specimens recovered during excavation are as follows: eg. 24/10, 6. Those not found during excavation are labelled eg. Str. 10.

Minimum number of individuals

The minimum number of individuals is based upon the largest number of elements (bone, tooth or antler) from the left or the right side of the body from a single species. Usually this number was based upon teeth, as these are the parts less affected by loss due to post-depositional weathering. For example, six left (sin.) lower third molars from red deer *Cervus elaphus* indicate that at least six individuals of this species were present at the locality concerned. Attempts were also made, where necessary, to count the remains of juvenile and adult individuals separately.

Comparison with Middle and Late Pleistocene localities in Europe

In the following section, reference has been made to faunas from Middle and Late Pleistocene localities in Europe. A brief description of those localities repeatedly referred to is given here.

Deposits in the Cromer Forest Bed Formation (Norfolk and Suffolk, England) belong to the Early Pleistocene and the beginning of the Middle Pleistocene (equivalent at least to the terms Cromer Complex and Elsterian used in Fig. 3). The exact stratigraphic position of many of the macrofaunal fossils, collected from this formation, is not known (Stuart, 1982).

The type-site of the Cromerian temperate stage in England is at West Runton, Norfolk (Upper Freshwater Bed), and Stuart (1981), has correlated this locality with that at Voigtstedt (G.D.R.). Correlations between the Cromerian of West Runton and the Neuwied Basin sequences are uncertain.

Several other Continental localities have been broadly correlated with the type Cromerian, including Mosbach and Mauer (G.F.R), Süssenborn (G.D.R.) and Stranska Skala (Czechoslowakia). The main fauna at Mosbach probably dates to the end of the Cromerian and the beginning of the following cold stage, the Elsterian (Kahlke, in Butzer & Isaacs, (eds.) 1975). The fauna from Süssenborn also contains temperate and arctic faunal elements, which suggests that both warm and cold stage deposits are also present at this site (Kahlke, 1960).

The site at Bilzingsleben (G.D.R.) has been correlated with the Holstein Interglacial (Mania, 1980). The deposits at Weimar-Ehringsdorf (G.D.R.), previously thought to date to the Last Interglacial (Behm-Blancke, 1960), may represent (at least the lower travertine) an inter-Saalian warm phase (van Kolfschoten, 1988). The locality of Taubach (G.D.R.) dates to the Last Interglacial (= Eemian).

CHAPTER 5
ORDER CARNIVORA

Family *CANIDAE* (Gray, 1821)

Basic identification

Dentition

The canid dentition is marked by the development of the upper fourth premolar and the lower first molar into blade-like (secodont) carnassial teeth. In the lower carnassial, the main cutting edge is formed by the

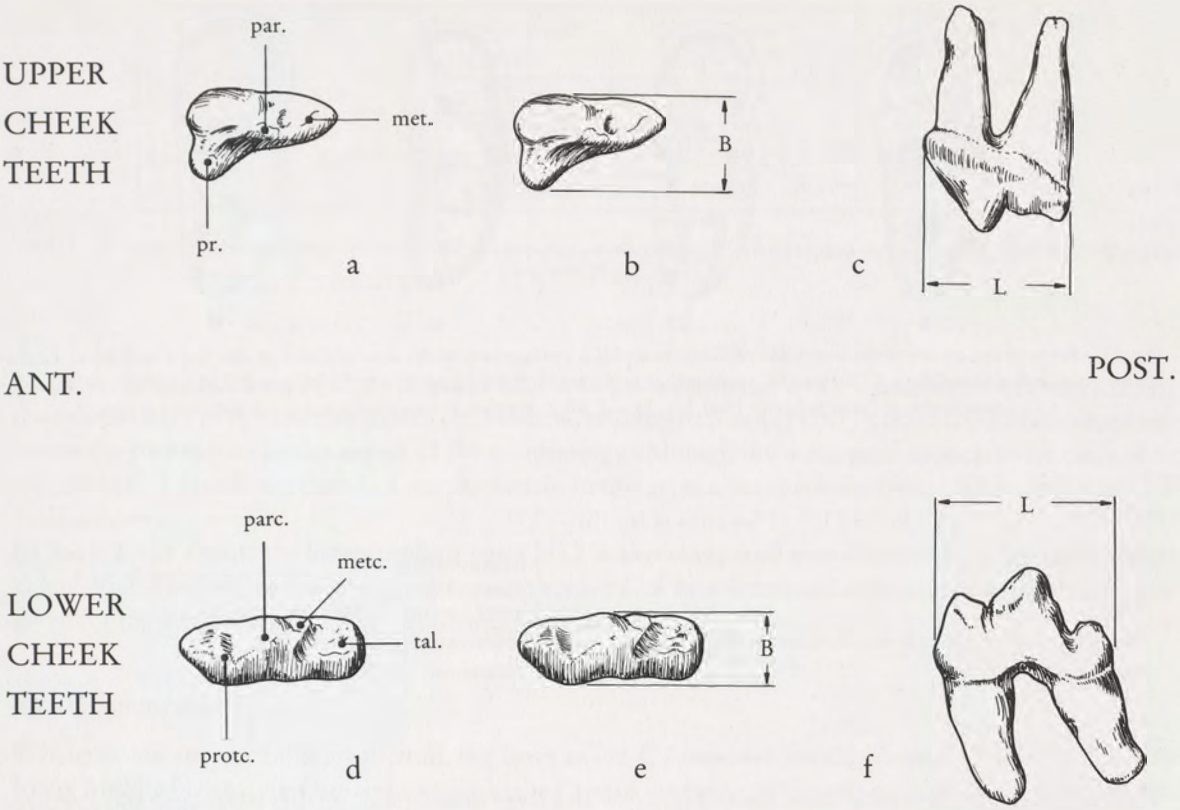


Fig. 22 Terminology used in the text to describe the upper and lower cheek teeth of the *Carnivora* and the measurements taken, using an upper P4 (a-c) and lower M1 (d-f) as examples (not drawn to scale).
Upper cheek teeth (P4). – a occlusal view. par.: paracone; pr.: protocone; met.: metacone. – b B breadth of tooth (occlusal view, measured at the base of crown). – c L length of tooth (buccal view, measured at base of crown).
Lower cheek teeth (M1). – d occlusal view. parc.: paraconid; metc.: metaconid; protc.: protoconid; tal.: talonid. – e (occlusal view) and f (buccal view) as b and c above.

ridges of the protoconid and paraconid; the metaconid is generally reduced. The distal part of the tooth, the talonid, is a low, crushing area (Fig. 22) (Hillson, 1986).

Post-cranial bone
The form of the humerus is typical of this family, having spreading distal condyles and the presence of a *Foramen supratrochleare* (Schmid, 1972).

A distinction between the various genera of this family is generally based on size of both the dentition and post-cranial bone. Further morphological details are given where relevant in the texts.

Genus *CANIS* (Linnaeus, 1758)

CANIS LUPUS MOSBACHENSIS
(Soergel, 1925)
Extinct wolf

Plate 20, a; Figure 23; Table 1.
Remains of this small canid have only been found at the Miesenheim I locality so far.

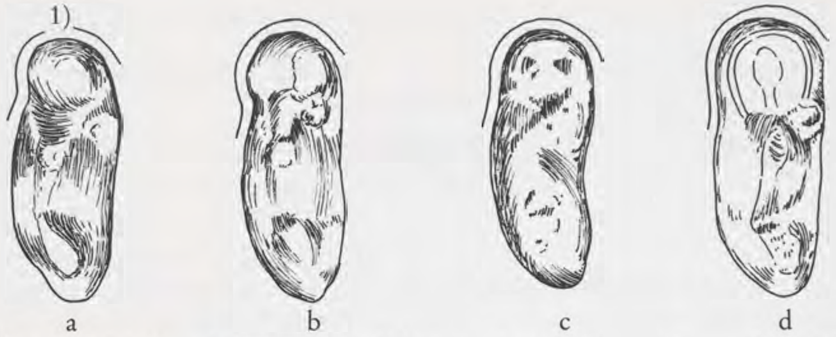


Fig. 23 Form of the crown of the lower M1 of *Canis* from Mi 2, comparison with those of *Cuon priscus* and *Canis lupus mosbachensis* (not drawn to scale): a *C. alpinus* Heppenloch (after Adam 1959, Fig. 4 no. 6). – b *C. Alpinus* Heppenloch (ibid., Fig. 5). – c C. *l. mosbachensis* (after Schaefer 1969, Fig. 2). – d Mi 2. 1. refers to morphological detail discussed in text.

Material

– MIESENHEIM I

Mi 2
An upper canine s/d; a lower first molar sin.;
a calcaneum sin.

Measurements

Upper canine: Length 33.7
Breadth at edge of crown 7.0
Calcaneum: Greatest length 48.6

Description

The lower M1 has the typical canid form (Fig. 22) with a large protoconid, smaller paraconid and a projecting metaconid on the lingual side. The pulpa of the talonid has been revealed, perhaps due to caries (Plate 20, a iii).

The tooth is too large to belong to fox (Genera: *Vulpes*; *Alopex*), but is smaller than the lower first molars of *Canis lupus* from Ariendorf and Andernach (Table 2). The tooth compares in size with those of the small, extinct wolf *Canis lupus mosbachensis* and the dhole (genus *Cuon*) (Table 1).

The wolf and the dhole can be distinguished by the dhole-like reduction of the lower first molar. The talonid of this tooth possesses a single cusp in *Cuon*, the talonid of *Canis lupus* has two. Unfortunately this characteristic has been obliterated on the specimen from the Mi 2 assemblage. Fig. 23 compares crown outlines of the lower M1 of *Canis lupus mosbachensis* from Süssenborn and the fossil *Cuon alpinus* from Heppenloch with the specimen from Mi 2. The talonid of the molars of *Cuon alpinus* are rounded and there is a distinct »waisting« between talonid and the anterior part of the tooth (Fig. 23a and b). The talonid of the molar of *Canis lupus mosbachensis* is not as rounded, presumably due to its possessing two cusps, and does not have the »waisting« characteristic of the teeth of *Cuon alpinus* (Fig. 23c). The specimen from Mi 2 resembles, in this aspect, the molar from *Canis lupus mosbachensis* (Fig. 23d).

Discussion

The taxonomy of the small, extinct wolf *C. l. mosbachensis* is confusing. Torre (1974), considers *C. l. mosbachensis* to be a subspecies, intermediate between *Canis lupus* and the Lower Pleistocene form *Canis etruscus*.

Bonifay (1971), considers that *C. l. mosbachensis* is a synonym for *C. etruscus*, and sees a continuous evolution from *C. etruscus* to the larger forms of *Canis lupus* found during the Saalian and Weichselian. Bonifay (*ibid.*), has also described an intermediate form, *Canis lupus lunellensis*, from a fauna at the site of Lunel-Viel, France, which has been dated to the Holstein Interglacial. *C. l. lunellensis* was small in size, but has the same dental morphology as the recent wolf. According to Bonifay (*ibid.*), *C. l. lunellensis* is the first representative of the true wolves in Europe. Due to the lack of morphological characteristics on the talo-

	Mi 2	*C.l. mosbachensis** (Mosbach)	*C.l. lunellensis*** (Lunel-Viel)	*Cuon priscus****
Length	23.0	22.4 - 24.7 x = 23.55	23.8 - 27.4 x = 25.6	23.3 –
Breadth	8.8	9.5 - 10.0 x = 9.75	9.0 - 10.6 x = 9.8	9.8 –

Table 1 Measurements of the lower M1 from Mi 2 and comparison with those of other Pleistocene canids. * Mottl, 1941;** Bonifay, 1971; *** Thenius, 1954.

nid of the lower M1 from Mi 2, a comparison as to *C. l. mosbachensis* or *C. l. lunellensis* was restricted to the morphology of the anterior part of the tooth. According to Bonifay (1971), there is little difference between the two species in this aspect of the morphology although the metaconid appears to be more prominent in *C. l. lunellensis* than *C. l. mosbachensis*. In this aspect, the specimen from Mi 2 is similar to *C. l. mosbachensis*.

In Table 1, the size of the lower molar 1 from Mi 2 is also compared with those of *C. l. lunellensis* from Lunel-Viel. The Mi 2 specimen is smaller than those of *C. l. lunellensis* and compares with the mean value given for the length of the *C. l. mosbachensis* specimens.

Stratigraphic range

Whatever the status of this small wolf, the form called *C.l.mosbachensis* has been recorded from many lower Middle Pleistocene faunas. It occurs in the Cromerian fauna of West Runton (Bishop, 1982), and its occurrence at the type-site of Mosbach (Soergel, 1925), indicates that it was present in West Germany at the end of the Cromer complex/beginning of the Elsterian. According to Bonifay (1971), the first appearance of true wolves occurred during the Holstein Interglacial and *C. l. mosbachensis* appears to have been replaced by these towards the end of the Cromer complex or during the Elsterian. The presence of *C.l.mosbachensis* in the Mi 2 assemblage indicates a pre-Holsteinian age for this fauna. The deposits in which the Mi 2 fauna is located have been correlated with the Holsteinian or with an interglacial at the end of the Cromer complex. The presence of *C.l.mosbachensis* in this assemblage suggests that the latter may be correct.

Palaeoecology

See *Canis lupus* (below).

CANIS LUPUS

(Linnaeus, 1758)
Wolf

Plate 20, b; Table 2; Appendix III.
This species occurs in several assemblages at localities in the Neuwied Basin region.

Material

– ARIENDORF

Ar 1
A mandible dex. with lower P2 - M2.
A minimum of one individual is represented.

Ar 2
Fragments of the lower cheek tooth rows sin. and dex. The lower M1 sin. is the only complete tooth preserved.
A minimum of one individual is represented.

	Ar 1	Ar 2	Andernach	Recent**
Length	(28.0)	28.0	30.0	27.2-31.0 x = 29.1
Breadth	11.0	11.2	12.0	–

Table 2 Measurements of the lower M1 (carnassial) of *Canis lupus* from Ariendorf and Andernach and comparison with recent specimens. – ** Bonifay, 1971.

– SCHWEINSKOPF

Sk 4
An upper canine dex.; an axis vertebra; a cervical vertebra; distal end of a humerus sin.; distal end of a tibia s/d.
A minimum of one individual is represented.

– WANNEN

Wa 3
Fragment of a cervical vertebra.
A minimum of one individual is represented.

– GÖNNERSDORF

The remains of at least two individuals of wolf have been identified by Poplin (1976, page 4). A further description of this material is not given here.

– ANDERNACH

A mandible sin.
A minimum of one individual is represented. The specimen has been identified and published by Poplin (in Bosinski & Hahn, 1972) and the measurements of the lower M1 are given here as a comparison with the material from Ariendorf.
It is not certain whether this specimen is from the An 1 or An 2 assemblage.

Description

The dentition has the typical canid morphology as described in the basic identification (Fig. 22). The lower first molars and the post-cranial bones compare in both size and morphology with recent specimens of *Canis lupus.*

Discussion

The evolution of *Canis lupus* has been discussed in the preceeding section (see *C. l. mosbachensis*). The lower M1s from Ar 1, Ar 2 and Andernach are all larger than the specimen from Mi 2, identified as *C. l. mosbachensis*, and the lower M1 of *C. l. lunellensis* from the site of Lunel-Viel (Table 2).
According to Bonifay (1971; in Lavocet (ed), 1966), the lower M1 of *Canis lupus* increases in length during the Saalian and Weichselian, attaining a length of about 30.0 mm. in the Weichselian. The lower M1 from the Late Weichselian assemblage at Andernach is 30.0 mm. in length (Table 2), and thus represents, according to Bonifay, an animal typical of those occurring during the Weichselian. The specimens from the Ariendorf assemblages, thought to date to the Saalian, are both 28.0 mm. in length. Bonifay (ibid) gives a length of 28.0 mm. as being typical of the lower M1s of wolves present in faunas dating to the Saalian. On the one hand, the three lower M1s from the Neuwied Basin assemblages support Bonifays' interpretation. However, as can be seen in Table 2, the length of the lower M1 of both »Saalian« and »Weichselian« forms fall into the size-variation given by the recent animals alone and it is probably pertinant not to attach too much stratigraphical importance to the three specimens from the Neuwied Basin assemblages.

Stratigraphic range

According to Bonifay (1971), the first known occurrence of the true wolf is during the Holsteinian. The species still exists today. *Canis lupus* occurs at Ariendorf in assemblages dated to the Third and Second Cold Stages BP, which in turn have been correlated with an older and a younger phase of the Saalian respectively. This species also occurs in the Late Weichselian assemblages at Andernach and Gönnersdorf. The occurrence of *Canis lupus* in the Neuwied Basin assemblages falls within the known stratigraphic range of this species in North-West Europe.

Palaeoecology

The present-day habitat of this species is the result of interference by man. It is ubiquitous, and originally occupied most of the Palaearctic and Nearctic, extending into the tundra, but avoiding deserts (Stuart, 1982). *Canis lupus* is known to have occurred in both cold and warm stage faunas during the Pleistocene, and inhabits woods, open country with cover and mountainous regions today (v. d. Brink, 1967).
Canis lupus occurs at Miesenheim I (*C. l. mosbachensis*) in a fauna associated with a open birch and pine woodland at the end of an interglacial phase. At Ar 1 and 2 it occurs in assemblages located in cold stage deposits, in association with a predominantly open steppe or steppe-tundra environment. At Gönnersdorf, this species occurs in an assemblage dating to the end of the Bölling Interstadial, in association with an open steppe environment.

CANIS **sp.**

unidentifiable canid

The remains of a small, unidentifiable canid have been found at Ariendorf.

Material

– ARIENDORF

Ar 1
Fragment of a sacrum.
A minimum of one individual is represented.

Description

The sacrum fragment is smaller than that of the recent wolf *C. lupus* and was not further identifiable.

Genus *VULPES* (Frisch, 1775)
Genus *ALOPEX* (Kaup, 1829)

The remains of foxes (genera *Vulpes* and *Alopex*) have been recovered from the assemblages at Schweinskopf, Tönchesberg, Hummerich and Andernach.

Basic identification

Mandible and dentition

The lower mandibles of fox can be distinguished from those of the larger canids by their small size and slender form. The lower dentition is of typical canid form.

Identification *Vulpes* or *Alopex*

Several methods of distinguishing between the genera *Vulpes* and *Alopex* have been proposed by authors such as Koby (1959) and Arambourg (1958). Poplin (1976), gives a detailed review of these methods. Those characteristics referred to here are restricted to the ones relevant for the sparse material from the Neuwied Basin assemblages.

1) Generally the genus *Alopex* is smaller in size than the genus *Vulpes*.
2) The mandibles of *Vulpes* are more elongated than those of *Alopex*. The short mandible of *Alopex* results in crowding of the lower cheek teeth in the jaw.
3) The morphology of the anterior cusps of the lower M2 is considered to be an important characteristic. In *Alopex* the cusps are placed next to each other and the buccal cusp is more prominent than the lingual one. In *Vulpes*, the cusps are slightly out of line and the lingual cusp is more prominent (Hagmann, 1898).
4) The talonid of the lower M1 of *Alopex* possesses two cusps. The talonid of *Vulpes* is tricuspid (Bonifay, 1971).
5) The lower M2 of *Vulpes* is larger in size than that of *Alopex* (Koby, 1959).

On the basis of these characteristics, the material from the Neuwied Basin assemblages could be separated into the genera *Vulpes* and *Alopex*. Poplin (1976), has already identified both genera amongst the Gönnersdorf material.

VULPES VULPES
(Linnaeus, 1758)
Red fox

Table 3.
The remains of red fox have been identified at Tönchesberg and Gönnersdorf.

Material

– TÖNCHESBERG

Tö 2
Mandible sin. with lower P1 - P4 and M1 - M2, and fragment of mandible dex. with C1 and P2.
A single, adult individual is represented.

– GÖNNERSDORF

The material has been described and published by Poplin (1976).
A minimum of one individual is represented.

Description

The Tönchesberg specimen is not complete. The lower P1 is missing on the right (dex.) side of the jaw, and the closed alveola shows that this tooth was apparently lost during the animals life-time. The mandible is broken in the region of the lower P3. On the left (sin.) side, the mandible has been broken recently behind the lower M2. There is a long gap between the lower P2 and P3, not seen on the recent comparative material.

In Table 3 the measurements of the mandible and the lower M1 and M2 of the specimen from Tö 2 and Gönnersdorf are given. The length of the lower M1 from both the fossil specimens falls into the range of the recent material.

Stratigraphic range

The first known occurrence of *Vulpes vulpes* in North-West Europe is in faunas dating to the Saalian (Bonifay, 1971). This species still exists, and forms part of the natural fauna of the Neuwied Basin today. *Vulpes vulpes* occurs at the Tönchesberg in an assemblage dating either to the Last Interglacial or an interstadial at the beginning of the Last Cold Stage BP, which in turn have been correlated with the Eemian and

Weichselian respectively. This species also occurs in a Late Weichselian assemblage at Gönnersdorf. Its occurrence in the Neuwied Basin assemblages falls within the known stratigraphic range for this species in.

Palaeoecology

Vulpes vulpes is known to have occurred in both cold stage and warm stage faunal assemblages during the Pleistocene. Its habitat today is variable, ranging from dry country, near scrub or woodland to forest and semi-open land (v. d. Brink, 1967; Weniger, 1982).

This species occurs at the Tönchesberg in warm stage deposits (interglacial or interstadial), in association with an open environment with some coniferous woodland. At Gönnersdorf, *Vulpes vulpes* is recorded from an assemblage dating to the end of the Bölling Interstadial, in association with the opening up of the wooded environment associated with the interstadial and the encroachment of the steppe conditions of the Older Dryas Stadial.

ALOPEX LAGOPUS

(Linnaeus, 1758)
Arctic fox

Table 3.

The remains of *Alopex lagopus* have been identified in assemblages at the Schweinskopf, Hummerich and Gönnersdorf localities.

Material

– SCHWEINSKOPF

Sk 2
Mandible dex. with lower C1, P1 -P4 and M1; mandible sin. with lower P4, M1 and M2. The mandibles are from the same, adult individual.

Sk 4
A lower C1 sin.; fragment of a mandible sin. with lower P2 and P3.
A minimum of one individual is represented.

– HUMMERICH

Hu 5
Mandible fragment dex. with lower P2, P4 and M1 - 3.
A minimum of one individual is represented.

– GÖNNERSDORF

The remains of at least thirty individuals have been identified and published by Poplin (1976).

Description and Discussion

The lower cheek teeth in the mandibles from Hu 5 and Sk 2 are crowded together as is typical for this species. The lower M1 and M2 from Hu 5 are smaller than the Sk 2 specimens. The length of the lower M1 from the Hu 5 specimen is comparable with those of *Alopex spitzbergensis* a small, extant, insular form (Table 3). The lower M1s from Gönnersdorf have a large range in size and compare, as Poplin has already stated (1976), with the living *A. lagopus*. The specimen from Sk 2 also compares with the living arctic fox (Table 3). The fossil *A. lagopus* appears to have a large variation in size, which could also be due to the small sample size.

Stratigraphic range

The first known occurrence of *Alopex lagopus* in North-West Europe is in faunas dating to the Saalian. This species still exists today.

Alopex lagopus occurs at the Schweinskopf in assemblages thought to date to the Second Cold Stage BP,

		Alopex lagopus			*Vulpes vulpes*	
		Sk 2	Hu 5	Gönnersdorf[1]	Tö 2	Gönnersdorf[1]
Height of mandible below M1		(14.3)	14.0	12.0-14.0 n = 23	16.4	12.7
M1	Length	14.2	13.3	13.0-15.1	14.0	15.5
	Breadth	5.7	(4.3)	4.7-5.8	5.4	6.4
M2	Length	6.2	4.9	5.4-6.5	7.3	6.9
	Breadth	4.2	3.9	3.6-4.4	5.3	6.0

		recent[2]		
		A. spitzbergensis	*Alopex lagopus*	*Vulpes vulpes*
M1	Length	12.6-13.2	13.8-15.4	13.4-16.8
	Breadth	4.4-5.0	4.6-5.2	4.8-6.0

Table 3 Size of the mandible and lower M1 and M2 of *Vulpes vulpes* and *Alopex lagopus* from localities in the Neuwied Basin and from recent specimens. – [1]After Poplin, 1976; [2]after Bonifay, 1971.

which in turn has been correlated with a younger phase of the Saalian. At the Hummerich, *Alopex lagopus* has been recorded in an assemblage dating to the beginning of the Last Cold Stage BP, which has been correlated with the Weichselian. This species also occurs at the Late Weichselian locality of Gönnersdorf. Its occurrence in the Neuwied Basin assemblages falls within the known stratigraphic range of this species in Europe.

Palaeoecology

Alopex lagopus appears to have been restricted to cold stage faunas in North-West Europe. This species is restricted today to arctic regions (v. d. Brink, 1967), where it inhabits tundra and boreal forest (Stuart, 1982).

This species occurs in assemblages located in cold stage deposits, such as Sk 2 and Sk 4; it also occurs in a reworked (soliflucted) cold stage deposit at the Hummerich (Hu 5). *A. lagopus* also occurs at the end of the Bölling Interstadial at Gönnersdorf.

Family *URSIDAE*

Genus *URSUS* (Linnaeus, 1758)

Basic identification

Dentition

The cheek teeth are bunodont; the upper M2 has two main buccal cusps (paracone and metacone) (Fig. 22).

Post-cranial bone

The epiphyses of the bones are large in relation to the size of the diaphyses and are more robust than those of carnivores of similar body-size, such as the large felids.

URSUS cf. *DENINGERI*
(von Reichenau, 1906)
Extinct bear

Plate 20,c; Table 4.
The remains of the bear *Ursus deningeri* have been provisionally identified from the Miesenheim I locality.

Material

– MIESENHEIM I

Mi 2
An upper second molar sin.; fragment of a lower third molar sin.; proximal end of a metacarpus I sin.; fragment of a metacarpus or tarsus; a second phalange; an os penis.

Measurements

Lower M3	Metacarpus I
Length: 24.0	Greatest breadth of proximal end: 21.9
Breadth: 19.0	Breadth of diaphysis: 11.7

A minimum of one adult individual is represented.

Description

The upper M2 is bunodont and is of the typical *Ursus* form with two main buccal cusps (metacone and paracone) and a third smaller cusp behind these. The tooth is small in size and, when viewed from above, slender in form. The occlusal surface of the talon is flat and there is no evidence of the mass of tubercules often seen on the teeth of some species of bear. The talon of the tooth is not particularly well-developed and is marked only by a small indentation behind the metacone. A low, short cingulum is located lingually below the protocone (Plate 20, c ii).

Post-cranial bone

Little could be said about this fragmentary material. The metacarpus I is slender when compared with the specimen from Wannen, identified as belonging to Ursus spelaeus (see page 216).

Discussion

Due to the large variation in size and morphology of the dentition even within a single species of *Ursus*, it is very difficult to identify such a small amount of material, particularly when only one complete tooth has been preserved.

The Early Pleistocene form, *Ursus etruscus*, can be excluded because of its small tooth-size. The cave bear *Ursus spelaeus*, can probably be excluded here on the basis of tooth-size (Table 4). The upper M2 of *U. spelaeus* is usually characterized by a mass of tubercules on the talonid, which are not present on the specimen from Mi 2.

The Mi 2 specimen is larger than the ranges given for the brown bear *Ursus arctos*, and compares in size with the lower Middle Pleistocene species *Ursus deningeri*, represented by two subspecies *Ursus deningeri deningeri* and *Ursus deningeri savini* (Table 4). The morphology of the Mi 2 specimen with weakly-defined talon without tubercules and a small lingual cingulum, is, however, characteristic of both *U. deningeri* and *U. arctos* (v. Reichenau, 1904; Rode, 1941).

However, because of the similarity in size between the Mi 2 specimen and those of *U. deningeri*, the remains of bear from Mi 2 have been tentatively identified as belonging to *Ursus* cf. *deningeri*.

	Mi 2	*U. d. deningeri*[2]	*U. d. savini*[1]	U. spelaeus[1]	*U. arctos*[1]
Length	40.0	37.0 - 50.0 x = 41.9	34.0 - 45.0 x = 39.1	40.3 - 54.2 x = 45.1	29.5 - 39.5 x = 34.0
Breadth	18.5	19.0 - 24.5 x = 21.6	18.5 - 22.1 x = 20.3	– x = 22.6	– x = 17.4

Table 4 Length and breadth of the upper M2 from Mi 2 and comparison with those of other Pleistocene species of *Ursus*. – [1]Taken from Bishop, 1982, 38 table 10 (after Schütt, 1968); [2]taken from v. Reichenau, 1906, 243 table A1.

Stratigraphic range

It is unfortunate that the bear material from Mi 2 is so sparse, as a definite identification as to species would be stratigraphically important for this assemblage. *U. deningeri* is, according to most authors, an intermediate form between the Early Pleistocene *U. etruscus* and the upper Middle Pleistocene *U. spelaeus* (Bishop, 1982; Bonifay, 1971). *U. deningeri*, has been recorded from the Cromer Forest Bed in England, but cannot be more closely defined stratigraphically within this formation (Bishop, 1982). *U. deningeri* has also been recorded in faunas from several lower Middle Pleistocene localities in Europe, such as Mosbach, where the subspecies *U. d. deningeri* has been identified (Kurtén, 1969), and Hundsheim, where the subspecies *U. d. savini* occurs (*ibid.*). The first known occurrence of *U. spelaeus* is during the Holsteinian (*ibid.*), and the last appearance of forms resembling *U. deningeri* must have been during the Elsterian.
The Mi 2 deposits have been correlated with the Holsteinian Interglacial or an interglacial at the end of the Cromer complex. If the identification of the *Ursus* remains are correct, then the known stratigraphic range of *Ursus deningeri* indicates that the Mi 2 assemblage is older than the Holsteinian.

Palaeoecology

The palaeoecology of *Ursus deningeri* is not particularly well known. It has been recorded from interglacial faunas such as West Runton and Mosbach. This species occurs at the Miesenheim locality in an assemblage deposited towards the end of an interglacial in association with open birch and pine woodland.

URSUS SPELAEUS

(Rosenmüller, 1794)
Cave bear

Tables 5 and 6.
The remains of the cave bear, *Ursus spelaeus*, have been identified from Wannen and Ariendorf.

Material

– WANNEN

Wa 1 and 2
A mandible sin. a mandible dex. with lower M1 still in alveola; a lower M2 sin.; a lower M3 sin.; a lower C1 dex.; fragment of the distal end of a scapula sin.; fragments of the distal end of a humerus dex. and sin.; an ulna sin.; a radius dex.; a metacarpus 1 dex.; a metacarpus 2 dex.; distal fragment of a metacarpus (?); several carpal bones; two first phalanges.

Measurements:	Metacarpus 1	Metacarpus 2
Greatest length:	69.5	79.9
Greatest breadth of proximal end:	24.9	19.6
Breadth of diaphysis:	13.3	18.7
Greatest breadth of distal end:	20.6	24.8

Radius (Wa 1)
Greatest breadth of proximal end : 47.3

Phalanx 1 (Wa 1)	97/51,28	96/54,34
Greatest length	45.7	41.6
Breadth of diaphysis	8.9	17.0

A minimum of one individual is represented.

– ARIENDORF

Ar 3
A C1 dex. (length tip of root to tip of crown: 81.9 mm.); fragment of a C1 s/d.; cranium fragments (parietal, frontale and part of sagittal crest preserved).

A minimum of one individual is represented.

The cranium has been identified and published by F. Poplin (in Brunnacker et al., 1975). Its original location is not known, but the state of preservation of the fossil suggests that it belongs to the Ar 3 assemblage.

Description

The mandibles from Wa 1 belong to the same, very old individual. The left mandible is very fragmentary. It was possible to restore the extremely worn lower M3 in its alveola. The loose lower M2 probably belongs to this mandible. The alveola for the posterior root of the lower M2 is still open; the lower M1 is missing and the alveola is closed, which shows that this tooth was lost before the animal died. The alveola for the P4 is still open, but the tooth is missing.

The right mandible is more complete and the measurements given in Table 5 are taken from this specimen. The mandible is broken in the region of the canine and most of the mandibular hinge is missing. A very worn fragment of the lower M1 is still in its alveola; the tooth had been pushed out of the jaw presumably after deposition of the fossil. The alveolae of the lower M3 and M2 are closed, and were presumably lost when the animal was still alive. The alveola for the P4 is still open, but the tooth is missing. As with the left mandible, there is no evidence of P1 - 3 or of their alveolae.

Discussion

The mandibles from Wannen are large. The size of the right mandible, particularly the height of mandible below the P4 (Table 5), compares more with that of *U. spelaeus* than *U. arctos*. The lack of P1 - P3 is also characteristic of *U. spelaeus* (Bonifay, in Lavocet (ed.), 1966).

The metacarpus 1 from Wa 1 is slender, but both proximal and distal ends are robust as in *U. spelaeus.* The length of the ulna from Wa 1 compares more in its length with the specimen of *U. spelaeus* (Table 6).

The cranium from Ariendorf has already been described by F. Poplin (in Brunnacker et al., 1975) as possibly being from *U. spelaeus*. The cranium is badly preserved, but the frontal bone on the right side is domed, as is usual for this species (Bonifay, 1971; in Lavocet (ed.), 1966).

Stratigraphic range

Ursus spelaeus evolved from *Ursus deningeri* (see page 214) and appears for the first time as a distinct species in faunas dating to the Holsteinian Interglacial. *U. spelaeus* has been recorded from faunas dating to the Saalian, but was more common during the Weichselian. It became extinct sometime towards the end of the Weichselian (Bonifay, 1971; in Lavocet (ed.), 1966; Kurtén, 1968).

U. spelaeus occurs at Wannen in an assemblage dating to the Second Cold Stage BP, which in turn has been

	Wa 1	*U. spelaeus*[1]	*U. arctos*[1]
Height of mandible between M1 and M2	70.4	–	–
Heigth of mandible below P4	64.0*	41-78	32
Length P4 to M3	91.0*	111	85
Length of diastema	64.0*	–	–

Table 5 Size of the right mandible of *Ursus* from Wa1 and comparison with those of *Ursus spelaeus* and *Ursus arctos*. – * Measured on alveola; [1]after Bonifay (in Lavocet ed., 1966).

	Wa 1	*U. spelaeus*[1]	*U. arctos*[1]
Greatest length	352	360	335
Length of olecranon	70.7	–	–
Greatest breadth across coronoid process	61.8	–	–

Table 6 Size of the ulna of *Ursus* from Wa1 and comparison with those of *Ursus spelaeus* and *Ursus arctos*.– [1]After Bonifay (in Lavocet ed., 1966).

correlated with a younger Saalian phase. At Ariendorf this species occurs in an assemblage dating to the beginning of the Last Cold Stage BP, which has been correlated with the Weichselian. Both occurrences fall within the known stratigraphic range of this species in North-West Europe.

Palaeoecology

Ursus spelaeus is known to have occurred in both warm and cold stage faunas, but appears to have preferred a temperate, more oceanic climate (Kurtén, 1968). During the Late Pleistocene its geographical range was restricted to the more central latitudes of Europe. It only occasionally reached Southern England during this time and did not range too far south: for example, it has not been recorded from localities in Southern Italy or Southern Spain (Kurtén, 1968).

This species occurs in faunal assemblages at Wannen located in cold stage deposits. At Ariendorf, it occurs in an assemblage located in an interstadial soil in association with a cool, alternating dry and humid climate.

URSUS sp.

Unidentifiable bear

Material

– ARIENDORF

Ar 1

Distal fragment of metacarpus or metatarsus. The fragment was not identifiable.

Family *HYAENIDAE* (Gray, 1869)

Genus *CROCUTA* (Kaup 1828)

CROCUTA CROCUTA
(Erxleben, 1777)
Spotted hyaena

The remains of this species have only been recorded at the Hummerich to date. Only one post-cranial element has been identified, although the presence of a large carnivore had already been postulated, due to gnaw-marks found on the other fossils (bone and antlers) occurring at the site (Bosinski et al., 1986).

Material

– HUMMERICH

Hu 4
Proximal end of an ulna sin.

Measurements:
Depth across Processus anconaeus 45.5
Smallest depth of olecranon 40.2

A minimum of one individual is represented.

Description and Discussion

The specimen was originally enclosed in a loess concretion and therefore parts of the proximal articulation have been recently damaged. The tip of the short *Processus olecrani* is blunt as is typical for the canids and hyaenids (Schmid, 1972). The ulna is too large to belong to the canids, and the form of the olecranon, particularly the proximal edge, is characteristic of the hyaenids. The sloping caudal edge of the bone is typical of the genus *Crocuta*; in *Hyaena* the caudal edge runs parallel to the vertical axis of the bone.

Stratigraphic range

Crocuta crocuta originated in Asia (Bonifay, 1971; Kurtén, 1958), and appears to have entered Europe sometime during the Cromer complex. This species occurs in the Cromerian fauna of West Runton and at other lower Middle Pleistocene localities such as Süssenborn (G.D.R.) and Stranska Skala (Czechoslowakia). It was a common element of Middle and Late Pleistocene faunas and became extinct in Europe during the Weichselian (Kurtén, 1968). Its occurrence at the Hummerich, in an assemblage thought to date to the beginning of the Last Cold Stage BP, falls within the known stratigraphic range of this species in Europe.

Palaeoecology

Crocuta crocuta has been recorded from both warm and cold stage Pleistocene faunas. It is known to have occurred in warm stage faunas in association with forested conditions, but also in forests with locally open, herbaceous vegetation ,and presumably with open conditions during the cold stages(Stuart, 1982). Its present-day range is restricted to parts of Africa, where it inhabits savannas and semi-desert and appears to avoid heavily-forested areas (Stuart, 1982). Its one occurrence in the Neuwied Basin region is in an assemblage located in an interstadial soil.

Family *MUSTELIDAE* (Swainson, 1835)

Genus *MELES* (Brisson, 1762)

Basic identification

Dentition

Badger is distinguished from other mustelids by the size and morphology of the cheek teeth. The upper carnassial (P4) is triangular in form and has a short, stout main blade (paracone) and a subsidiary blade in the form of a cusp (Hillson, 1986). The upper first molar is very typical with its broad crown, three cusps on the buccal edge and rounded lingual edge. This tooth does not have the narrowing of the crown typical of the upper first molars of other mustelids.

Mandible

The mandible is straight; the upper and lower edges run parallel to each other. Typical for this species is the way in which the basal edge of the mandible rises sharply upwards towards the ascending ramus.

MELES MELES
(Linnaeus 1758)
Badger

Table 7.

Remains of badger *Meles meles* are known from Wannen. A mandible fragment from Niederbieber, described as belonging to *Meles meles* (Loftus, R. 1984), could no longer be found for this study.

Material

– Wannen

W3

Upper cheek tooth row consisting of upper P3, P4 and M1 dex.

Measurements:

P3	Length: 5.4	M1	Length: 12.1
	Breadth: 3.5		Breadth: 9.9

A minimum of one individual is represented.

Description

The maxillary bone is missing, the teeth have been held together by the formation of a chalk concretion around their roots. The upper P4 and M1 both show the characteristics of this species as described in the basic identification.

	Wa 3	*M. thoralis*[1]	*Meles meles*[2]
Length	7.4	10.6	8.4
Breadth	6.3	8.5	7.7

Table 7 Length and breadth of the upper P4 of *Meles meles* from Wa3 and comparison with those of *M. thoralis* and recent *M. meles*.– [1]After Bonifay, 1971, 326 table 101 (QSV 1); [2]after Hugueney, 1975.

Discussion

A distinction between the recent *Meles meles* and fossil forms such as the Early and Middle Pleistocene *Meles thoralis* and *Meles thoralis spelaeus* is based on the size and morphology of the dentition (Bonifay, 1971; Hugueney, 1975).

In the fossil forms the upper P4 is larger than those of the living species. The upper P4 from Wa 3 is smaller than that of *M. thoralis* (Table 7) and compares in size with that of *Meles meles*. The upper P4 of the recent *Meles meles* has a rounded posterior edge, a characteristic which also occurs on the specimen from Wa 3.

Stratigraphic range

The stratigraphic ranges of the fossil and recent forms of badger are not particularly well-known (Kurtén, 1968). *Meles meles* has been identified from the fauna at the locality of La Fage, France, possibly dating to the Saalian (Hugueney, 1975). The species still exists in Europe and forms part of the natural fauna of the Neuwied Basin region today.

Meles meles occurs at the Wannen locality in an assemblage thought to date to the Second Cold Stage BP, which in turn has been correlated with a younger phase of the Saalian. The occurrence of this species in the Neuwied Basin assemblages falls within its known stratigraphic range in Europe.

Palaeoecology

Badger inhabits mixed deciduous woodland with clearings in both lowlands and mountains (v. d. Brink, 1967). This species is rare in Pleistocene deposits; its present-day habitat and range (it is not found in the extreme north of Europe), suggests that it preferred a temperate environment (*ibid.*). Its presence at the Wannen, in an assemblage located in cold stage deposits, indicates that the assemblage may have been contaminated by material from other deposits (see page 341 for further discussion).

MELES sp.

Table 8.

Material

–MIESENHEIM I

Mi 2
A mandible sin.
A minimum of one individual is represented.

Description

The anterior part of the mandible from Mi 2 is broken in the region of the canine. The ascending ramus is broken at the base. A portion of the lingual edge in the region of the M1 is also missing. The lower cheek teeth are missing. The form of the mandible has all the characteristics given in the basic identification.

	Mi 2	*Meles* sp.[1]	*M.thoralis spelaeus*[1]	*Meles meles*[1]
Height of mandible in front of lower M1	15.9	15.9	13.6 - 13.8	–
Height of mandible below lower M1	17.4	–	–	15.2 - 15.5
Height of mandible behind lower M1	15.5	–	–	15.0 - 16.0

Table 8 Size of the mandible in several species of *Meles*. – [1]After Bonifay, 1971; [2]after Hugueney, 1975.

Discussion

Bonifay (1971, page 326), describes a mandible from *M. thoralis spelaeus* from the Lunel-Viel locality, southern France. The lower P2 and P3 are both placed oblique to the axis of the jaw and the lower P4 is placed parallel to the axis of the jaw on this specimen. On the Mi 2 specimen, only the alveola of the lower P2 is placed oblique to the axis of the jaw, the lower P3 and P4 are both placed parallel to the axis of the jaw.
The Mi 2 mandible compares in size with that of the mandible from *Meles* sp. found at the locality of l'Escale (France) and is larger than *M. thoralis spelaeus*. In comparison to the recent form, the Mi 2 specimen is higher below the first molar, but falls into the size-range in the height of mandible behind molar 1 (Table 8).
The Mi 2 mandible compares in size with both the recent and some fossil forms of *Meles*. In morphology, it is similar to the recent *Meles meles*. A further identification was not possible and the specimen has been therefore described as *Meles* sp.
The occurrence of badger in the Mi 2 assemblage is consistent with the usual habitat of this genus. The Mi 2 assemblage is associated with open birch and pine woodland at the end of an interglacial.

Family *FELIDAE* (Gray, 1821)

Genus *FELIS* (Linnaeus, 1758)

Basic identification

Dentition
The secodont dentition of the genus *Felis* is characterized by the reduction of the molars. For example, the lower first molar (carnassial) has a single continuous blade, with a »nick« in the middle (Hillson, 1986). The metaconid is missing and the talonid is hardly developed.

Post-cranial bone
The post-cranial bone was identified following those characteristics given by Schmid (1972). Typical of the *Felidae* is the presence of a *Foramen supracondylicum* close to the distal end of the humerus (Schmid, *ibid.*). A further definition to species is based mainly on size.

FELIS (LYNX) LYNX
(Linnaeus 1758)
Lynx

Table 9.
Lynx occurs only at two localities, the Tönchesberg and Andernach to date.

	Tö2	*Felis (Lynx) spelaea*[1]		*Felis (Lynx) lynx*[1]	*Felis (Lynx) pardina*[1]
		L'Escale	Grimaldi	recent	recent
Length	19.4	16.4 - 18.1	17.0 - 18.0	18.6 - 19.4	14.0 - 16.0

Table 9 Length of the upper P4 from Tö2 and comparison with those of several species of *Lynx*.– [1]After Bonifay 1971.

Material

– TÖNCHESBERG

Tö 2
A lower canine dex.; fragment of a lower first molar sin.; an
upper P4 sin. and an upper P3 sin.

Measurements:

P3: Length 12.7	Breadth 7.7
P4: Length 19.4	Breadth 10.1

A minimum of one individual is represented.

– ANDERNACH

A mandible fragment with lower dentition. The specimen has been identified by Poplin (in Bosinski & Hahn, 1972), but it is not sure whether this find belongs to the An 1 or An 2 assemblage. The specimen was not seen during the course of this study.

Description

The open roots of the canine and molars from Tö 2 indicate that the material is from a young individual. The canine is short and robust. The upper P3 is fairly large and has a single, high cusp (protocone) flanked by a smaller second cusp and a third cusp in the form of a cingulum (metastyle). A cingulum is also present anteriorly on the lingual side.

The upper P4 is typical of this species and has a single large cusp (paracone), flanked on the buccal side by an elongated parastyle, lingually by a low protocone and posteriorly by a flat, elongated metacone. There is no distinct waisting of the talon part of the tooth. The size of the cheek teeth and their morphology is typical of lynx.

Discussion

Three species of lynx occurred during the Middle and Late Pleistocene, the extinct *Felis (Lynx) spelaea*, and those forms still existing today, the Northern lynx *Felis (Lynx) lynx* and the Pardell lynx *Felis (Lynx) pardina* (Bonifay, 1971; Kurtén, 1968). These forms differ in their body-size, the Northern lynx being the largest, and morphological characteristics of the dentition, the recent Pardell Lynx and the extinct *F. (L.) spelaea* both have a more secodont dentition than *F. (L.) lynx* (Bonifay, 1971).

Table 9 compares the length of the upper P4 from Tö 2 with those of *Felis (lynx) spelaea* from the localities of L'Escale (Middle Pleistocene) and Grimaldi (Late Pleistocene) and the recent forms. The specimen from Tö 2 compares more in size with the upper P4 of the recent *F.(L.) lynx* than the other species. Morphologically, the teeth appear to be less secodont than those of the extinct *F. spelaea* as figured in Bonifay (1971, Fig. 62).

Thus, the specimens from Tö 2 are described as belonging to *Felis (Lynx) lynx*. Poplin (in Bosinski & Hahn, 1972), also described the mandible from Andernach as probably belonging to this species.

Stratigraphic range

Felis (Lynx) lynx appeared late in Europe (Bonifay, 1971; Kurtén, 1968). The earliest known occurrence of this species is at the locality of Taubach (D.D.R.), in a fauna dating to the Eemian. This species still exists in Europe today.

Felis (L.) lynx occurs at the Tönchesberg in an assemblage thought to date to the end of the Last Interglacial or an interstadial at the beginning of the Last Cold Stage BP, which in turn have been correlated with the Eemian and Weichselian respectively. It is also present at the late Weichselian locality of Andernach. Its occurrence in the Neuwied Basin falls within the known stratigraphic range of this species in Europe.

Palaeoecology

Felis (Lynx) lynx is restricted today to parts of Scandinavia and eastern Europe. It is known to have occurred during the Pleistocene in warm stage faunas, such as the one from Taubach.

During the Weichselian it appears to have had a larger range than its present one, being occasionally found at localities dating to this period in southern France (Bonifay, 1971) and Italy and Greece (Kurtén, 1968). Its dependance on woodland for its habitat explains its absence at sites where open steppe conditions predominated (Kurtén, 1968). Its present distribution in montane regions is probably the result of interference by man.

This species occurs at the Tönchesberg in deposits indicative of warm conditions in association with a molluscan fauna indicating an open environment and a warm climate. Its occurrence at Andernach has not been stratigraphically defined and it could therefore belong to either the Bölling Interstadial or the Alleröd Interstadial assemblage at this locality.

Genus *PANTHERA* (Oken, 1816)

PANTHERA LEO cf. *SPELAEA*
(Goldfuss, 1832)
Extinct lion

Tables 10 and 11.

Remains of extinct lion have been identified at several localities, including Ariendorf, Wannen, Schweinskopf and Hummerich.

Material

–SCHWEINSKOPF

Sk 4

Distal end of a humerus dex.

A minimum of one individual is represented.

– WANNEN

Wa 1 and 2

A mandible sin. and dex.; maxillary fragment with canine sin.; fragment of a pelvis dex.

The mandibles belong to the same, very old, individual; the maxillary fragment probably belongs to this individual too.

A minimum of one individual is represented.

Wa 4/5

Fragment of a humerus sin.

A minimum of one individual is represented.

Wa Pr III

Distal end of a humerus sin.

A minimum of one individual is represented.

– HUMMERICH

Hu 4

An upper canine s/d from a young adult; distal end of a humerus dex.

Measurements:
Canine:
Greatest length: (113.9)
Breadth at base of crown: 36.1
A minimum of one individual is represented.

Hu unstratified

A metatarsus IV dex.

Measurements:
Greatest length: 143.6
Greatest breadth of the proximal end: 31.2
Greatest breadth of the distal end: 23.8
The specimen was recovered from the fill of a burrow in Hu 4 (see page 183).

	Wa 1/2	*P. leo fossilis* Mosbach[1]	*P. leo spelaea* Gailenreuth[2]	 Steeden[3]
Length of cheek tooth row	78.6	75.0 - 80.0	72.3 - 82.0 x = 77.15	74.0 - 75.0
Height of jaw before P3	60.0	43.0 - 53.0	51.0 - 61.8 x = 56.4	
Height of jaw behind M1	67.7	50.0 - 67.0	56.3 - 62.0 x = 59.15	

Table 10 Size of mandible and length of lower cheek tooth row of fossil lion from Wa 1/2 and comparison with those of *Panthera leo fossilis* and *Panthera leo spelaea*. – [1]and [3] After v. Reichenau, 1906, 307; [2]after Dietrich, 1968, 350 Table 3.

	Wa Pr III	Sk 4	Hu 4	*P. leo spelaea* Gailenreuth[1]
Distal breadth	104.5	90.6	(100.5)	95.0

Table 11 Size of the distal humeri of fossil lion from localities in the Neuwied Basin and comparison with *P. leo spelaea*. – [1]After Dietrich, 1968, 351 Table 4.

Description

Both mandibles from Wa 1 and 2 are damaged, but the remains of the very worn stumps of the lower P3 and P4 and M1 are still present. The maxillary fragment consists of part of the premaxilla with the remains of a very worn canine sin. still in the alveola. The tooth may possibly have been broken during the life-time of the animal (pers. comm. Dr. Fejfar, 1988). The alveolae for the upper I3 and 4 are also present.

The mandibles are large, the basal edge is straight and the *Fossa masseter* begins under the posterior edge of the lower first molar, a characteristic typical for the felids. The presence of only P3, P4 and M1 is typical for the feline dentition. The pelvis is rather slender and elongated in form. The rim of the acetabulum is flat; in other large carnivores, such as bear (*Ursus*), the rim of the acetabulum is higher. The humeri have the typical felid characteristics as described in the basic identification. The phalanges are large in size and the profile of the bone is curved, as is usual for the felids (Bonifay, in Lavocet, 1966).

Discussion

The taxonomy of the extinct lion is not clear. Bonifay (1971), refers this species to the genus *Felis* and calls it *Felis spelaea*. According to Anderson & Jones (1984), the genus *Panthera* (Oken, 1816) is invalid, but still widely used for recent lions. The fossil lion is however referred here to *Panthera leo spelaea*, as this is the name still used by German palaeontologists.

Two types of extinct lion occurred in Europe during the Middle and Late Pleistocene, the lower Middle Pleistocene form, *Panthera leo fossilis* and the upper Middle and Late Pleistocene *Panthera leo spelaea* (Bishop, 1982). An identification as to one of these forms is based mainly on size; morphological differences do not appear to be known. For example, the mandible of *P. leo spelaea* is more robust than that of *P. leo fossilis*, although the length of the cheek tooth row is the same. Table 10 compares the size of the more complete mandible (dex.) from Wa 1/2 with those of *P. leo fossilis* from Mosbach and *P. leo spelaea* from the type-site of Gailenreuth (G.D.R.) and Steeden on the Lahn, the latter being a Late Weichselian locality located close to the study area.

The mandible from Wa 1/2 is from a large individual. It is larger than the specimens from Steeden, although, as can be seen in Table 10, the specimens of *P. l. spelaea* from Steeden appear to be from small individuals. The Wannen specimen compares with *P. leo spelaea* (height of jaw before lower P3) and *P. leo fossilis* (height of jaw behind lower M1).

Table 11 compares the distal breadth of the humeri from the Neuwied Basin assemblages with that of *P. leo spelaea* from Gailenreuth. The specimens from the Neuwied Basin assemblages are all different in size. The specimens from Wa Pr. III and Hu 4 are large and are larger than the specimen from Gailenreuth. The specimen from Sk 4 is smaller. The fragment from Wa 4/5, which could not be measured, also appeared to be small in size. Both the mandibles and the humeri show a large variation in size between assemblages and in comparison with other fossil examples. The material from the Neuwied Basin assemblages appears, in the majority of cases, to be comparable to that of *P. l. spelaea* in size and has therefore been described provisionally as belonging to this sub-species.

Stratigraphic range

The earliest known occurrence of *P. leo spelaea* in Europe is in faunas thought to date to the Holstein Interglacial, such as Lunel-Viel (southern France) (Bonifay, 1971), and Bilzingsleben (G.D.R.) (Toepfer, 1983). This species was more common at Late Pleistocene sites (Dietrich, 1968) and became extinct in Europe sometime during the Weichselian (Bonifay, 1971; Kurtén, 1968).

P. l. spelaea occurs at Schweinskopf and Wannen (Wa 1 and 2) in assemblages dating to the Second Cold Stage BP and at Wannen (Wa 4/5) to the Last Cold Stages BP, which in turn have been correlated with a younger phase of the Saalian and the Weichselian respectively. At Hummerich it is associated with an assemblage dating to the beginning of the Last Cold Stage BP. The occurrence of *P. l. spelaea* in the Neuwied Basin falls within the known stratigraphic range for this species in Europe.

At Gönnersdorf, an engraving of a lion on a slate slab was recovered. The remains of this animal have not been found at the site, and therefore this is not direct evidence that the lion was part of the fauna living at the time. The engravings of the larger mammals at Gönnersdorf are, however, so realistic that it is could be postulated that lions were still existing in the Neuwied Basin at about 12,500 BP.

Palaeoecology

P. l. spelaea is known to have occurred in both warm and cold stage faunas during the Pleistocene. This species occurs in assemblages located in cold stage deposits at Wannen and Schweinskopf. At Hummerich it occurs in an assemblage located in a soil formed possibly under interstadial conditions.

Lions inhabit open, lightly wooded areas today and are only rarely found in dense forested conditions (Stuart, 1982). Their presence is very much dependant on the presence of large herbivores which are their main source of prey.

***FELIS* sp.**

Unidentifiable large felid

Material

– ARIENDORF

Ar 1
A fragmentary second phalange.
A minimum of one individual is represented.

CHAPTER 6
ORDER PROBOSCIDEA

Family *ELEPHANTIDAE* (Gray, 1821)

Basic identification

Dentition

The dentition of the *Elephantidae* is characterized by two large tusks (incisors) and lophodont upper and lower cheek teeth. The cheek teeth have multiple enamel plates or »lamellae«, stacked against each other, joined at the base and invested with cement (Fig. 24). Although technically premolars and molars, all the cheek teeth are referred to here as molars. There appears to be no rule regarding the order in which the cheek teeth are further described. In this study, the first three molars are referred to as deciduous molars (dp) and the last three molars as permanent teeth (M).

Post-cranial bone

Post-cranial bone is rare or, if present, very fragmentary from the assemblages described here. Complete post-cranial finds from the *Elephantidae* are easily identified by their large size and morphology as given, for example, by Walker (1985).

Genus *ELEPHAS* (Linnaeus, 1758)

ELEPHAS ANTIQUUS

(Falconer & Cautley, 1845)
Straight-tusked elephant

Plate 21 A; Table 12 and 13.
Elephas antiquus has been recorded from the Kärlich locality.
This species is also referred to as *Palaeoloxodon antiquus* (Stuart, 1982). However, Maglio (1973), considers the diagnosis of *Palaeoloxodon* to be inadequate and refers this species to the genus *Elephas*. *Elephas antiquus* is also a synonym for *Elephas namadicus*, which Maglio (ibid) has shown to have preference. The name *Elephas antiquus* has been used here.

Basic identification

Dentition

The tusks are, as the English name for this species suggests, only slightly curved along their length. They are known to have attained a considerable length in adult individuals.
The upper and lower cheek teeth are high and narrow; the crown height being generally 50 - 150% greater than the width of the tooth (Maglio, 1973). The plates are broad and closely-spaced, there being between 12 and 19 plates on the third molars. The enamel of the plates is coarsely wrinkled and can be rather thick (1.0 - 3.5 mm., Maglio, 1973). The molars of this species also possess pointed median expansions on the plates, although this feature does not occur on every tooth (Fig. 24).
The occlusal surface is rectangular in shape. In the first stages of wear, the enamel of the plates on the occlusal surface have an oval central figure with circular lateral figures (described as median lamellar lateral annular, or med. lam. lat. ann. for short), becoming, with increasing wear, rhombic in form.

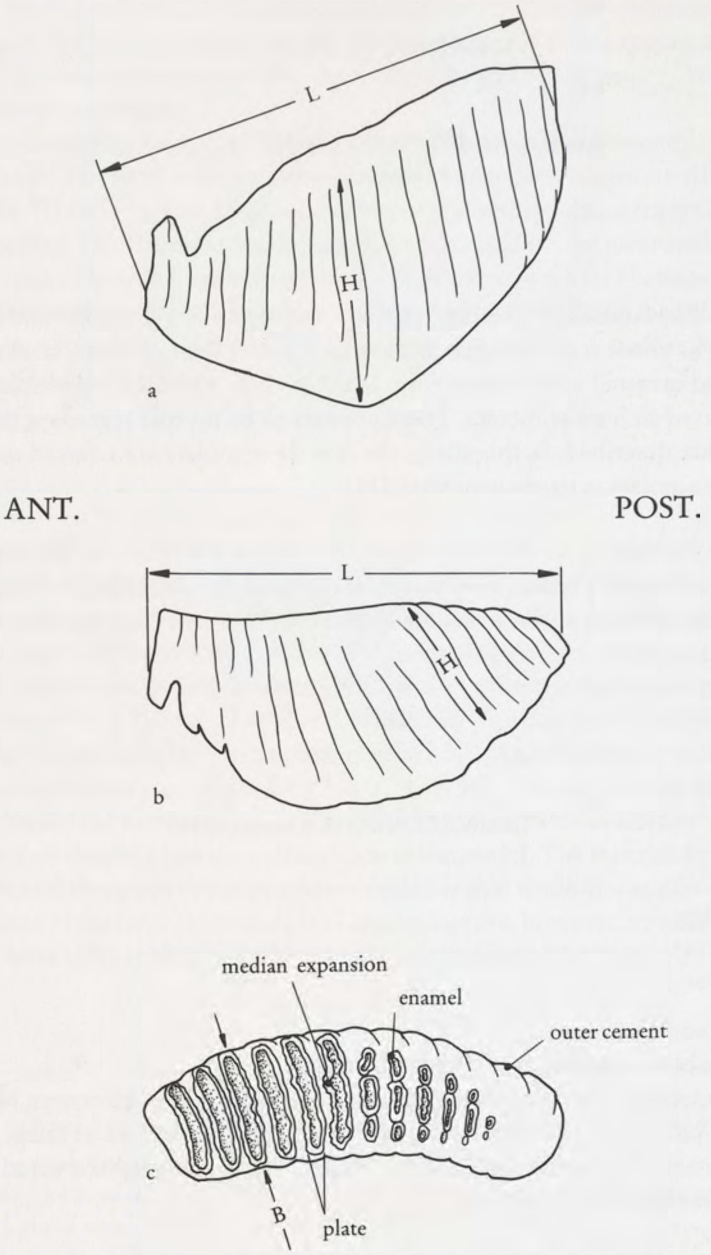


Fig. 24 Terminology used in the text to describe the upper and lower cheek teeth of the Family *Elephantidae* (Genera *Mammuthus* spp.; *Elephas*), and the measurements taken: a Upper M3 (buccal view). – b Lower M3 (lingual view). – c Lower M3 (occlusal view).

Explanation to Fig. 24, and Tables 12 - 16:
L = Overall length. Measured from most anterior to most posterior point of tooth along axis of growth and perpendicular to the lamellar plane. Length of tooth measured on fragmentary specimens indicated by a »+« after the measurement. Very fragmentary specimens were not measured. – B = Breadth. Taken at the occlusal surface on the widest plate remaining on tooth. The number of the plate on which the measurement is taken is indicated in parentheses. – H = Height. Measured on an unworn plate if possible. The plate number is given in parentheses. – No. of plates. A »+« symbol before the number of plates indicates that anterior plates are missing due to wear. – A »-« symbol before or after the number of plates indicates that the tooth is broken. – Thickness of enamel. This measurement is taken at various points along the side of the tooth if possible, or at the occlusal surface. – Plate frequency. Taken, as in the length, along the axis of growth at the base of the crown and towards the occlusal surface on both the lingual and buccal sides over 10cms. The measurement given is the average of these. Plate frequencies in parentheses indicate that this has been estimated as follows:

$$\frac{\text{length of tooth} \times 100}{\text{number of plates}}$$

Post-cranial bone

The neural spines of the thoracic vertebra of *Elephas antiquus* stand at right angles to the longitudinal plane of the vertebra (Andrews & Cooper, 1928).

Material

– Kärlich

Kä 1

Distal fragment of a deciduous tusk; an almost complete tusk from an adult individual; an upper M3 sin. and dex. and a mandible with both lower M3s in jaw from the same adult individual; an upper M2 and M3 dex. from a second adult individual; two complete and fragments of a third cervical vertebrae; two complete and fragments of a third thoracic vertebrae.

Measurements:

Cervical vertebra	55/85,5	73/55,5
Greatest height:	277.0	293.0
Greatest breadth dorsal:	-	414.0
Greatest breadth ventral:	-	241.0
Thoracic vertebra	Numbers not given	
Greatest height:	750.0	750.0

One juvenile and two adult individuals are represented to date (Kulemeyer, 1985; Turner, in Kroeger, in press).

Kä H

Two upper M3s sin.; one upper M2 sin.; one lower M3 sin.; fragmentary upper or lower molars.

The finds are described as being found at the base of the reworked Brockentuff deposits near to the 1981 - 2 excavation area, and have been identified by K. Lanser (in Brunnacker et al, 1980). They belong, without a doubt to unit H, despite their being registered as unit J.

A minimum of two individuals are represented.

Kä Ja

One upper M2 or M3 sin., (described incorrectly by Lanser as a lower molar, in Brunnacker, 1980, page 306).

A minimum of one individual is represented.

These fossils may originate from the humic soils at the base of unit Ja (Fig. 3).

Description

Tusk fragments identified as belonging to *Elephas antiquus* occur in Kä 1. The fragment of a tusk from a young individual consists of the distal end preserved to a length of about 160.0 mm. The diameter at its widest part is 47.0 mm.

It was only possible to measure the complete tusk from the adult individual found during the first excavation campaign in 1981 - 2. The tusk is 231 cm. long (measured on the lateral side). The find is damaged towards the proximal end and was originally longer.

The upper and lower molars from the Kärlich deposits are all characteristic of *Elephas antiquus*, with high, narrow crowns, and rectangular occlusal surfaces. The complete upper molars from Kä 1 all have some individual variation in tooth length and, in the case of the upper M3s from the same individual (81/II, 36 and 81/II, 24), in the number of plates per tooth (Table 12). The length, breadth and height of the teeth from the Kärlich deposits all fall into the size-variation given for *Elephas antiquus* by Maglio (1973, page 43, table 18). The plate frequency of the upper M3s from the Kärlich deposits (total range: 4.9 - 6.0, Table 12) falls to the lower end of the range (4.5 - 7.7) given for this tooth by Maglio (ibid). The exception to this being the upper M3 from Kä H, identified by Lanser, which has a estimated plate frequency of 10. This high frequency may mean that the identification of this tooth fragment is incorrect; although the tooth does have the characteristics of this species.

The enamel of the upper and lower molars from Kä 1 (Table 12 and 13) is thick and falls into the upper end of the range (for example, upper M3: 1.8 - 3.0; lower M3: 1.8 - 3.4) also given by Maglio (ibid). The enamel of the molars from horizons H and Ja is also thick and compares with those from Kä 1 (Table 12).

	Length	Width	Height	No. of plates	Enamel thickness	Plate frequency	
Kä 1							
M2 Kä	143.0+	91.3 (3)	–	+7-	x = 3.04 n = 7	5.1	Individual I
M3 Kä 11/1	262.0+	80.7 (2)	190.0 (5)	13-	x = 3.16 n = 5	5.2	
M3 81/II,36	300.5	83.1 (4)	185.0	+13	x = 2.7 n = 10	5.2	Individual II
M3 81/II,24	320.0	83.5 (5)	–	+14	x = 2.5 n = 10	4.9	
Kä H[1]							
M2 127	193.0	73.0 (4)	173.0 (7)	-11	x = 2.7	(5.5)	
M3 128	65.0	70.0 (1)	–	-6-	–	(10)	
M3 130	99.0	73.0 (2)	131.0	6-	–	(6)	
Kä Ja							
M2/3 165	–	76.0	164.0 (5)	+11	x = 2.5 n = 4	–	

Table 12 Absolute measurements of the upper molars of *Elephas antiquus* from Kärlich. – [1]Taken from Lanser in Brunnacker et al., 1980, 306.

	Length	Width	Height	No. of plates	Enamel thickness	Plate frequency
Kä 1						
M3 87/301	–	73.0 (6)	-13	5.1	x = 3.9 n = 7	–
Kä H[1]						
M3 88	–	–	–	-3-	3.2	–

Table 13 Absolute measurements of the lower molars of *Elephas antiquus* from Kärlich. – [1]Taken from Lanser in Brunnacker et al., 1980, 306.

The complete upper and lower molars from Kärlich all have the coarsely wrinkled enamel typical for this species. The details of the occlusal surfaces of the complete upper molars from the two adult individuals in Kä 1 are given below.

Individual I

The upper M2 (Plate 21A, a) is in the last stages of wear and all of the remaining plates have a single enamel figure. The plates are broad, but the figures are not particularly rhombic in form. The lateral ends of the plates, especially on the buccal side, slope backwards towards the posterior end of the tooth. Although the enamel is coarsely wrinkled, the median expansion is missing on all of the plates and in its place there is a more intensive wrinkling of the enamel.

The upper M3 (Plate 21A, a) from the same individual is in the first stages of wear, and only four plates have wear figures. The first plate has been damaged on the anterior side. The wear figure is almost completely fused and has a circular and an oval figure in the middle and median lateral figures. A median expansion is present on the posterior edge of the oval figure in the centre of the tooth. The second plate has a large circular figure in the middle and next to this two smaller circular figures placed at an angle to the axis of the plate. One of these is presumably the median expansion. The lateral figures are annular. Plate 3 consists of four equally-sized enamel rings and the third plate has three smaller ones.

Individual II

The upper M3 sin., (Kä 81/II,36, Plate 21A, b) has 11 plates in wear. A prominent median expansion occurs on the anterior and posterior edges of those plates in the central part of the occlusal surface. Plates 2 and 3, being more worn, have the typical rhombic form, the remaining plates are more band-like in form. The posteriormost plates, which are only just being brought into wear, have the oval median and lateral circular wear figure typical of this species. The upper molar dex., and lower molars from this individual have the same characteristics as this tooth.

Hypoplasia grooves

All of the molars have a thick outer cement layer around the occlusal surface and reaching down the sides of the tooth. This cement is particularly well-preserved on the lingual sides of the two upper third molars (Plate 21A, c) already mentioned above and shows, towards the occlusal surface, three horizontal hypoplasia grooves. Hypoplasia grooves on the enamel of human teeth usually indicates a deficiency of vitamin A and D and is also linked with specific occurrences of disease (Hillson, 1986).

Hypoplasia grooves often occur on fossil elephant teeth, Guenther (1975) recorded this on 72% of the *Elephas antiquus* molars from the site of Ehringsdorf (G.D.R.). Typical for this species are the presence of such grooves on the lingual sides of the upper molars as is the case with the Kärlich material. It is still not clear as to the reasons for these on elephant teeth, the incidence of occurrence being too high to be accounted for by disease or vitamin deficiency.

Post-cranial bone

The complete thoracic vertebra from the Kä 1 assemblage are typical of this species (see basic identification).

Discussion

The molars of the Middle and Late Pleistocene European populations of *Elephas antiquus* have a great deal of variability in size and morphology (Maglio, 1973). Molars with characteristics considered to be primitive, such as low plate frequency and thick enamel, are known to occur in populations dating to the Early or lower Middle Pleistocene (van Kolfschoten, 1981; 1985), but also occur in faunas dating to the beginning of the Late Pleistocene (pers. comm. A. Lister, 1968). Therefore, although the molars from the two adult individuals in Kä 1 both have a low plate frequency and thick enamel and could be described as being primitive, this should not be taken as direct evidence that the assemblages in which these fossils were recovered are old.

Stratigraphic range

The earliest known occurrence of *Elephas antiquus* in Europe is in the Cromer Forest Bed Formation, which includes deposits dating to the Early and Middle Pleistocene periods. Unfortunately a more exact stratigraphic position for the fossils within this formation cannot be given. This species also occurs in lower Middle Pleistocene faunas at localities such as Süssenborn and Mosbach, and appears to have persisted throughout much of the Middle Pleistocene (Kurtén, 1968; Maglio, 1973), becoming extinct at the end of the Eemian Interglacial. The remains of *Elephas antiquus* have been identified in Kä H, Ja and Kä 1. According to the stratigraphy of the Kärlich deposits the units Kä H and Ja are the Third and Second Cold Stages BP, which in turn have been correlated with an older and younger phase of the Saalian.

The Kä 1 assemblage has not been stratigraphically defined. Absolute dating of tephra deposits in units Kä H and Ja indicate that these could be older than the Saalian. The remains of *Elephas antiquus* from Kä H, Ja and Kä 1 cannot be used to date these deposits further. It can only be said that the remains of *Elephas antiquus* from Kärlich fall within the known stratigraphic range of this species in Europe.

Palaeoecology

Elephas antiquus has been recorded in interglacial faunas in association with temperate forest (Stuart, 1982). In the Kä 1 assemblage, this species is associated with a late temperate to post temperate phase at the end of an interglacial. The specimens from Kä H and Ja may also be associated with interglacial deposits (see Part IV).

Genus *MAMMUTHUS* (Burnett, 1850)

Plate 21B; Tables 14, 15 and 16.

Remains identified as belonging to the genus *Mammuthus* (*M. meridionalis, M. trogontherii* or *M. primigenius*) have been identified at Kärlich, Miesenheim I, Ariendorf, Schweinskopf, Wannen, Polch and Gönnersdorf.

Both *M. trogontherii* and *M. primigenius* are descended from *Mammuthus meridionalis*, and form part of a continuously evolving lineage *meridionalis-trogontherii-primigenius*, during the latter part of the Early Pleistocene to the end of the Late Pleistocene (Maglio, 1973). A further identification to one of the species of this genus is based, in the absence of the cranium, primarily on characteristics of the upper and lower cheek teeth. A definite identification of the cheek teeth of *Mammuthus* from the Neuwied Basin assemblages was, in most cases, impossible. The reasons for this being firstly the small amount of fragmentary material from this region (see Material below), and secondly the problems of comparing and identifying such material using the cheek teeth of a genus which underwent continous evolution and therefore has a large variation in size and morphology.

Thus, the majority of the specimens from the Neuwied Basin assemblages could only be described as being comparable (cf.) to a particular species using the basic identification (based on descriptions given by Maglio, 1973), or were simply referred to as *Mammuthus* sp.

Basic identification

Dentition

– *Mammuthus meridionalis* (Nesti, 1825):

The tusks are massive, strongly curved and twisted in the adults. The permanent cheek teeth are relatively broad, have thick plates and, in comparison with the molars of *M. trogontherii* and *M. primigenius*, are rather low. The third molars have 11 - 14 plates and a plate frequency of 3.7 - 7.7. The enamel is rather thick (about 2.0 - 4.0 mm.). Occasionally the molars have median enamel loops as in the species *Elephas antiquus*.

– *Mammuthus trogontherii* (Pohlig, 1885):
The name *Mammuthus trogontherii* is used in this study, even though Falconers' (1857) name of *M. armeniacus* has priority for this species (Aguirre, 1969).
The tusks of this species are large, occasionally reaching lengths of up to five metres in adult individuals (Maglio, 1973), and not so curved as those of *M. primigenius*. The permanent molars of *M. trogontherii* are narrow with 15 - 21 plates on the third molars and a plate frequency of about 5 - 8 on permanent molars. The height of the permanent molars is variable, in some individuals they attain a height greater than those of *M. primigenius*. The plates are thin and closely-spaced, with thin (1.5 - 3.0 mm.), finely wrinkled enamel. The wear-figures of the plates on the occlusal surface lack the median expansions characteristic of *Elephas antiquus* and occasionally seen on *M. meridionalis* molars, and are band-like in shape and rather irregular. Those plates just being brought into wear have oval median and oval lateral figures (med. lam. ann. lam.).

– *Mammuthus primigenius* (Blumenbach, 1803):
The permanent molars are similar in structure to those of *M. trogontherii*. This species possesses, however, a higher number of plates per tooth and a higher plate frequency. The cheek teeth are relatively high-crowned in relation to crown width. The M3s have 20 - 27 plates and the permanent molars have a plate frequency of 7 - 12. The plates are very thin and closely-spaced, with extremely thin (1.0 - 2.0 mm.), finely-wrinkled enamel. The wear-figures are the same as for *M. trogontherii*. Typical for this species is the presence of a thick outer cement, particularly around the edges of the occlusal surface.

Post-cranial bone
Post-cranial bone is rare in the assemblages from the Neuwied Basin and is not further described here.

Material

– KÄRLICH

Kä D-E
Maxillary fragment with fragment of upper M3; fragment of a tusk.
A minimum of one individual is represented.

Kä F
Anterior fragment of an upper M1 sin.; fragment of an upper M1 dex.; fragment of upper M1 sin.; posterior fragment of an upper M1 dex.; fragment of an upper M2 sin.; posterior fragment of a lower M3 sin; posterior fragment of a lower M3 s/d.
A minimum of five individuals is represented.

Kä Gb
Fragment of a tusk; fragment of lower M2; a lower M3 s/d.;
Length of tusk (measured on lateral side): 97.0+ cm.
Diameter of tusk: 26 - 27 cm.
A minimum of two individuals is represented.

Kä H
Fragments of post-cranial bone, tusk fragments; an upper M3 dex.; posterior fragment of an upper M3 dex.
A minimum of two individuals is represented. The finds have been published by Würges (1984).

– MIESENHEIM I

Mi 2
Occlusal fragment from a molar; plate fragment of a dp2.
A minimum of two individuals is represented.

– ARIENDORF

Ar Ch.
An upper and lower M3 from the same adult individual; a lower M3 from a second adult individual; two M1s; a complete, but poorly-preserved femur.
Length of femur: 106.0 cm.
A minimum of four individuals is represented.
The material has been identified and published by Poplin, and a complete list of finds can be found in Brunnacker (et al., 1975). Only the complete specimens are included here.

Ar 1
Posterior fragment of a dp2.
A minimum of one individual is represented.

Ar 2
An upper M1 and two lower M1s from the same indi-

vidual; a lower M2 fragment; fragmentary post-cranial material.
A minimum of one individual is represented.

Ar 3
Fragment of an upper or lower M1; an upper M3 fragment.
A minimum of two individuals is represented. The upper M3 is in the Geyr private collection and has been identified by Poplin (in Brunnacker et al, 1975).

– SCHWEINSKOPF

Sk 4
Fragment of a M2(?) s/d; posterior fragment of a dp2.
A minimum of one individual is represented.

– WANNEN

Wa 2/3
Fragment of a M2 s/d.
A minimum of one individual is represented.

– POLCH

The remains of a single adult individual are represented. Measurements on the upper M3 dex. and lower M3 dex. are included here (Table 16).

– GÖNNERSDORF

A femur s/d; molar fragments; tusk fragments.
Measurements:
Femur greatest length: 94.0
The finds have been identified by Poplin (1976, page 50), as belonging to *M. primigenius*.

– ANDERNACH

An 1
Only fragments of tusks have been recovered from this assemblage.

Description

Of all the measurements taken and shown in Tables 14, 15 and 16, the plate frequency and the thickness of the enamel were the ones which could be taken on even the most fragmentary specimens and thus used for comparison. The evolution *meridionalis - trogontherii - primigenius* is marked by a gradual increase of plates per tooth, a corresponding increase in plate frequency and a reduction in the thickness of the enamel. Fig. 25 plots the plate frequency and the enamel thickness (mean value) of the specimens from the Neuwied Basin assemblages and compares them with the ranges given by Maglio (1973) for the three species of *Mammuthus*. The assemblages are listed stratigraphically, beginning with the oldest at the base, whereby Kä H and Ar Ch may be contemporary with each other and the position of Sk 4 and Wa 4/5 are only tentative (see Chapter 4). The upper and lower M3s are marked separately, as these teeth proved to be more useful for identification purposes than the M1s and M2s.

Kärlich

Kä D-E: Only one molar fragment has been found. The thickness of the enamel of this specimen compares with that of both *M. meridionalis* and *M. trogontherii* is, however, closer to the mean value for *M. meridionalis*. The tooth is rather narrow for a molar of *M. meridionalis* (Table 14), and has been described here as *M*. cf. *trogontherii*.

Kä F: As stated above, the M1s from this and other deposits were difficult to identify. The M1s from Kä F tend to compare more with *M. primigenius* in enamel thickness, but in plate frequency range either between *M. meridionalis - trogontherii* or *M. trogontherii - primigenius*. The specimens are described as *Mammuthus* sp. The complete lower M3 (KW F 64), compares in plate frequency and enamel thickness with the variation given for both *M. meridionalis* and *M. trogontherii*. The plate frequency of this tooth falls between the mean values for both species. The crown of the tooth is rather high for *M. meridionalis* and, in this aspect, the specimen resembles *M. trogontherii*. The width of the plates (17.3 mm.) are more

No.	Length	Width	Height	No. of plates	Enamel thickness	Plate frequency
Kä D-E (171) Upper M3	–	(71.0) (2)	–	-5-	2.5-3.0 n = 4 x = 2.85	–
Kä F (2) Upper M1	58.5+	51.5 (4)	51.0 (5)	+5-	1.2-1.5 n = 2 x = 1.35	(8.5)
Kä F (3) Upper M1	75.0+	52.0 (4)	54.0 (4)	+6-	as F2	(8)
Kä F (94) Upper M1	133.0+	51.0 (3)	64.5 (5)	+7-	1.0	(5.2)
Kä F (99) Upper M1	98.0+	55.5 (1)	79.0 (4)	+5-	1.4-2.0 n = 2 x = 1.7	(5.1)
Kä F (68) Upper M2	112.0+	83.0 (4)	+69.0 (6)	-6-	1.5-2.0 n = 5 x = 1.66	(5.3)
Kä F (64) Lower M3	75.0	95.0 (1)	151.0 (1)	-5-	2.4-3.5 n = 4 x = 2.77	(6.6)
Kä F (7) Lower M3	–	(+104.0)	(171.0)	–	–	–
Kä Gb (73) Lower M2	116.0	80.0	–	+7	2.5-3.0 n = 5 x = 2.9	6.0
Kä Gb (459) Lower M3	–	–	105.5	–	2.7-3.4 n = 5 x = 3.02	–
Kä H (66) Upper M3	260.0	(101.0)	–	–	3.0-3.5 n = 4 x = 3.12	–
Kä H (121) Upper M3	245.0	100.0 (6)	153.0 (6)	+13	2.0-3.0 n = 7 x = 2.48	5.3

Table 14 Measurements of the upper and lower molars of *Mammuthus* from Kärlich.

No.	Length	Width	Height	No. of plates	Enamel thickness	Plate frequency
Ar Ch.[1] Upper M (No. 25)	320.0	90.0	180.0	+18	1.8 - 2.7 n = 5 x = 2.28	6.5
Lower M3	355.0	95.0	150.0	+20	–	6.5
Lower M3 (No. 16)	260.0	75.0	130.0	+20	1.8 - 2.5 n = 3 x = 2.06	–
M1 (70.17)	85.0	54.0 (3)	–	+6	1.2 - 1.7 n = 5 x = 1.4	(7)
M1 (70.9)	110.0	62.8 (5)	–	+9	1.1 - 1.8 n = 5 x = 1.63	(8.1)
Ar 2						
Upper M1 (84/11,1)	147.0	71.0 (7)	(+98.0)	+11	1.5	7.4
Lower M1 (80/11,1)	155.0	64.0 (5)	82.0	+12	1.5 - 2.0 n = 5 x = 1.75	7.7
Lower M2 (82/12,1)	65.0	(71.0)	121.0	-5	1.1 - 1.45 n = 5 x = 1.45	(7.6)
Ar 3						
M1 (?) (Str. 1)	43.0+	52.0	–	-5	1.0 - 1.5 n = 5 x = 1.25	10
Upper M3 (Coll. Geyr.)[1]	250.0+	–	170.0	(25)	–	–

Table 15 Measurements of the upper und lower molars of *Mammuthus* from Ariendorf. – [1] Measurements taken from Poplin, in Brunnacker 1975, 124 table 4.

typical of *M. meridionalis*. The height of the fragmentary lower M3 (KW F 7, Table 14) also resembles that of *M. trogontherii*.

Kä Gb: The lower M2 is referred to *Mammuthus* sp. The thickness of the enamel of the lower M3 fragment is close to the mean value for *M. meridionalis*, but this specimen is too fragmentary to allow a closer identification and is also referred to *Mammuthus* sp.

Kä H: When placed together, the tusk fragments are only moderately curved in form, which excludes *M. meridionalis* and *M. primigenius*.
The complete upper M3 from this horizon (KW H 121) compares with both *M. meridionalis* and *M. trogontherii* in plate frequency, but is closer to the mean for *M. meridionalis* : the enamel thickness falls between the mean values for both species. The height of the tooth is comparable with those of *M. trogontherii*. The enamel thickness of the fragmentary upper M3 (KW H 66) is close to the mean value for *M. meridionalis*, but this specimen is described, due to the lack of other available characteristics, as *Mammuthus* sp. (Table 14).

No.	Length	Width	Height	No. of plates	Enamel thickness	Plate frequency
Sk 4 35/48,1 M2	–	41.0 (3)	66.4 (3)	-4	0.8 - 1.2 n = 2 x = 1.0	–
Wa 4/5 Str. 2 M2	–	80.6 (2)	104.3 (3)	-3-	1.8 - 2.1 n = 5 x = 1.98	–
Polch Upper M3 dex.	–	105.3 (6)	–	+13	1.4 - 1.6 n = 6 x = 1.5	(7.2)
Lower M3 dex.	–	77.2 (3)	–	+7	1.5 - 2.1 n = 7 x = 1.84	–

Table 16 Measurements of the upper and lower molars of *Mammuthus* from Schweinskopf, Wannen und Polch.

Miesenheim I

Mi 2: The occlusal fragment is very small (15. 0 x 10. 0mm.). Part of the buccal or lingual fold has been preserved. The enamel is 2. 7mm. thick and falls into the range given for *M. trogontherii*. The plate fragment from the deciduous molar is thin, has finely wrinkled enamel and is 34. 5mm. wide.

Ariendorf

Ar Ch.: The first molars are difficult to identify precisely; the permanent molars have been described by Poplin (in Brunnacker, 1975), as belonging to a form intermediate between *M. trogontherii* and *M. primigenius*. The difference in size between the two lower M3s is possibly due to sexual dimorphism, the smaller tooth (Ar 16) belonging to an elephant cow, the larger one (Ar 25) to an elephant bull (*ibid.*).
The thickness of the enamel of both the upper M3 (Ar 25) (Plate 21B, a) and lower M3 (Ar 16) is close to the mean value for *M. trogontherii*. The plate frequency for the upper and lower M3s from the same individual (Ar 25) is low, and falls between the mean value for both *M. meridionalis* and *M. trogontherii*. Both teeth are, however, high-crowned and are therefore described here as *M.* cf. *trogontherii*. The plate frequency of the lower M3 (Ar 16) falls between the mean values for *M. trogontherii* and *M. primigenius*.

Ar 1: The specimen is too fragmentary to be further identified.

Ar 2: The plate frequency and the enamel thickness of the M1s and M2 from this assemblage fall into the variation of both *M. trogontherii* and *M. primigenius* (Plate 21B, b).

Ar 3: Both specimens compare in plate frequency and enamel thickness with the molars of *M. primigenius*.

Schweinskopf

Sk 4: The enamel thickness of the M2 is very thin and compares with that of *M. primigenius*.

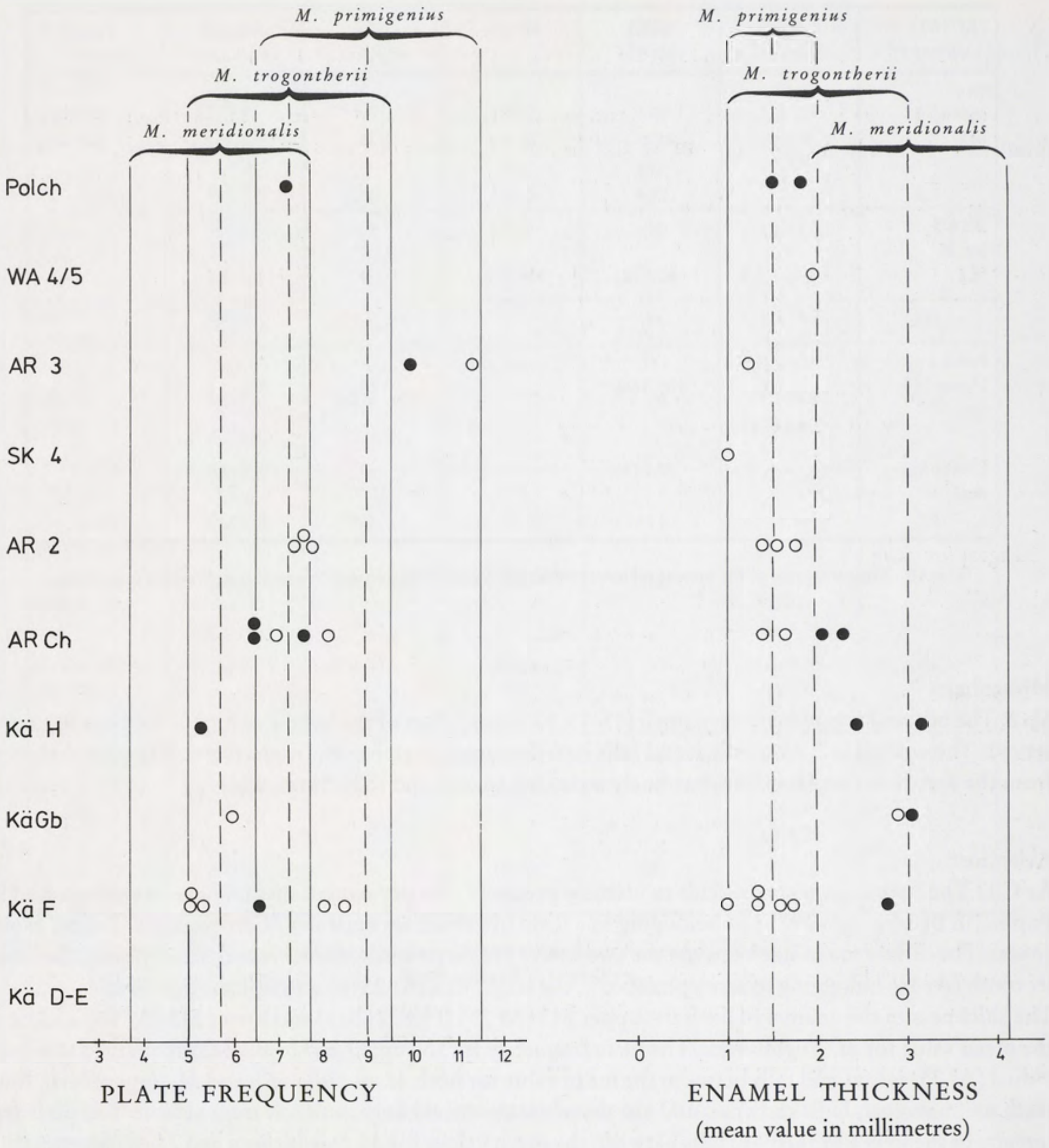


Fig. 25 Plate frequency and enamel thickness of the upper and lower cheek teeth of *Mammuthus* from the Neuwied Basin assemblages and comparison with those of *M. meridionalis, M. trogontherii* and *M. primigenius* (minimum - maximum and mean value, after Maglio 1973). – ● upper and lower third molars (M3). – O other cheek teeth. (Only the mean value for the enamel thickness of the Neuwied Basin specimens is given).

Wannen

Wa 4/5: The enamel thickness of the M2 fragment compares with the variation of both *M. trogontherii* and *M. primigenius*.

Polch

The plate frequency of the upper M3 is rather low, but the thickness of the enamel of this tooth compares with that of *M. primigenius*. The teeth all have a thick outer cement layer, typical of *M. primigenius*.

Gönnersdorf

The remains have been identified as belonging to *M. primigenius* (Poplin, 1976).

None of the molars from the Neuwied Basin assemblages possessed those characteristics typical only of *M. meridionalis*. One specimen from Kä F (KW F 64) has wide plates as in *M. meridionalis*, but was also similar in height of the tooth to *M. trogontherii*. This specimen probably represents an intermediary form. The remaining molars resembled those of *M. trogontherii* or *M. primigenius*.

Fig. 25 plots the plate frequencies and enamel thicknesses of the molars identified to the genus *Mammuthus*. It can be seen that those molars found in assemblages thought to date to the lower Middle Pleistocene (Kä D-E, F and Gb) have a low plate frequency in comparison to those from assemblages dating to the Late Pleistocene, such as Ar 3. There is also a gradual decrease in the enamel thickness between those molars from the lower Middle Pleistocene assemblages and those from assemblages dating to the upper Middle Pleistocene, such as Sk 4, and those dating to the Late Pleistocene such as Ar 3 and Polch. The evolution of the genus *Mammuthus* during the Middle and Late Pleistocene is characterized by an increase in plate frequency and a reduction in enamel thickness on the upper and lower cheek teeth, and it can be said that the *Mammuthus* molars from the Neuwied Basin assemblages also show this.

Stratigraphic range

The earliest known occurrence of *M. trogontherii* is in the Cromer Forest Bed Formation, where *M. meridionalis* and the intermediate form *M. meridionalis - trogontherii* also occur. A more exact stratigraphic position within this formation cannot be given (Stuart, 1982). *M. trogontherii* also occurs at the Mosbach locality, in a fauna dated to the Elsterian (Kurtén, 1968), and in faunas at other lower Middle Pleistocene localities such as Süssenborn (Guenther, 1969).

The further evolution of *M.trogontherii* to *M. primigenius* is described by Adam (1961) and Kurtén (1968) as follows: intermediate forms between these two species begin to occur as early as the Elsterian; forms closer to *M. primigenius* than *M. trogontherii* first appear during the Saalian phase and the fully-evolved *M. primigenius* is restricted to the Late Pleistocene, particularly in faunas dating to the Weichselian.

It was previously thought that *M. primigenius* became extinct early in Europe; only being found in Siberia and north America during the latter part of the Late Pleistocene. However, recent discoveries of mammoth remains at sites in England, France and Switzerland (Coope & Lister, 1987), show that this species was still surviving during the period of climatic amelioration following the last maximum glacial episode in Europe and known here as the Bölling Interstadial. One of several individuals of *M. primigenius* found recently at Condover, England, has been absolute dated to about 12,700 +/- 160 BP and 12,920 +/- 390 BP (Coope & Lister, *ibid.*).

A summary of the stratigraphic ranges of the genus *Mammuthus* during the Middle and Late Pleistocene periods is as follows:

M. meridionalis forms: Cromer Forest Bed Formation =latter part of the Early Pleistocene and beginning of the lower Middle Pleistocene (last appearance cannot be more precisely defined).

M. trogontherii forms: Cromer Forest Bed Formation (as above, first appearance cannot be more precisely defined) - Saalian (upper Middle Pleistocene). Typical *M. trogontherii* forms known from Elsterian faunas.

M. primigenius forms: Saalian (upper Middle Pleistocene) - end of Late Pleistocene. Typical *M. primigenius* forms only found in latter part of this range.

The identification of the Neuwied Basin material, based primarily on the upper and lower M3s in Fig. 25, can be summarised as follows:

Lower Middle Pleistocene assemblages (Kä D - Gb and Mi 2) - forms comparable with *M. trogontherii* or forms intermediary between *M. trogontherii* and *M. meridionalis*. Molars comparable only with those of *M. meridionalis* do not occur in these deposits.

Upper Middle Pleistocene assemblages (Ar Ch., Ar 2, Sk 4 and possibly Kä H) - The molars from Ar Ch. appear to resemble *M. trogontherii*, and those from the younger assemblage, Ar 2, appear to be intermediate between *M. trogontherii* and M. *primigenius*. The molar fragment from Sk 4 is comparable to that of *M. primigenius*.

Kä H could belong to an older phase of the Saalian (stratigraphy) or may be older (absolute dating). The molars from Kä H are comparable to those of *M. trogontherii*, but are of no further use in dating the deposit.

Late Pleistocene assemblages (Ar 3, Polch and Wa 4/5) - The molars from these assemblages are comparable with those of *M. primigenius*.

The molars of *Mammuthus* from the Neuwied Basin assemblages fall into the broad stratigraphic ranges for the species given above.

Interesting is the recent discoveries of *M. primigenius* at localities dating to the end of the Late Pleistocene in Europe. These discoveries support the idea that *M. primigenius* was actually present in or around the Neuwied Basin during the time that the site of Gönnersdorf was occupied by early man. The assemblage at Gönnersdorf has been dated to about 12,500 BP. The mammoth remains at Gönnersdorf are the last occurrence of the genus *Mammuthus* in the Neuwied Basin during the Pleistocene.

Palaeoecology

The palaeoecologies of both *M. meridionalis* or *M. trogontherii* are not well known. Tooth fragments identified as possibly belonging to *M.trogontherii*, have been recorded from a fauna pollen-dated to the end of an interglacial at Miesenheim I, in association with open birch and pine woodland.

M. primigenius is known to have occurred mainly in cold-stage faunas in association with predominantly open grassland. It also known to have occured in interstadial faunas and faunas dating to the end of interglacial phases, in association with boreal, temperate deciduous and coniferous forest (Stuart, 1982). This species fed on grass and other herbaceous plants.

Mammuthus remains occur mainly in assemblages located in cold stage deposits in the Neuwied Basin region. Where palaeoenvironmental evidence from these assemblages is known, these faunas are all associated with an open steppe or steppe-tundra environment. At Ar 3, *M. primigenius* has been identified in a fauna located in soil thought to have formed under interstadial conditions, in association with a molluscan fauna indicating a cool climate and alternating dry and humid episodes. At Gönnersdorf, this species has been recorded from a fauna dating to the end of the Bölling Interstadial, in association with the opening up of the wooded conditions associated with this interstadial and the encroachment of steppe due to the oncoming Older Dryas Stadial.

CHAPTER 7
ORDER PERISSODACTYLA

Family *EQUIDAE* (Gray, 1821)

Basic identification

Dentition
The cheek teeth are hypsodont with a complex pattern of selenodont enamel folds (Fig. 26). The deciduous cheek teeth can be distinguished from the permanent ones by their low crowns and spreading roots.

Post-cranial bone
The post cranial bones are more slender and lightly - built than that of the large bovids or rhinoceros. The metapodia consist of a single, large third digit (metacarpus and metatarsus): the second and fourth digits are reduced.

Genus *EQUUS* (Linnaeus, 1758)

***EQUUS* spp.**
Horse

Plates 22 - 23A; Fig. 27 - 29; Tables 17 - 26; Appendix III.
Remains of wild horse occur in most of the assemblages from the Neuwied Basin localities.

Material

– KÄRLICH

Kä E/F
A mandible fragment sin. with lower dp 2 - 4 and M1, a metacarpus III sin.
The lower dp2 - 4 and M1 have been identified and published by Nobis (1970) and were not examined during the course of this study.
A mininmum of two individuals is represented.

Kä F
Proximal end of a metatarsus III dex.; distal end of a metacarpus or tarsus III s/d.
A minimum of one individual is represented.

Kä Ga
Upper third molar dex.
A minimum of one individual is represented.

Kä Gb
Maxillary fragment with complete upper incisor row and both canines; maxillary fragments with upper cheek teeth row (P2 -M3) sin. and dex. (the fragment from the left side has been recently sawn through) an upper third molar; fragment of a radio-ulna s/d.; distal end of a metacarpus or tarsus III, fragments of ribs and vertebrae.

The remains are all from the same adult individual. They are possibly associated with a quartzite cleaver found nearby and therefore may be part of an archaeological assemblage (pers. comm. K. Würges).
Maxillary fragment with complete incisor row; mandible fragment dex. with lower molar 1 - 3; upper P4 (?) and M1 sin.; upper P4, M1 and M2 dex.: upper M1 - 3 dex.: distal end of a metacarpus III s/d.: distal ends of two tibiae dex.
A minimum of three individuals is represented.

Kä Ga/b
Upper P3 and P4 sin.
A minimum of one individual is represented.

Kä H
Upper I1 - 3 sin. and dex.; upper I1 - 2 and di3, per-

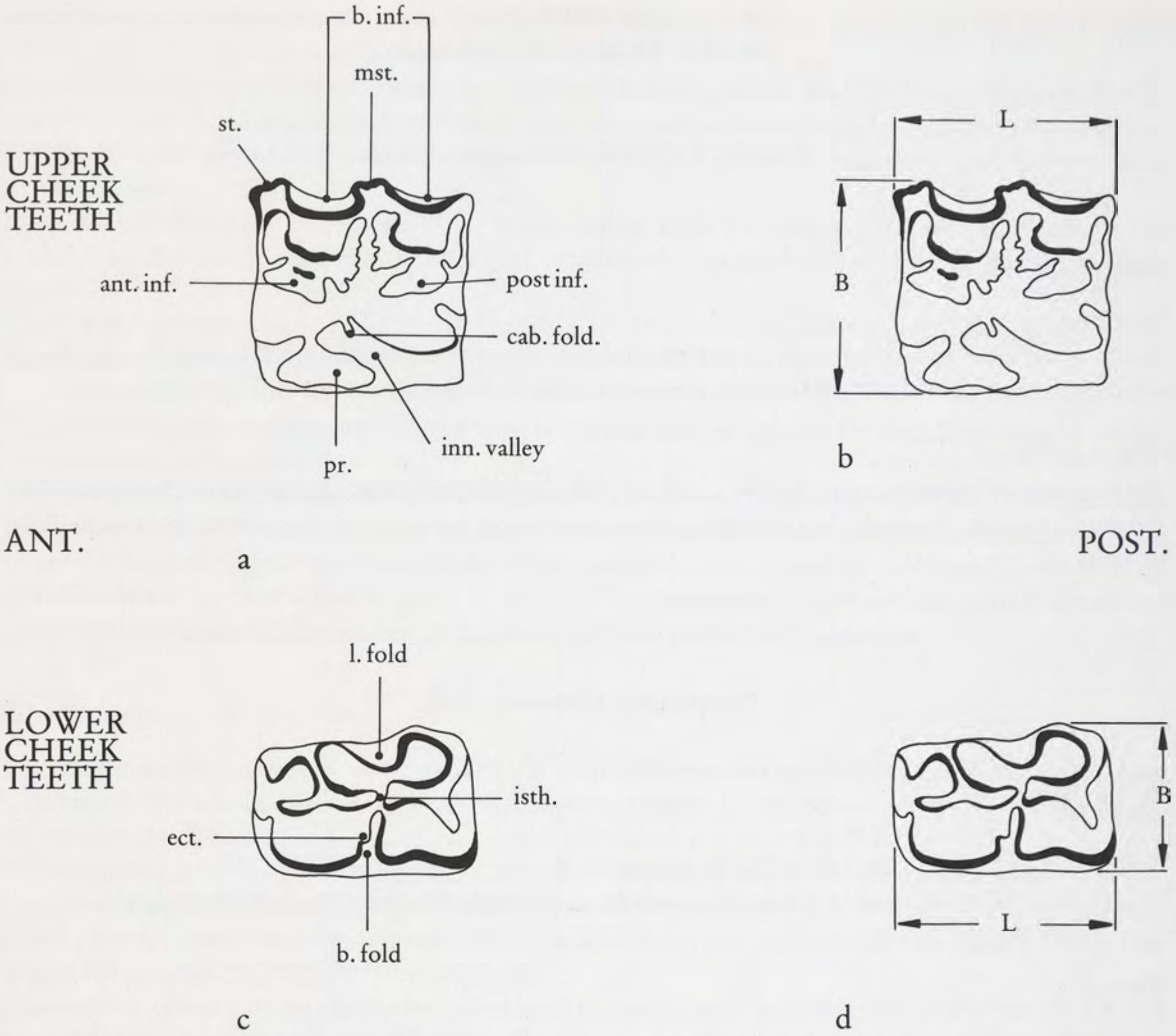


Fig. 26 Terminology used in the text to describe the upper and lower cheek teeth of the Family *Equidae*, and the measurements taken. Upper cheek teeth (M1 or M2) (occlusal views). – a pr.: protocone; inn. valley: inner valley; cab. fold.: caballine fold; ant. inf.: anterior infundibulum; post. inf.: posterior infundibulum; b. inf.: buccal infolding; pst.: parastyle; mst.: mesostyle. – b L length of tooth (measured at occlusal surface); B breadth of tooth (measured at occlusal surface).
Lower cheek teeth (M1 or M2) (occlusal views). – c l. fold: lingual fold; b. fold: buccal fold; isth.: isthmus; ect.: ectostylid. – d as b) above.

manent I3 still in jaw; mandible fragment with lower P2 - 4 and M1 sin.; mandible fragment with lower P2, P4 and M1 - 3 sin.; upper M1 sin.; an upper P4 and M1 (the specimens have been identified and described by Nobis (1970); distal ends of two humeri dex.; distal ends of two tibiae sin.; proximal end of a metacarpus III s/d.; a metatarsus III dex.; a second phalange.
A minimum of one juvenile and two adult individuals is represented.

Kä Ja
An upper or lower I1; an upper or lower I3; a lower P2 dex.; a lower P3 dex.; distal end of a metatarsus III s/d. The metatarsus has been described and published by Lanser (in Brunnacker et al, 1980).
A minimum of one individual is represented.

Kä 1
Two incisor fragments
A minimum of one individual is represented.

– MIESENHEIM I

Mi 2
Distal end of a tibia dex.; a calcaneum dex.; an astragalus sin.; an os tarsale 3 dex.; an os tarsi centrale dex.; a cuboid dex.; distal end of a metatarsus III dex.; a

first phalange dex.; a third phalange s/d.
A minimum of one individual is represented.

– ARIENDORF

Ar Ch.
A lower P3 and fragment of a P2 sin.; distal end of a femur sin.; distal end of a metatarsus III s/d. The specimens have been identified and published by Poplin (in Brunnacker et al., 1975).
A minimum of one individual is represented.

Ar 1
An upper P3/4 dex.; an upper M1 dex.; an upper M1/2 sin.; a lower M1/2 dex.; a lower P3/4 dex.; a lower M3 dex.; a cervical vertebra; a tibia dex.; distal end of a tibia sin.; a tarsale 3 sin.; an os tarsale centrale sin.; a first phalange dex.; a second phalange sin.
A minimum of two individuals is represented, based on differences in the size of the teeth.

Ar 2
An upper M3 dex. and fragment of an upper M2/3 dex. from the same individual; a mandible fragment sin. with lower M3; lower P2 dex.; a cervical vertebra; a pelvis sin. and dex.; two humeri sin.; a radius s/d; a metacarpus III dex. (juvenile); a tibia sin.; distal end of a tibia dex.; a calcaneus sin.; an astragalus sin.; a metatarsus III dex.; distal ends of a metatarsus sin. and dex.; proximal ends of a metatarsus sin. and dex.; first phalange dex.; a second phalange dex.
A minimum of two individuals is represented.

Ar 3
An upper M1 dex.; fragment of the distal end of a humerus dex.
The tooth has been described and published by Poplin (in Brunnacker, 1975).
A minimum of one individual is represented.

– LEUTESDORF

Horizon 17
An upper third molar.
The find has been described and published by Poplin (in Brunnacker et al, 1974).

– SCHWEINSKOPF

Sk 1
Incomplete upper and lower cheek teeth rows sin. and dex. from the same individual, including upper P2 - 4 and M1 - 3 sin., upper P4 and M1 - 2 dex., a lower molar and four lower incisors.
One individual is represented.

Sk 2
Two first phalanges dex.
A minimum of two individuals is represented.

Sk 4
Mandible fragment with lower dp 2, 3 and 4 sin. and fragment of dp 3 dex.; upper dp 2 and dp 3 sin.; an upper dp3 s./d.; upper dp2 sin.; upper dp3 sin.; mandible fragments with lower P2 - 4 and M1 - 3 sin. and dp 4, P4 and M2 - 3 dex.; lower P2 dex.; lower P2 sin.; lower P2/3sin.; lower P3/4 sin. and dex.; lower M1/2 sin. and dex.; lower M1/2 dex.; lower M3 dex.; upper I1; upper cheek tooth rows with dp 2 - 4 and M1 - 3 sin. and dex. (P4 is missing on dex. side); upper cheek tooth rows with P3 - 4 and M1 - 3 sin. and dex.; an upper P2/3 sin.; an upper M1/2 dex.; an upper M1 sin.; an upper M2 sin.; an upper M3 sin. and dex. from the same individual; three upper M3s dex., an upper M3 sin.; a complete cervical vertebra, two cervical vertebrae from a juvenile individual(s); fragment of a sacrum; three scapulae sin.; a radius sin.; proximal end of an ulna dex.; distal ends of two humerii dex.; distal end of a humerus sin.; a pelvis-fragment dex.; a complete metacarpus III sin.; proximal ends of a metacarpus III sin. and dex.; distal ends of two metacarpii III dex., a metacarpus III sin. and a metacarpus III s/d.; two complete femora dex.; distal ends of five tibiae dex., one tibia sin. and fragment of a tibia s/d.; two complete metatarsi III dex.; proximal end of a metatarsus III sin.; two os tarsi centrale sin.; an os tarsale 3 sin.: two calcanei sin.: an astragalus sin.; fragments of two astragali sin. and an astragalus dex.: two first phalanges: five second phalanges: three third phalanges. A minimum of nine individuals, based on the deciduous dentition and the permanent upper M3s sin. and dex. which are all in different stages of wear, are represented.

– WANNEN

Wa 1
A lower dp2 sin.; a lower dp4 sin.: a lower dp3 sin.; a lower dp4 sin.; an upper dp 2, dp 3 and dp 4 dex.; a lower M2 sin.; a lower M2 dex.; a lower M3 sin.; mandible fragments with complete cheek teeth rows sin. and dex.; upper cheek teeth rows sin. and dex.; a cervical vertebra; a scapula sin.; distal ends of two humeri sin. and two humeri dex. proximal fragment of a humerus s./d.; proximal ends of a radius dex.; a radio ulna sin.; a pelvis dex.; distal end of a femur sin.; proximal end of a tibia dex.; distal end of a tibia sin.; a tibia sin. and dex. from the same individual; fragment of a tibia sin. from a juvenile individual; two astragali sin.; two astragali dex.; a calcaneus sin. and dex.; an os tarsi centrale sin.; an os tarsale 3 sin.; a metatarsus

III sin.; proximal end of a metatarsus III dex.; four first phalanges; a second phalange.

A minimum of two juvenile individuals and two adult individuals is represented.

Wa 2

Mandible fragment with dp 2 - 4 sin.; mandible fragment with dp 2 - 4 sin.; mandible fragment with permanent incisors and canines dp 2 - 4, M1 - 2 and M3 just erupting; an upper dp2 dex.; an upper dp3 dex. an upper dp 4 dex.; an upper dp2 and 3 sin.; mandible fragments with complete lower cheek teeth rows; an M1 sin.; an atlas vertebra; a cervical vertebra; a radius sin. juvenile individual; an ulna dex.; two radii sin.; a pelvis sin. and dex. from the same individual; two pelvis fragments dex. from juvenile individuals; proximal fragment of a femur dex.; distal ends of two femora dex.; fragments of three femora dex.; a complete tibia sin. and dex.; proximal fragment of a tibia; distals ends of two tibiae dex.; two metacarpii III dex.; proximal end of a metacarpus III dex.; fragments of a metacarpus III from a juvenile individual; proximal end of a metatarsus III sin.; distal end of a metacarpus or tarsus III s/d.; three calcaneum sin.; a calcaneum dex.; four first phalanges; three second phalanges.

A minimum of three juvenile individuals is represented by the deciduous cheek teeth.

A minimum of three adult individuals is represented by post-cranial bone.

Wa 3

A lower dp4 sin.; an upper dp 2 sin.; an upper dp 4 sin.; an upper dp 3 dex.; an upper dp 4 dex.; upper dp 2 and 3 dex. from the same individual; upper dp 3/4 sin.; an upper P2/3 sin.; distal end of a humerus dex.; two radio ulnae sin.; an ulna dex.; a metacarpus III dex.; pelvis fragments from three juvenile individuals; two femora sin.; a tibia sin.; an astragalus dex.; a metatarsus III dex.; two metatarsi III sin.; proximal end of a metatarsus III dex.; distal end of metatarsus III from a juvenile individual; four first phalanges; a second phalange, a third phalange.

A minimum of three juvenile and two adult individuals is represented.

Wa 4/5

Mandible fragment with lower dp2 and dp3 sin.; a lower P2 dex. and sin., a M2 sin., a M3 dex. and sin. from the same individual, an upper P2 dex.; an upper M1 dex.; distal end of a humerus dex.; a radius sin. and dex.; a radio-ulna dex.; a metacarpus III sin. and dex.; pelvis fragments sin. and dex. from three individuals; two astragali sin. and two dex.; a calcaneus sin.; distal end of a metatarsus III sin.; proximal end of a metatarsus III dex.; three first phalanges; four second phalanges; two third phalanges.

A minimum of one juvenile and three adult individuals is represented.

Wa Pr III

An upper dp2 dex.; an upper dp3 sin.; a mandible fragment with P4 and M1 - 3 dex.; a mandible fragment with complete cheek teeth row sin. and dex.; mandible fragment with P4 and M1 - 3 dex.; mandible fragment with M1 - 2 sin.; an upper P2 sin. a scapula sin.; a scaphoid sin.; a metacarpus III dex.; proximal end of a metacarpus III sin.; distal end of a metacarpus III; proximal end of tibia sin.; two metatarsi III dex.; distal ends of two metatarsii III s/d.; a first phalange, a second phalange.

A minimum of one juvenile and three adults is represented.

– HUMMERICH

Hu 2

An upper P3 sin. and dex., an upper P4 sin. and dex., upper M1 - 3 sin. from the same individual; an upper M1/2 sin.; a lower P2, P3 and P4; a metacarpus III sin.; distal end of a tibia sin.; a astragalus sin.; two first phalanges.

A minimum of two individuals represented.

Hu 4

A lower dp 4 dex.; an upper dp3/4 sin.; a mandible fragment with P2 - 4 and M1 sin.; a lower P2 and 3 sin.; a lower P3 dex.; a lower P4 sin.; a lower P3/4 sin.; a lower M1/2 sin.; two lower M1/2 dex.; an upper P4 sin.; a upper M1 sin.; an upper P3 and 4 dex.; P3 sin., M1 sin., M1/2 and M3 dex. from the same individual; upper M3 sin.; proximal end of an ulna sin.; distal ends of a humerus sin. and dex.; proximal ends of three metacarpi III sin. and two metacarpi III dex.; a metacarpus III s/d.; distal ends of three tibiae dex. and two tibiae sin.; distal ends of two radii dex.; two complete metatarsi III sin.; proximal ends of a metatarsus III sin.; distal ends of two metatarsi III s/d.; distal ends of a metacarpus or tarsus III s/d.; proximal end of a metatarsus III dex.; an astragalus dex.; two astragali sin.; two calcanei sin.; a calcaneus dex.; an os tarsale 3 dex.; an os tarsi centrale dex.; four first phalanges dex.; a first phalanges sin.; two first phalanges s/d.; two second phalanges dex.; a second phalange sin.

A minimum of three individuals is represented.

Hu 5

An upper M1 sin.

A minimum of one individual is represented.

– TÖNCHESBERG

Tö 1
Fragmentary post-cranial bones only.
A minimum of one individual is represented.

Tö 2
A radio-ulna dex.; an astragalus sin.; a first phalange dex.; a second phalange s/d.; a second phalange sin. from a juvenile individual; a third phalange dex.; a third phalange s/d.
A minimum of individual is represented.

– METTERNICH

Upper loess (Fig. 15, 2)
Höfer (1937), described a metacarpus III as belonging to *Equus germanicus* and a phalange as belonging to *Equus Prezswalski.*

– ANDERNACH

An 1
Horse is present in this assemblage, but details about the remains are not available.

– GÖNNERSDORF

According to Poplin (1975), 13 individuals are represented in the Gönnersdorf assemblage. My own measurements of some specimens of metapodia are given in Tables 25 and 26. Measurements given by Poplin (1976) were also used in Fig. 29.

– NIEDERBIEBER

An upper dp1 dex. and sin., dp2 dex., and dp3 dex. from the same individual, an astragalus.
A minimum of one individual is represented.

– MIESENHEIM II

A metatarsus III dex.
A minimum of one individual is represented.

Description and Discussion

The taxonomy and evolution of the European Pleistocene horses is not particularly well-known and the many named Middle and Late Pleistocene species of *Equus* only serve to confuse the situation. Although recent studies, Eisenmann (1979, 1980); Nobis (1971); Prat (in de Lumley [ed.], 1976) have attempted to bring some clarity into the situation , there are still conflicting theories regarding the evolution of the Pleistocene horses, their identification to species, and subsequently their use as biostratigraphic indicators. Thus, the Middle and Late Pleistocene horses from the Neuwied Basin assemblages are all referred provisionally to *Equus* sp., and occassionally attempts have been made to compare these with named species of Pleistocene horses.

The term *Equus caballus*, has been used by some authors to describe caballine Pleistocene horses (for example, Prat, in Lavocet [ed.], 1966; in de Lumley [ed.], 1976). This term has not been used here, as Eisenmann (1980), states that this name should only be used only for the modern domesticated horses.

According to Eisenmann (1980), the best criteria for species identification amongst the equids are morphological characteristics of the cranium. However, the complete specimens necessary for this type of study, are rare in assemblages such as those from the Neuwied Basin. Thus, attempts to compare the equid remains from the Neuwied Basin with named Pleistocene species of *Equus* had to be based upon the available criteria, such as changes in the size and morphology of the dentition and the size of the post-cranial bone both of which, as is shown below, are less reliable.

Dentition

Equid cheek teeth underwent changes in morphology and size during the Middle and Late Pleistocene periods. Marked changes in morphology can be seen if we compare the cheek teeth of the primitive Early and lower Middle Pleistocene species, such as *Equus stenonis* , with those of the more evolved caballine horses also occuring during the Middle Pleistocene. However »primitive« dental characteristics can occa-

M1	Kä Gb (35)	 (277)	 (52)	Kä H (232)	*E. stenonis*[1]	*E. süssenbornensis*[2]	*E. mosbachensis*[3]
Length	32.0	27.7	34.0	30.0	24.0 - 30.8 n = 11 x = 27.4	30.2 - 35.0 n = 23 x = 32.6	25.7 - 33.8 n = 19 x = 29.7
Breadth	31.5	29.0	32.0	28.5	27.0 - 32.8 n = 11 x = 29.9	25.5 - 32.8 n = 23 x = 29.1	27.5 - 31.4 n = 19 x = 29.4
Protocone length	–	13.0	–	–	8.8 - 12.0 n = 11 x = 10.4	11.0 - 16.5 n = 23 x = 13.7	12.2 - 19.9 n = 19 x = 15.7
M3	Kä Ga			Kä Gb	[4]		
Length	35.0			29.3	28.7 - 33.0 n = 11 x = 30.8	30.3 - 33.5 n = 3 x = 31.6	31.0 - 32.2 n = 3 x = 33.4
Breadth	27.0			25.3	25.8 - 29.5 n = 11 x = 27.6	26.2 - 26.6 n = 3 x = 26.3	24.0 - 29.0 n = 3 x = 26.5

Table 17 Size of the upper M1 and M3 of *Equus* sp. from Kärlich compared with those of lower Middle Pleistocene species of *Equus* – [1]After Nobis, 1971 Tab. I; [2]after Musil, 1969; [3]after Nobis, 1971 table XXXIV; [4]after v. Reichenau, 1915.

sionally occur on the cheek teeth of caballine horses from upper Middle and Late Pleistocene deposits, so that attempts to date an assemblage on »primitive« or »progressive« morphology alone is generally not possible. The same problems arise with the size of the cheek teeth of *Equus*. The cheek teeth of the caballine horses show a gradual decrease in size from those occuring in the lower Middle Pleistocene to those found in the Late Pleistocene. Unfortunately, the variation in dental size between the named species of Pleistocene equids is not so marked that the few specimens of cheek teeth from the Neuwied Basin assemblages could be referred with certainly to a particular species on size alone. Unsuccessful attempts to compare the size of equid cheek teeth from deposits at Kärlich with those of named species of *Equus* illustrate this problem (Table 17). Comparisons of the size of cheek teeth from assemblages in the Neuwied Basin dating to the upper Middle and Late Pleistocene, with species of *Equus* recorded from other faunas dating to these periods were not attempted.

Post-cranial bone and body-size

The Middle and Late Pleistocene caballine horses also underwent a continuous reduction in body-size (withers height), from large horses occurring in lower Middle Pleistocene faunas, to smaller, stocky horses associated with faunas dating to the end of the Late Pleistocene. This trend is especially marked in the size (length / breadth of diaphysis) of the metapodia (metacarpus III and metatarsus III). These bones are also useful in reckoning, after Kiesewalter (1888), the withers height (body-size) of the horse.

However, the same problems arise regarding the size of the post-cranial bone as with the size of the dentition. For example, Nobis (1971, page 26) gives a variation in length of 28 mm. for the metacarpi III of *Equus mosbachensis* from the Mosbach locality. A similar variation in length has been recorded on only two specimens of metatarsi III from Ar 2 (Table 26). As sexual dimorphism does not occur amongst the equids (Eisenmann, 1979, 1980), this variation in metapodial length appears to represent that occuring normally amongst fossil population of *Equus* .

It does, however, mean that there is often a large overlap in metapodial length (and ultimately withers height) between the various named Middle and Late Pleistocene species of *Equus* (Fig. 29). The metapodi-

al bones are, however, well-represented amongst the equid remains found in the Neuwied Basin assemblages and therefore, despite the problems described above, the size of these bones were used to attempt tentative comparisons of the Neuwied Basin equid remains with the named species of Pleistocene horse.
Metapodial ratio-diagrams, as proposed by Eisenmann (1979), were also made for all the specimens from the Neuwied Basin assemblages. However, the fragmentary state of some of the metapodia from the study area, and the lack of comparative diagrams for the named Pleistocene species of *Equus* meant that the results of this type of study were not very successful. Often the diagrams only showed that one bone was larger than another, which could be seen anyway from the absolute measurements. As a more detailed study of the equids from the Neuwied Basin assemblages, particularly in the light of raw material not included in this study will be necessary, the results given here are restricted to a few basic measurements on the metapodia.
The remaining post-cranial bones, although mentioned in the text and given in tables 19 - 24, are too few in number to be of comparative use. For example, in Table 23, the distal breadth of the radius of *Equus* are compared. The size of the specimens from Ar 2, Sk 4, Wa 1 and Tö 2 all fall into the size variation given by only two specimens from Hu 4. The only exception to this being the example from Wa 2, which is smaller as it belongs to a juvenile individual.

As the equid remains from the Neuwied Basin assemblages form a large corpus of material, the following description and discussion of the specimens has been divided into sections, such as lower Middle Pleistocene, upper Middle Pleistocene etc. The description of named species of Middle and Late Pleistocene equids has been taken from several sources, such as Eisenmann (1980), Nobis (1971), Prat in Lavocet (ed., 1966), in de Lumley (ed., 1976).

LOWER MIDDLE PLEISTOCENE

During the lower Middle Pleistocene, horses with cheek teeth characterized by a primitive morphology, such as *Equus stenonis* and *Equus süssenbornensis* occurred. Horses with a more progressive caballine morphology also appeared for the first time during this period.

Equus stenonis was a medium-sized horse, associated primarily with faunas dating to the Early Pleistocene, but which also persisted into the lower Middle Pleistocene. The upper cheek teeth of this species are characterized by a short »zebrine« protocone (Fig. 26), the inner valley often ends in a series of enamel folds or extends across the occlusal surface, almost touching the anterior infundibulum. The caballine fold is missing. The buccal infoldings are flat or only slightly concave and the vertical outer grooves on both parastyle and mesostyle are usually missing. The lower cheek teeth have a V-shaped lingual fold, and the buccal fold extends to the isthmus and occasionally beyond.
Equus süssenbornensis was large in size and had large cheek teeth with primitive morphological characteristics similar to those of *E. stenonis*. The cheek teeth of *E. süssenbornensis* are characterized further by multiple folds of enamel, particularly on the inner side of the posterior and anterior infundibulae of the upper molars and premolars.
The lower Middle Pleistocene caballine horses were also large in size with, in comparison to *E. stenonis*, more progressive dental characteristics. The upper cheek teeth have long »caballine« protocones, and the inner valley usually ends in a simple caballine fold. The buccal infoldings are concave and both parastyle and mesostyle have outer vertical grooves, although these may be absent on the upper molars. The lower cheek teeth have a U-shaped lingual fold and the buccal fold does not usually extend beyond the isthmus. Caballine horses first appeared during the lower Middle Pleistocene, and are usually referred to the species *Equus mosbachensis* (Eisenmann, 1979, 1980; Nobis, 1971; Prat, in Lavocet (ed.), 1966; in de Lumley (ed.), 1976).

Lower Middle Pleistocene assemblages in the Neuwied Basin:

KÄRLICH

Dentition

Kä E-F

Nobis (1970), has identified a series of lower deciduous teeth from this horizon as being from *E. süssenbornensis* on the basis of their large size and primitive morphological characteristics. These specimens are not in the Würges collection and were not seen during the course of this study. A photograph of the teeth published in the 1970 report shows that the specimens do not possess the multiple enamel fold characteristic of *E. süssenbornensis*.

Kä Ga

The upper third molar (Ga 462) has a long, caballine protocone and a long, thin inner valley. The tooth does not possess a caballine fold. The buccal infoldings are flat and the tooth has an enamel islet on the posterior part of the occlusal surface.

Kä Gb

The upper cheek tooth rows (Gb 277) show a mixture of primitive and progressive morphological characteristics (Plate 22A,a). The protocone is long. Outer vertical grooves are present on both the parastyle and the mesostyle of the premolars and the buccal infoldings are concave. The end of the inner valley on the premolars is elongated and almost touches the anterior infundibulum, as is often seen on the upper cheek teeth of both *E. stenonis* and *E. süssenbornensis*. The upper molars all possess an unusually prominent caballine fold, which extends beyond the inner valley.

The teeth are, with their combination of primitive and evolved characteristics and the form of the inner valley, similar to *Equus marxi*, a lower Middle Pleistocene equid from the Süssenborn locality described by Musil (1969), as being a progressive form.

A single upper M1 (Gb 52) from the same horizon has more progressive characteristics. The specimen has been damaged on the lingual side, but appears to have had a long, caballine protocone (Table 17), and the inner valley ends in a protocone fold. The buccal infoldings are concave (Plate 22A,b). In Table 17 the size (length, breadth and length of protocone) of the upper M1s and M3s from Kä Ga and Gb compared with those of *E. stenonis*, *E. süssenbornensis* and *E. mosbachensis*. The M1 from the specimen Gb 227 is comparable in size to those of *E. stenonis* has, morphological characteristics similar to more progressive forms such as *E. marxi*. The specimen Gb 52, compares in size with the equally primitive *E. süssenbornensis*, possessed, however, none of the morphological characteristics associated with the species. The upper M3 from Kä Ga is longer than any of the known lower Middle Pleistocene species, but compares with *E. stenonis* in the breadth of the tooth. Table 17 serves to illustrate the problems of trying to identify single teeth of *Equus* to species. In comparison to the upper M1s and M3s from assemblages dating to the upper Middle and Late Pleistocene in the Neuwied Basin, the specimen from Kärlich are all relatively large (compare measurements in Table 17 with those in Table 18).

Post-cranial bone

Only a single, measurable third metacarpus from Kä F is known. The specimen is very long (302.0 mm). Unfortunately, the bone is poorly-preserved and encased, for the most part, in a loess concretion, so that only a few measurements could be taken (Table 25). It is longer than the metacarpus III of the two larger species of lower Middle Pleistocene horse *E. süssenbornensis* (metacarpus length: 237.0 - 286.0 mm) and *E. mosbachensis* (metacarpus length: 240.0 - 268.0 mm) (Data taken from Nobis, 1971). This bone represents a very large animal, with a withers height of about 193.5 cms. (The poor state of preservation of this specimen meant that the withers height had to be reckoned using the absolute length of the bone and not the lateral length; the actual height of this individual would have been about 2 - 3 cms smaller). However, this individual would still have exceeded the height of both *E. süssenbornensis* (withers height: 151.9 - 183.3 cms) and *E. mosbachensis*: 151 - 166 cms), but would have been closer in body-size to *E. süssenbornensis*.

The metatarsus III fragments from Kä F and Gb and the remaining postcranial bones from these deposits are also large in size (Tables 19 - 26). For example, a comparison of the breadth of the distal tibia in Table 19, shows that the find from Kä Gb, with an average of 90.00 mm is amongst the largest found in the Neuwied Basin, although some specimens from other, younger assemblages such as Sk 4 and Wa 1, do occasionally attain this size.

MIESENHEIM I

Mi 2

Post-cranial bone

The post-cranial equid bones from Mi 2, are also large in size (Tables 19 - 24). The calcaneum, the astragalus and the third phalanges (Appendix III) from Mi 2 are amongst the largest specimens from the Neuwied Basin assemblages so far.

Lower or Upper Middle Pleistocene assemblages in the Neuwied Basin:

KÄRLICH

Kä H

This horizon is described separately as its stratigraphical position is not clear (Chapter 3). The deposit could belong to either the lower Middle Pleistocene phase (absolute dating) or, the upper Middle Pleistocene (stratigraphy).

Dentition

Nobis (1970), has described specimens from the deposit as being, on the basis of their size and morphology, comparable to those of *E. mosbachensis*. An upper M1, seen in the Würges collection (H 232), has a long protocone, a caballine fold in the inner valley, concave buccal infoldings and outer vertical grooves on both parastyle and mesostyle (Plate 22A,c). These are all characteristics of caballine horses. This specimen does not show much difference in size when compared to the upper M1s from the older Kärlich deposits, and compares with the mean value given for the upper M1 of *E. mosbachensis* (Table 17). The lower cheek tooth from Unit H all have U-shaped inner infoldings.

Post-cranial bone

The single metatarsus III from this horizon is longer than the specimens from the younger Neuwied Basin assemblages (Table 26), and is slightly longer than those of *E. mosbachensis* (length: 298.0 - 320.0; after Nobis, 1971, Table XLVIII). The tibia from this assemblage is also large (Table 19). This horse had a withers height of about 172.5 cm (reckoned on absolute length and not lateral length).

Kä 1

The material from the Kärlich 1 assemblage (two fragmentary incisors) is not described further.

UPPER MIDDLE PLEISTOCENE

The caballine horse occurring at the beginning of the Saalian phase was a medium to large sized horse, which could attain the body-size of *E. mosbachensis*, but was usually slightly smaller (Nobis 1971; Prat in de Lumley (ed.), 1976). The cheek teeth of the Saalian caballine horses show only minor morphological differences when compared to those of the caballine horses occuring in the lower Middle Pleistocene.The further evolution of the caballine horses is marked by a continuing decrease in both body and dental size during the upper Middle Pleistocene (Nobis 1971).

A typical example of the Saalian caballine horse is *E. achenheimensis* from horizons 20c/d - 20a at the Achenheim locality, France, (Wernert, 1957; Nobis, 1971, page 41). This horse had a metatarsus length of 273.0 - 316.0, and a metacarpus length of 229.0 - 259.0 (after Nobis, 1971, Tables LXIV and LXVIII). Nobis (*ibid.*), gives a withers heigth of 155 - 165 cm. for the species, although a height of 141.2 - 162.0 cm. was calculated from the lateral lengths given by this author in the tables quoted above.

Another species occuring during the Saalian is *E. steinheimensis*. This horse was, with a metatarsus length of 285.0 - 292.0 (taken from data given by v. Reichenau, 1915 and Mourer-Chauvire, 1972), and a withers height of about 152.3 - 155.1 cms., similar in body size to the contemporary caballine horses, but retained some primitive characteristics in the dentition and metapodia reminiscent of *E. stenonis* (Prat, in de

Lumley (ed.), 1976). The cheek teeth of *E. steinheimensis* are characterized by primitive features such as a reduced protocone, multiple folding of the enamel on the occlusal surface, a short inner valley on the upper cheek teeth and the occurrence of V-shaped lingual folds on the lower cheek teeth.

Primitive characteristics are also present on the distal ends of the metatarsals in this species, whereby the breadth of the distal end is smaller than the breadth of the distal epiphyses. However, the difference in size between these two measurements appears to be very small: for example, Mourer-Chauvire (1972), gives a variation of only 1 mm for horses described as *Equus* aff. *steinheimensis* from the site of Chatillon-St. Jean, France. Thus, an identification to species on this characteristic alone is problematic. The absolute measurements of metatarsals from the Neuwied Basin assemblages shows that this characteristic occurs quite often (Appendix III). This characteristic should only be used on complete metatarsals, where the length of the bone is also known.

Upper Middle Pleistocene assemblages in the Neuwied Basin:

KÄRLICH

Kä Ja

Dentition

The upper and lower premolars have typical caballine characteristics. The metatarsus fragment is comparable in size to those from Ar 2 (Table 26 and Fig. 28). The tibia is small (Table 19).

LEUTESDORF

Dentition

The upper M3 has been described by Poplin (in Brunnacker et al., 1974) as belonging to a caballine horse. The presence of outer vertical grooves on both parastyle and mesostyle are characteristics usually occurring on the molars of the caballine horses. Poplin considers, quite rightly, the size of this single tooth to be unimportant; and states that this horse could belong to either. *E. mosbachensis* or the younger *E. germanicus*. The specimen is, however, larger than upper M3s from the other assemblages (Table 18). The tooth has three equally-sized distal pillars on its posterior face; a characteristic considered to be typical of *E. mosbachensis* by v. Reichenau (1915, Table IX, fig. 11).

Upper M1	Ar 1	Ar 3	Hu 2	Hu 4	Hu5
Length	27.9	27.9	23.8	27.5	26.9
Breadth	28.4	28.3	25.6	30.9	30.0
Length of protocone	–	15.1	11.0	14.6	16.8
	Sk 1	Sk 4	Wa 1	Wa 2	Wa 4/5
Length	25.2	26.6 - 32.9 n = 4	31.0	28.5	25.5
Breadth	27.6	22.9 - 30.5	26.2	30.0	26.9
Length of protocone	14.8	14.2 - 15.4	13.7	15.2	13.4

Upper M3	Lt	Ar 2	Hu 2	Hu 4	Sk 1	Sk 4	Wa 1
Length	35.3	30.3	28.8	31.8	29.9	32.0 - 33.9 n = 5	32.6
Breadth	–	–	–	24.9	23.4	24.7 - 25.7	27.5
Length of protocone	16.5	–	–	12.1	14.8	16.0 - 17.3	–

Table 18 Size of the upper M1 and M3 of *Equus* from the Neuwied Basin assemblages.

Kä Gb	Mi 2	Kä H	Kä J	Ar 1	Sk 4
88.0 - 92.0 n = 2	88.2	86.0	74.0	83.8	83.4 - 91.1 n = 6
Wa 1	**Wa 2**	**Wa 3**	**Wa Pr III**	**Hu 4**	**Hu 2**
82.6 - 89.2 n = 3	73.0 - 87.1 n = 3	81.8	97.3	79.4 - 84.0 n = 4	85.5

Table 19 Distal tibia breadth of *Equus* from assemblages in the Neuwied Basin.

	Mi 2	Ar 2	Sk 4	Wa 6	Hu 4
Length	130.1	–	124.0 - 126.0 n = 2	121.0	118.0
Breadth	63.0	61.0	59.0 - 61.0 n = 2	–	59.2 - 63.5 n = 3

Table 20 Size of *Equus* calcanei from the Neuwied Basin assemblages.

ARIENDORF

Ar Ch.

Dentition

The lower P2 (Appendix III) has been described by Poplin (in Brunnacker et al. 1975, page 121), as being comparable in size with both *E. mosbachensis* and others except the form occuring during the Late Weichselian, referred to *E. gallicus*. The specimen shows no particular morphological characteristics, other than those normally occurring in the caballine forms. The post-cranial bone from this assemblage was not measurable.

Ar 1

Dentition

The upper M1/2 has a long, thin protocone, but does not possess a caballine fold. Both parastyle and mesostyle have vertical outer grooves. The lower M3 has a primitive V-shaped lingual fold. Two smaller specimens, an upper M1 (Table 18) and a lower M1/2, possibly belonging to the same individual, were also found in this assemblage.

Post-cranial bone

Only two specimens from this assemblage could be measured. The tibia is small in comparison to the same bone from the lower Middle Pleistocene deposits at Kärlich and Miesenheim I, but compares in size with the specimens from the other assemblages (Table 19).

Ar 2

Dentition

The lower M3 has caballine characteristics. The other cheek teeth from this assemblage are too fragmentary to be described.

Post-cranial bone

The variation in length between the two complete metatarsals III from this assemblage is large (271.0 - 299.0 = 28 mm.) : the same variation in size is also given for other populations of Pleistocene species of *Equus* and appears to be normal for a fossil population. When compared to metatarsi III from other assemblages in the Neuwied Basin, the specimens from Ar 2 range in size with the larger specimens from Hu 4, Wa 1, Wa Pr III and Sk 4 (Table 26; Fig. 28). The single metacarpus III from Ar 2 falls in size between the specimens from these assemblages (Fig. 27). Morphological characteristics of the distal end of the metatarsus III, such as those found in *E. steinheimensis* (see

	Mi 2	Sk 4	Wa 1	Wa 3	Wa 4/5	Hu 4	Hu 5
Height	72.0	51.0-71.0 n = 4	61.0-65.0 n = 3	64.0	58.0	66.0-70.0 n = 2	66.0
Breadth	76.0	65.5-69.0 n = 3	–	66.0	73.0	69.0	69.0

Table 21 Size of *Equus* astragali from assemblages in the Neuwied Basin.

Kä H	Ar 2	Sk 4	Wa 1	Wa 3	Wa 4/5
98.5	81.8	94.5-96.2 n = 3	84.4-86.5 n = 3	82.1	82.5-85.0 n = 2

Table 22 Distal humerus breadth of *Equus* from assemblages in the Neuwied Basin.

Ar 2	Sk 4	Wa 1	Wa 2	Wa 3	Hu 4	Tö 2
82.3	85.3	83.1	72.7 juv.	79.0-84.5 n = 2	79.6-88.3 n = 2	88.8

Table 23 Distal radius breadth of *Equus* from assemblages in the Neuwied Basin.

above) were absent on the two complete specimens. An incomplete find (78/06,1, see absolute measurements, Appendix III) is the only example from this assemblage in which the breadth of the distal end is smaller than that of the distal epiphysis. However, as stated above, this characteristic is only valid on complete specimens where the length of the bone is also known. This single specimen does not necessarily mean that the horses from Ar 2 belong to the species *E. steinheimensis*. The results of comparison of the remaining post-cranial bone (radius, humerus, phalanx 1 etc.) from this assemblage are insignificant.

SCHWEINSKOPF

Sk 1

Dentition

Horse remains are represented by the incomplete upper and lower cheek teeth rows from a single individual only (Plate 23A,a).

The upper and lower cheek teeth are small in size in comparison to the material from the younger assemblage, Sk 4, (Table 18, for size of M3). The protocone is long and has a flat, lingual side. A caballine fold and outer vertical grooves on parastyle and mesostyle are only present on the upper premolars. The buccal infoldings are flatter than those on the upper cheek teeth from Sk 2. This is usually considered to be a more primitive characteristic. The upper M3 has two columns on its posterior face, the lingual one is bifurcated by a vertical ridge (Plate 23A,a). The single lower tooth has a U-shaped inner fold.

Sk2

Post-cranial bone

Only two phalanges have been found to date (Table 24).

Sk 4

Dentition

The teeth are larger than those of the individuals from Sk 1 (Table 18). A caballine fold is present on the premolars. The shape of the protocone is variable and can be either long with a vertical groove on the lingual side or

	Mi 1	Ar 1	Ar 2	Sk 2	Sk 4
Greatest length	97.0	91.5	93.0	82.0	87.0 - 95.4 n = 2
Proximal breadth	67.0	59.3	64.1	58.2 - 60.2 n = 2	67.9
Distal breadth	53.9	49.8	51.5	48.3 - 54.5 n = 3	48.3 - 54.2 n = 3

	Wa 1	Wa 2	Wa 3	Wa 4/5
Greatest length	87.0 - 94.0 n = 4	89.0 - 92.0 n = 2	89.6 - 91.0 n = 2	81.0 - 90.0 n = 3
Proximal breadth	56.0 - 62.5 n = 4	63.5 - 65.0 n = 2	62.0 - 67.9 n = 3	50.2 - 65.9 n = 3
Distal breadth	50.0 - 57.5 n = 4	53.1 - 54.4 n = 2	51.6 - 53.2 n = 2	38.5 - 49.3 n = 3

	Hu 4	Hu 5	Tö 2	Gö[1]
Greatest length	90.0 - 98.0 n = 5	76.0 - 93.0 n = 3	96.0	70.0- 77.0
Proximal breadth	59.2 - 65.0 n = 5	54.5 - 62.3 n = 3	62.3	
Distal breadth	50.0 - 57.3 n = 5	44.8 - 52.4 n = 3	41.3	

Table 24 Size of *Equus* first phalanges from assemblages in the Neuwied Basin. – [1]After Poplin, 1976.

short. The inner valley is long, occasionally thin, and sometimes ends in a series of enamel folds (Plate 23A,b). A vertical outer groove on the parastyle and mesostyle is present on the premolars. The buccal infoldings are deep and U-shaped.

The upper M3s have two columns on the posterior face, the lingual one being thicker than the buccal one. Two specimens of upper M3 (Plate 23A,c) have small enamel islets on the posterior part of the occlusal surface, a feature which is regarded as being primitive (Cregut, 1980), and which occurs on only one other specimen from Kä Gb. Smaller upper molars also occur with a short, thin inner valley (Plate 23 A, b). The lower cheek teeth have U-shaped inner infoldings and the external valley reaches to the isthmus (Plate 23 A, d).

Post-cranial bone

The length of the complete metatarsus III compares with those from assemblages such as Ar 2, Wa 1 and Wa Pr III (Table 26; Fig. 28). This specimen and the distal end of a second metatarsus III both show the primitive characteristics associated with the metapodia of *E. steinheimensis*, but are shorter than the length of specimens given for this species. The dentition from this assemblage has, however, none of the characteristics associated with *E. steinheimensis*.

The horse from Sk 4 has a withers height of 143.91 - 153.1 cm. This horse is smaller in size than the Saalian examples from Ar 2.

In comparison to known Pleistocene equids, it is similar in size to the holotype of *E. germanicus* (Fig. 29).

LATE PLEISTOCENE

Last interglacial/Early Weichselian

This phase is characterized by smaller-sized caballine horses. Prat (in de Lumley, 1976) considers that *E. steinheimensis* also persisted into this phase. The caballine horse occuring during the Early Weichselian was smaller than the Saalian form and more stocky in build. These horses are usually referred to the species *Equus germanicus*. The holotype of *Equus germanicus* was discovered in loess deposits dating to the Last Cold Stage BP (= Weichselian) at Unkelstein, near Remagen- on - Rhine, about twenty kilometres north of the Neuwied Basin (Nehring 1884). Nobis (1971), has calculated a withers height of about 151.9 - 153.1 for the holotype. The withers height of 130.0 - 142.9 cms. used here for this species (Fig. 29), is based upon metapodial measurements given by v. Reichenau (1915) (metacarpus length: 222.0 - 249.0; metatarsus length: 244.0 - 285.0).

ARIENDORF

Ar 3

Dentition

Only a single upper M1 is known from this assemblage. The find has been described and published by Poplin (in Brunnacker et al. 1975). The tooth has a long, caballine protocone and a thin, long inner valley. The mesostyle has a vertical outer groove, the parastyle is damaged. The tooth does not possess a caballine fold. The specimen is comparable in size to the upper M1 from Ar 1 (Table 18).

HUMMERICH

Hu 2

Dentition

The upper and lower cheek teeth are small in size (Table 18 for length and breadth of upper M1 and M3). The inner valley is short and thin and ends in a small caballine fold. The premolar possessess outer grooves on both parastyle and mesostyle (Plate 22B,a). The upper M3 (Plate 22B,a) has a wide open, groove between the two columns on its distal face, a feature, which v. Reichenau regarded as being characteristic of *Equus taubachensis* (1915, Plate IX, fig. 8) from the fauna at Taubach (G.D.R.). *Equus taubachensis* is described as a horse similar in body-size to E. *germanicus* but with some primitive dental characteristics (ibid.).

Post-cranial bone

The size of the single metacarpus III from this assemblage falls towards the smaller end of the size variation of the specimens from the Neuwied Basin assemblages (Tab. 25). The withers height of this horse is 139. 7 cm.

Hu 4

Dentition

A caballine fold is present on the upper premolars. The inner valley is thin. Some molars have short protocones with a pronounced vertical groove on the lingual side; others have long protocones with flat lingual sides (Plate 22B,c). Outer vertical grooves are present on both the parastyle and mesostyle of the premolars, but are only present on the mesostyle of the molars. Primitive characteristics, such as the flat buccal infoldings, also occur on the molars from this assemblage. An upper M3 has three equally-sized vertical columns on its posterior face (Plate 22B,b). The lower cheek teeth have U-shaped lingual folds. The buccal fold does not reach to the isthmus (Plate 22B,d).

Post-cranial bone

The length of the two metatarsals III from Hu 4 fall towards the larger end of the size variation for this bone from the assemblages in the Neuwied Basin (Table 26). Primitive characteristics of the distal end, as found in *E. steinheimensis* , are not present on these specimens (see absolute measurements, Appendix III). The single first phalange from this assemblage is one of the largest found to date (Table 24).

The horse from this assemblage has a withers height of 150. 0 - 151. 9 cms., based on the two metatarsals. This falls within the range given for the Saalian horse from Ar 2, and is similar to that given for *E. germanicus* (Fig. 29).

Hu 5

Dentition

Only a single upper cheek tooth has been recovered from this assemblage. The protocone is long in comparison

	Kä F	Ar 2	Sk 4
Greatest length	(302.0)	229.5	–
Proximal breadth	66.0	58.7	56.5 - 59.5 n = 4
Distal breadth	61.5	53.4	51.6 - 59.6 n = 3

	Wa 2	Wa 3	Wa 4/5	Wa Pr III	Hu 2	Gö[1]
Greatest length	233.0 - 240.0 n = 2	239.0	213.0 - 218.0 n = 2	231.0	225.0	202.0 - 210.0
Proximal breadth	58.5	57.6	50.0 - 51.5 n = 2	51.6 - 55.4 n = 2	58.5	49.5
Distal breadth	51.5 - 53.1 n = 2	53.8	46.6 - 49.2 n = 2	48.7 - 58.7 n = 4	51.5 - 53.1 n = 2	45.8

Table 25 Size of *Equus* metacarpi III from assemblages in the Neuwied Basin. – [1] After Poplin, 1976.

to those on the molars from Hu 4, and has a shallow vertical groove on the lingual side. The inner valley is long and thin, and does not possess a caballine fold. The buccal infoldings are U-shaped and the parastyle and mesostyle do not possess outer vertical grooves.

TÖNCHESBERG

Tö 2

Post-cranial bone
The few post-cranial bones found in this assemblage are probably from one single, adult individual and represent a large animal (Tables 23 and 24). Whether large size is typical of this population or refers to this individual alone is difficult to ascertain.

Late Weichselian

The caballine horse occurring during the Late Weichselian phase has been referred to *Equus gallicus*; the holotype of this species has been identified at the site of Solutre, France (Prat, in de Lumley (ed.), 1976). The species was smaller in body-size than the early Weichselian forms, but less stocky (Prat, ibid). This horse had a withers height of 125.6 - 142.8 cm. (metacarpus length: 211 - 228 mm.; metatarsus length: 248 - 274 mm., taken after Nobis 1971, Tables LXXV and LXXVIII).

A more detailed description of the Gönnersdorf and Andernach equid remains will be given elsewhere (Poplin, in preparation; Street, in preparation). The measurements included here (Tables 25 and 26) for the metapodia from Gönnersdorf are taken from Poplin, 1976 and my own observations on two specimens. The length of the metatarsi III from Gönnersdorf are comparable in size with those of *Equus gallicus*: the metacarpi III from Gönnersdorf are shorter. The withers height of the Gönnersdorf horse based on these specimens is 129.0 - 136.0 cm., which compares with the variation in height given for *E. gallicus* (Fig. 29).

NIEDERBIEBER

The equid material from this locality is too poorly preserved to be described in detail. The upper dp 2 shows little difference in size when compared with specimens from Wannen (Wa 1, 2 and 3) but is slightly larger than specimens from Sk 4 (see absolute measurements, Appendix III).

	Kä F	Kä Gb	Kä H	Mi I	Ar 2	Sk 4
Greatest length	–	–	323.0	–	271.0 - 299.0 n = 2	273.0
Proximal breadth	60.5	–	–	–	55.2 - 61.4 n = 4	57.8 - 62.3 n = 3
Distal breadth	59.0	62.0	–	(58.0)	53.5 - 56.2 n = 3	54.4 - 55.7 n = 2

	Wa 1	Wa 2	Wa 3	Wa 4/5	Wa Pr III
Greatest length	274.0	–	261.0 - 275.0 n = 2	254.0	273 - 276.0 n = 2
Proximal breadth	59.9	60.5	54.0 - 61.2 n = 2	52.6	51.2 - 60.6
Distal breadth	(57.3)	–	50.9 - 55.8 n = 2	43.5 - 50.3 n = 2	52.7 - 57.1 n = 3

	Hu4	Gö[1]	Miesenheim II
Greatest length	285.0 - 287.0 n = 2	258.0 - 262.0	269.0
Proximal breadth	54.0 - 60.0	50.4	(52.1)
Distal breadth	52.6 - 52.8 n = 4	49.5	51.4

Table 26 Size of *Equus* metatarsi III from the Neuwied Basin. – [1] After Poplin, 1976.

MIESENHEIM II

The single metatarsus III is slightly longer and more slender than the specimens quoted here from Gönnersdorf. The withers height of the horse from Miesenheim II is 143 cm.; it is larger than the one from Gönnersdorf, but also compares with the variation in height of *E. gallicus* (Fig. 29). The Wannen locality has produced numerous remains of horse from assemblages probably dating to the Second and Last Cold Stages BP (younger Saalian phase and Weichselian) (Chapter 4), and these are described separately here.

WANNEN

Wa 1

Dentition

The upper cheek teeth are similar in size and morphology to those from Sk 4 (Table 18 and absolute measurements, Appendix III). The protocone on the molars has a vertical lingual groove. The inner valley is long, thin and ends in a caballine fold or a series of enamel folds. The buccal infoldings habe a deep U-shape as on the Sk 4 specimens. The lower cheek teeth have a wide, U-shaped inner infolding. The inner valley reaches to the isthmus.

Wa 2

Dentition

The teeth compare in size and morphology with those of Wa 1 (Plate 23A,e).

Wa 3

Dentition

The upper premolars are large (Plate 23A,e). The protocone has a very pronounced groove on the lingual side and the inner valley is wide and ends in a caballine fold. Outer vertical grooves are present on both parastyle and mesostyle. The buccal infoldings are slightly flatter than those on the upper cheek teeth from Wa 1 and 2.

Wa 4/5

Dentition

The premolars have a short protocone with a vertical lingual groove. The inner valley is long, broad and has a prominent caballine fold. The buccal infoldings are flatter than those on the upper cheek teeth from Wa 1 and 2. The upper molars are small in size. The protocone on the molars is long and has a vertical lingual groove. The inner valley is long, thin and has a caballine fold. The buccal infoldings are flatter then those observed on teeth from Wa 1 and 2. The lower cheek teeth have a U-shaped inner infolding. The outer valley reaches to the isthmus.

Wa Pr III

Dentition

Only deciduous upper cheek teeth or permanent upper cheek teeth in the first stages of wear have been found in this assemblage and a further description of these specimens is not given. The lower cheek teeth have U-shaped inner infoldings. The external valley reaches to the isthmus on the premolars and occasssionally reaches slightly beyond on some molars.

All assemblages

Post-cranial bone

The majority of the post-cranial bones from the older assemblages Wa 1, Wa 2, and to some extent from Wa 3, are similar in size to one another and are therefore not described separately. The specimens from Wa Pr III are also similar in size to those of the older main site assemblages (Tables 19 - 23).

A more noticeable difference is to be seen between the metapodia from Wa 1, 2 and 3 and those specimens from Wa 4/5. For example, the metapodia from Wa 4/5 are much shorter and stockier than those from the other assemblages at this locality, with the exception of one metatarsus from Wa 4 (Table 26).

The withers height of the horses from the Wannen assemblages are as follows:

Wa 1	144.44 cms.
Wa 2	145.0 - 149.0 cms.
Wa 3	144.44 - 149.35 cms.
Wa 4/5	133.78 - 136.53 cms.
Wa Pr III	138.0 - 147.10 cms.

The horses from assemblages 1, 2 and 3 are all very similar in height. The horses from Wa Pr III also compare in size with those of Wa 1, 2and 3. The horse from Wa 4/5 is the smallest one.

SUMMARY

The results of this short study of the remain of *Equus* from the Middle and Late Pleistocene assemblages in the Neuwied Basin are as follows:

1) Tooth-size could not be used alone to identify to species, and changes in tooth-size were also useless in establishing a biostratigraphy for the Middle and Late Pleistocene deposits of this region.
   This was obviously related to the small sample size from the Neuwied Basin assemblages. For example, the upper M1s and M3s were the only tooth-types which provided enough measurable specimens for comparison in Table 17 and 18. »Large« teeth occurred in assemblages dating to the lower Middle Pleistocene and thought to date to the upper Middle Pleistocene.
2) Tooth morphology was found to be very variable, not only between the horses from different assemblages, but occasionally between individuals from the same assemblage. The only teeth with a distinct morphology were the ones from Kä Gb (KW 277). Occasionally a morphological characteristic occurred which could be compared with that of named species. For example, the form of the posterior face of the upper M3s showed morphological characteristics which allowed a comparison to named species. It

was not always clear, at least from the Neuwied Basin material, how far these characteristics were related to the morphology of the particular individual or to a population. It may, however, be of interest to study the morphology of the horse teeth from these assemblages in more detail than could be attempted here, when the sample-sized has increased.

3) Comparison of the body-size (length and breadth of the metapodia and withers height) of Middle and Late Pleistocene horses from the Neuwied Basin assemblages produced some results.

   Fig. 27 plots the breadth of diaphysis length of the complete third metacarpals of horses from the Neuwied Basin assemblages. Three very provisional groups can be identified. Group a is represented by the extremely large metacarpus from Kä F. Group b is represented by the metacarpals from Ar 2, Sk 4, Wa 2, Wa 3 and Hu 2. These bones are from relatively robustly-built horses, they vary in length from 250.0 mm to about 225.0 mm but remain constant in the width of the diaphysis. Group c is represented by the metacarpals from Wa 4/5, Wa Pr III and Gönnersdorf. These bones are all shorter than the ones from group b and, despite a reduction in the breadth of the diaphysis, indicate that the horses from this group tended to be more stocky in build in comparison with those of group b.

   In Fig. 28, where the length and breadth of diaphysis of the third metatarsals are plotted, the same pattern emerges. Group a is not represented here (lack of measurable samples), but the metatarsus from Kärlich H (length 323.0 mm) may belong to this group. Group b is represented by metatarsals from Ar 2, Sk 4, Wa 1, Hu 4 and Wa Pr III. Group c is represented again by the metatarsals from Gönnersdorf, Wa 4/5 and the single specimen from Miesenheim II. The metatarsals from Wa 3 range between group b and group a.

   Fig. 29 compares the withers height of the horses from the Neuwied Basin assemblages. The withers height show a gradual decline in size from the large horses occuring in Kä F and Kä H to the small horses occuring at Gönnersdorf. This decrease in body-size has already been recorded for the Middle and Late Pleistocene horses in Europe.

   The three groups described for the metapodia are still present in Fig. 29. Group a is represented by the horses from Kä F and possibly Kä H. The withers heights of both horses had to be reckoned from the greatest length of the bone, because of the state of preservation of the specimens. This means that the original heights of the horses would have been slightly smaller than the ones given here; a height of about 190.0 cm for the specimen from Kä F, and about 170.0 cm for the horse from Kä H would be correct. Both examples are larger than the size-variation given for *E. mosbachensis* which represents the »largest« caballine horse in Fig. 29. The unit Kä F is a lower Middle Pleistocene deposit, correlated broadly with the Cromer complex. The specimen from Kä F is close in size to *E. süssenbornensis* (see page 247), a species which also occurred during this period. Unit H was originally correlated with an older phase of the Saalian, although recent dating suggests that this unit could have been deposited during the lower Middle Pleistocene (Chapter 3).

   Group b is represented by the horses from Ar 2, Sk 4, Hu 2 - 4, and Wa 1 - 3. These horses range in size from about 157.0 - 141.0 cm. They occur, so far, in assemblages dated to the Second Cold Stage BP (Ar 2), and to the beginning of the Last Cold Stage (Hu 2 - 4). The assemblages Wa 1 - 3 have also been tentatively dated to the Second Cold stage BP. The largest horses from group b, are those occurring in the Ar 2 assemblage. This assemblage was deposited towards the end of the Second Cold Stage BP, and the variation in withers height of the horses from this assemblage can be taken as representing horses typical for the end of the Saalian in the Neuwied Basin region. The remaining horses from the other assemblages in group b are comparable with the Ariendorf ones in height, or show a tendency to be slightly smaller. When compared with the named species of *Equus* (Fig. 29), the withers heights of the horses from group b tend to compare with the overlap in the size ranges of *E. achenheimensis* and *E. germanicus*. *E. achenheimensis* is known to have occurred at the beginning of Saalian, and *E. germanicus* was present at the beginning of the Weichselian. Thus, the horses from group b could be described as comparable to those occurring at the end of the upper Middle Pleistocene and beginning of the Late Pleistocene periods in Europe.

   Group c is represented by the more stockily-built horses from Gönnersdorf and Wa 4/5. The

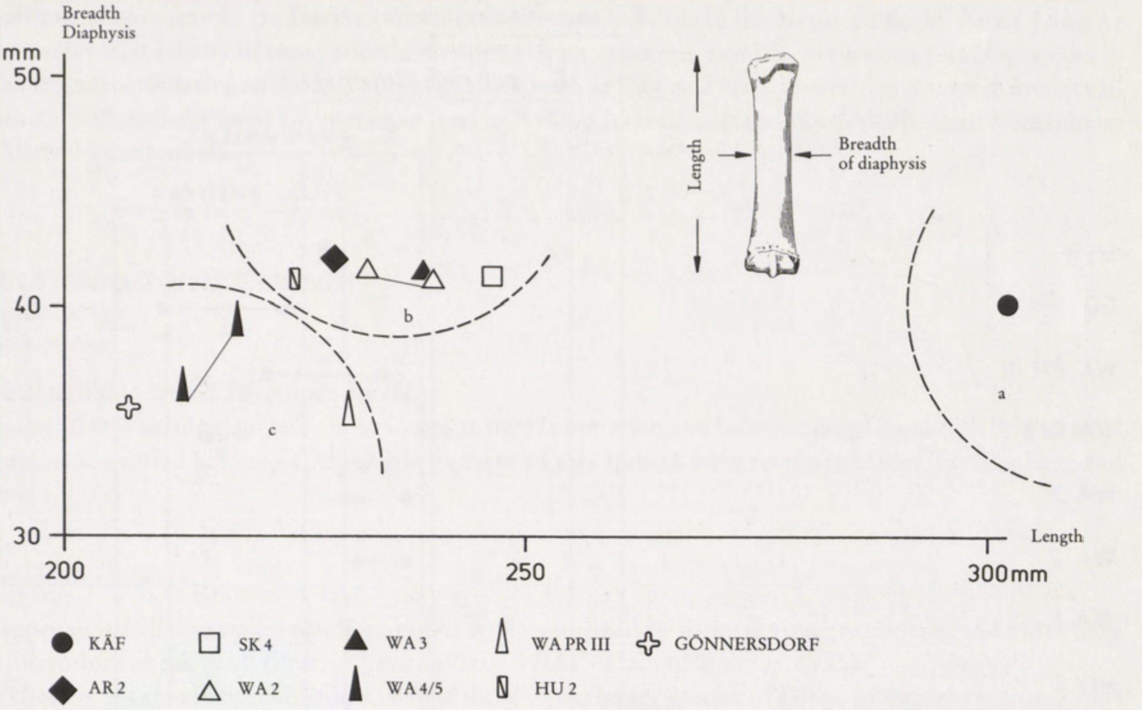


Fig. 27 Length plotted against the breadth of the diaphysis of the third metacarpals of *Equus* spp. from assemblages in the Neuwied Basin region.

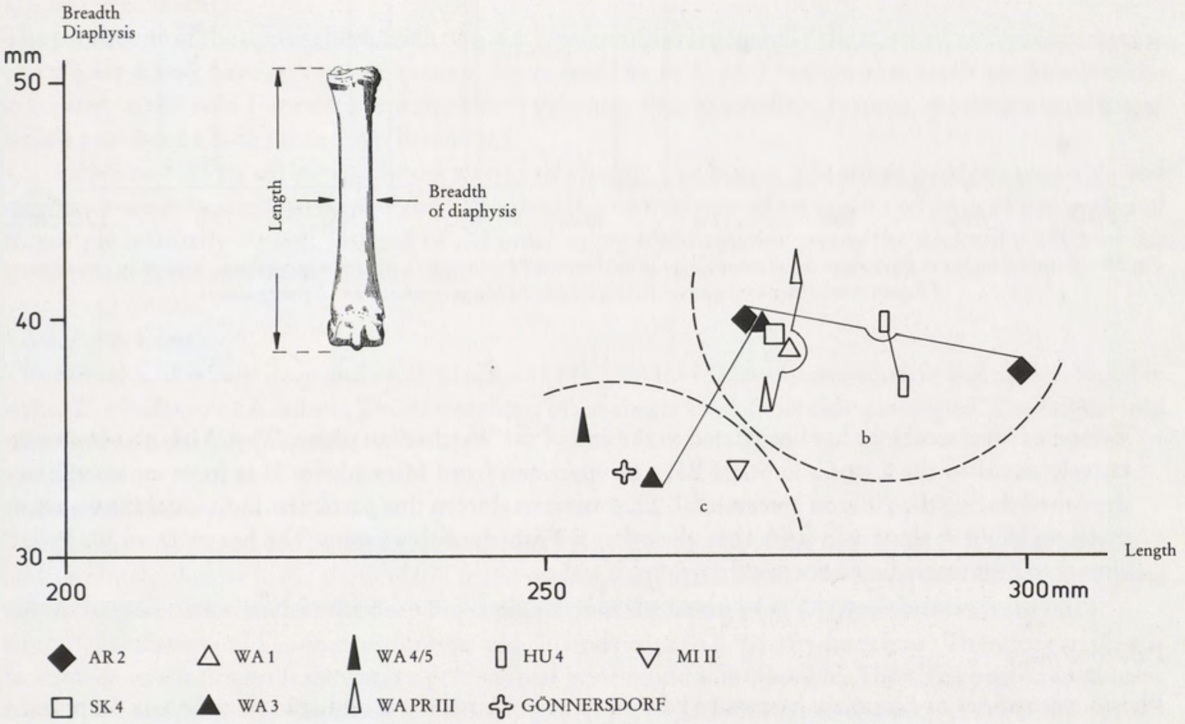


Fig. 28 Length plotted against the breadth of diaphysis of the third metatarsus of *Equus* spp. from assemblages in the Neuwied Basin region.

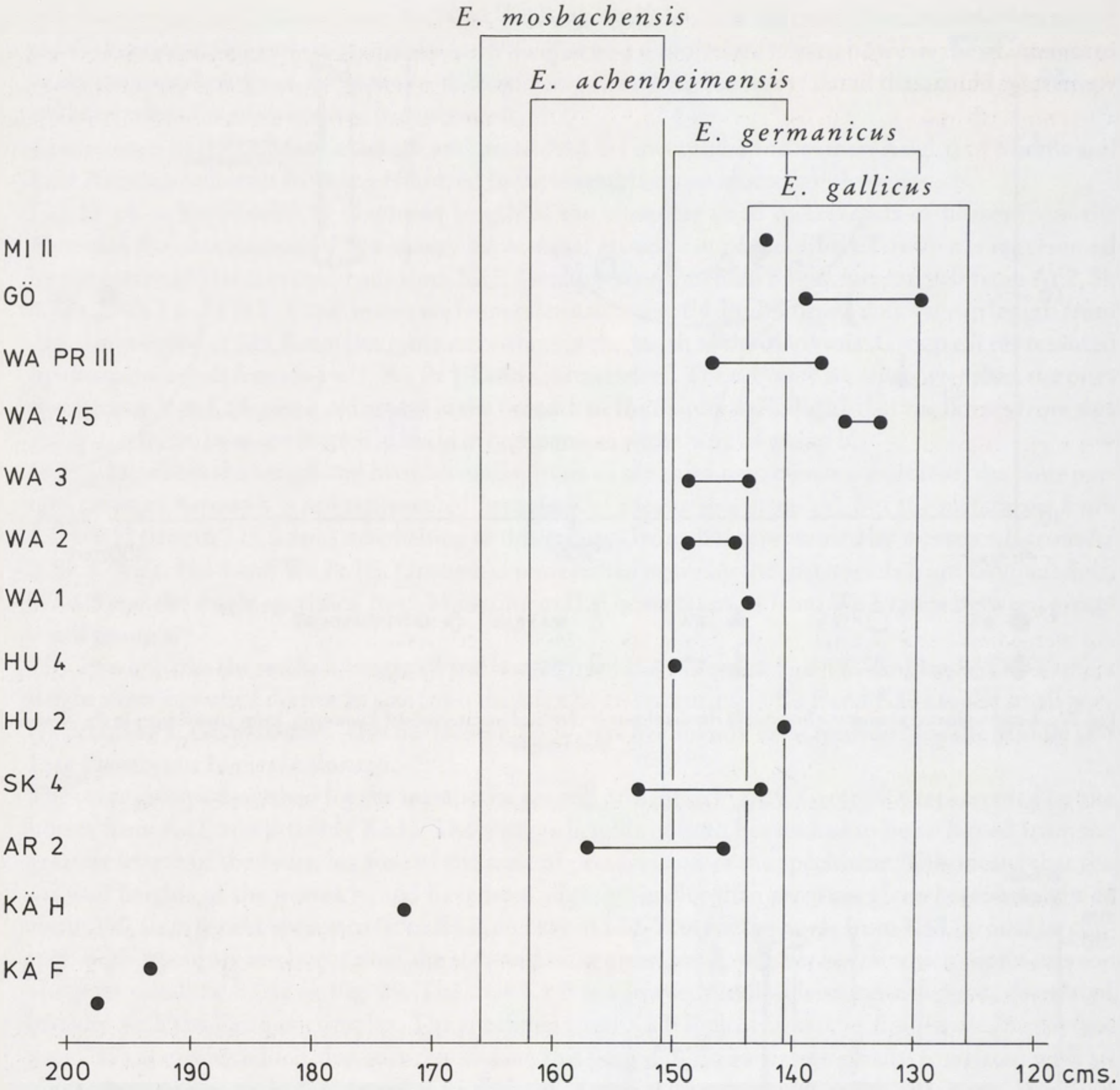


Fig. 29 Withers heights of *Equus* spp. from assemblages in the Neuwied Basin region, plotted against those (minimum - maximum) of *Equus mosbachensis, Equus achenheimensis, Equus germanicus* and *Equus gallicus*.

Gönnersdorf assemblage has been dated to the end of the Weichselian phase. Wa 4/5 has also been tentatively dated to the Last Cold Stage BP. The specimen from Miesenheim II is from an assemblage deposited during the Alleröd Interstadial. This metatarsal from this particular individual shows a tendency to be more slender in form than the other specimens of this group. The horses from Wa Pr III, appear to be intermediate between the groups b and c.

Palaeoecology

Pleistocene species of *Equus* are known to have occurred in both warm and cold stage faunas. Important for horse is the presence of some form of grassland where it can graze. This can either be open steppe or clearings in an otherwise wooded environment.

Equus spp. often occur in the faunas located in cold stages deposits in the Neuwied Basin. At Ar 1 and Ar 2, for example, it occurs in association with open steppe or steppe-tundra environment. It also occurs in warm stage faunas dating to the end of interglacials, such as Kä 1 and Mi 2. Horse also occurs in interstadial faunas, such as those from Gönnersdorf (end of Bölling Interstadial) and Niederbieber and Miesenheim II (Alleröd Interstadial).

EQUUS (ASINUS) HYDRUNTINUS

(Regalia, 1904)
Extinct wild ass

Plate 23B; Table 27 and 28; Appendix III.
Remains of this small equid have been found at the Hummerich and Schweinskopf localities. Post-cranial fragments identified as being comparable to those of this species were recovered from Tönchesberg and Wannen.

Basic identification

This species has all the typical equid traits, but is characterized by its small size, grazile limb and foot bones and microdont cheek teeth (Prat, in Lavocet (ed.), 1966; Stehlin & Graziosi 1935).
The cheek teeth are much smaller in size than those of the larger species of *Equus* (compare measurements of *E. (A.) hydruntinus* cheek teeth in Table 27 with those of *Equus* spp. in Table 17 and 18).
The morphology of the upper and lower cheek teeth described below (Fig. 26), distinguish this species from recent asses (*Equus asinus*) and onagers (*Equus hemionus*) , and are similar to those of the extinct Early and lower Middle Pleistocene horse *Equus stenonis* (Stehlin & Graziosi, *ibid.*; Prat, *ibid.*).

Upper cheek teeth

The protocone of the upper cheek teeth of *E. (A.) hydruntinus* is generally short, whereas *Equus hemionus* and *Equus asinus* have an oval protocone. Some teeth from *E. (A.) hydruntinus* teeth are however the exception to this rule. For example at this site of Pair-non-Pair (Girondon, France), specimens were found which possessed a long protocone (Prat 1956).
The caballine fold ist often weakly-developed or absent. The buccal infoldings between parastyle and mesostyle are only slightly concave and often flat. The vertical groove on the buccal faces of parastyle and mesostyle is usually absent. The end of the inner valley often extends across the occlusal surface of the tooth towards the anterior infundibulum.

Lower cheek teeth

The buccal fold is very deep and often touches the lingual fold. This characteristic is not so developed in either *E. hemionus* or *E. asinus*. The ectostylid is often absent or only weakly developed. The lingual fold is straight and sharply pointed.

Post-cranial bone

The post-cranial bones can be distinguished quite easily from those of the larger equids by their small size and extremely slender form, particularly in the metapodia (Plate 23B,d). However, they still retain typical equid characteristics, such as the deep Fossa plantaris of the femur of *E. (A) hydruntinus* from Hu 4.
Both *E. hemionus* and *E. asinus* are comparable in body-size to *E. (A.) hydruntinus* . Therefore an identification as to species on fragmentary post cranial bone alone is impossible. Thus, the post-cranial bone from Hu 4 and Sk 4 was identified as belonging to *E. (A.) hydruntinus* , as cheek teeth from this species were also present in these assemblages: the fragments of bone from Wa 1 and Tö 2 could only be described as *Equus (A)* cf. *hydruntinus* .

	Upper cheek teeth		Lower cheek teeth		
	M1	M 1/2	P 3/4	M1	M2
	Hu 4 Str. 3	Hu 4 34/84,6	Sk 4 Str.	Hu 4 -15/33,1	
Length	23.2	22.4	23.0	22.5	22.9
Breadth	22.5	12.8	14.6	–	15.4
Length Protocone	7.8	11.8	–	–	–

Table 27 Absolute measurements of upper and lower permanent cheek teeth of *Equus hydruntinus.*

	Hu 4		*E. hydruntinus* Romanelli*		*E. hemionus* recent*	
	ant.	post.	ant.	post.	ant.	post.
Length	81.0-86.0 n = 4 x = 83.25	75.2	86.0	76.0	73.0	66.5
Breadth of diaphysis	22.9-25.2 n = 3 x = 23.8	23.5	27.0	23.5	24.3	25.0

Table 28 Comparative measurements of anterior and posterior first phalanges of *Equus hydruntinus* from Hu 4 and Romanelli and recent *Equus hemionus.* – * Stehlin & Graziosi, 1935.

Material

– SCHWEINSKOPF

Sk 4

Fragment of a metatarsus s/d.; a lower P3 or 4 sin. A minimum of one individual is represented.

– HUMMERICH

Hu 4

A lower dp2 dex. and dp3 dex. (the teeth belong to the same individual); an upper M1 sin.; an upper M1 or M2 sin.; two lower, not further identifiable premolars dex. (same individual); distal end of a femur dex.; distal end of a metacarpus or tarsus s/d.; distal epiphysis of a metacarpus or tarsus s/d. (juvenile); distal end of two metacarpi III s/d.; proximal end of a metatarsus III sin.; an astragalus dex.; a first anterior phalange sin.; a first anterior phalange s/d.; two first phalanges ant./post. s/d.; a first posterior phalange s/d.; a second anterior phalanges s/d.; fragments of two posterior phalanges s/d.; two third phalanges ant/post. s/d.

A minimum of one juvenile and two adult individuals is represented by the cheek teeth.

EQUUS cf. *HYDRUNTINUS*

Material

– WANNEN

Wa 1

Fragment of a first phalange ant/post. s/d.

A minimum of one individual is represented.

– TÖNCHESBERG

Tö 2

Fragment of a pelvis, juvenile (?).

A minimum of one individual is represented.

Description

Dentition

The cheek teeth have all the characteristics described in the basic identification. The upper and lower M1 from Hu 4 are particularly characteristic for this species (Plate 23B,a and b). The protocone on the upper M1 is very short and the lingual edge is convex. The tooth possessess, however, a well-defined caballine fold. The lower M1 has an extremely deep buccal infolding, touching the lingual infolding. The lower P3 or 4 from Sk 4 (Plate 23B, c) has a pronounced »V«-shaped lingual infolding only reaches to the middle of the occlusal surface.

Post cranial bone

The absolute measurements of the post cranial bone is given in Appendix III (Plate 23B,d). Table 28 compares the length and diaphysis breadth of anterior and posterior first phalanges from Hu 4 with those of *E. (A.) hydruntinus* from the Romanelli cave (Italy) and recent *E. hemionus*. The Hu 4 specimens compare in size with those of *E. (A.) hydruntinus* from Romanelli cave.

Discussion

The small equid was first described by Regalia (1904) from remains found amongst faunal material from the Romanelli cave near Otranto, Italy. It was subsequently named *Equus (Asinus) hydruntinus* on the basis of morphological differences between this species and the onager *Equus hemionus* (Regalia 1907).

Stratigraphic range

Equus (A.) hydruntinus occurred during the Middle and Late Pleistocene periods in Europe. It has been recorded in faunas dating to the Saalian and Weichselian cold phases (Prat, in Lavocet (ed.), 1966), and is also known from faunas dating to the Eemian Interglacial (Bökönyi, 1954). This species appears to have survived quite late into the Holocene in parts of Europe. For example, Bökönyi (1954), has identified this equid at the Neolithic site of Hodmezovassrhdy-Bodzaspart in the Hungarian plain.

E. (A.) hydruntinus occurs at Schweinskopf and Wannen in assemblages located in deposits thought to date to the Second Cold Stage BP, which has been correlated with a younger phase of the Saalian, at Tönchesberg in an assemblage possibly dating to the Last Interglacial (Eemian) and at Hummerich in an assemblage dating to the beginning of the Last Cold Stage BP (Weichselian).

The occurrence of *E. (A.) hydruntinus* in the Neuwied Basin assemblages falls within the known stratigraphic range of this species in North-West Europe.

Palaeoecology

During the Middle and Late Pleistocene periods this species occurred throughout most of Europe, including southern England, but not in Alpine regions, northern Germany, Spain or Greece. *Equus (A.) hydruntinus* is known to have occurred in interglacial or interstadial faunas in North-West Europe, and has also been recorded in cold-stage, reindeer-dominated faunas in southern France (Prat, 1966). As with the larger equids, this species indicates an open steppe environment or at least locally open, herbaceous vegetation.

This species has only been recorded from the volcano localities so far. It occurs in assemblages in cold stage deposits, such as at Wannen and Schweinskopf. At the latter locality, it is associated with a macrofauna dominated by reindeer *Rangifer tarandus* and artic fox *Alopex lagopus*. At Hummerich and Tönchesberg *Equus (A.) hydruntinus* is associated with faunas located in soils formed under warm conditions. At Tönchesberg, warm molluscan and mammalian microfauna have been recovered from these deposits. The sparse pollen from Tö 2 deposits indicates an open environment with some coniferous woodland.

Family *RHINOCEROTIDAE* (Owen, 1845)

Two genera of Pleistocene rhinoceros, *Dicerorhinus* and *Coelodonta*, are recognizsed in Europe. The skulls of the Pleistocene rhinoceros are identifiable as to species, but are rarely found complete. The teeth of *Coelodonta* are very characteristic (see page 272): those of the various species of *Dicerorhinus* are more difficult to identify.

Fig. 30 gives the terminology used and the measurements taken on the dentition from these genera. The post-cranial bone was measured following Guerin (1980).

Genus *DICERORHINUS* (Gloger, 1841)

Basic identification

Three species of *Dicerorhinus* are known from the Middle and Late Pleistocene faunas of Europe. Identification as to species is difficult and is based primarily on characteristics of the upper and lower cheek teeth.

Dicerorhinus etruscus Falconer, 1859.

The teeth of this species are characterized by their smooth enamel and low crowns (brachyodont). Two subspecies have been identified (Guerin, 1980), the primitive and more gracile *D. e. etruscus* and the larger, more evolved *D. e. brachycephalus*.

Dicerorhinus mercki Jäger, 1839; Kaup, 1841.

This species of *Dicerorhinus* is characterized by its large size. The teeth of *D. mercki* have smooth enamel and are not particularly high-crowned (hypsodont).

Dicerorhinus hemitoechus Falconer, 1868.

The cheek teeth of this species are high-crowned (hypsodont) and have finely wrinkled enamel.

DICERORHINUS ETRUSCUS cf. *BRACHYCEPHALUS*

(Schroeder, 1903)

Extinct rhinoceros

Plate 24, a; Figures 31 - 34; Tables 29 - 32.

Specimens described as being comparable to this subspecies occur only at Miesenheim I.

Material

– MIESENHEIM I

Mi 1

A cuboid, large cuneiform and proximal end of a metatarsus IV sin. The bones could be rearticulated after excavation and belong to a single, adult individual.

Mi 2

An upper dp3; a calcaneum sin; a small cuneiform; fragments of phalanges. A minimum of two individuals, a juvenile represented by the deciduous tooth and an adult represented by the post-cranial material have been identified.

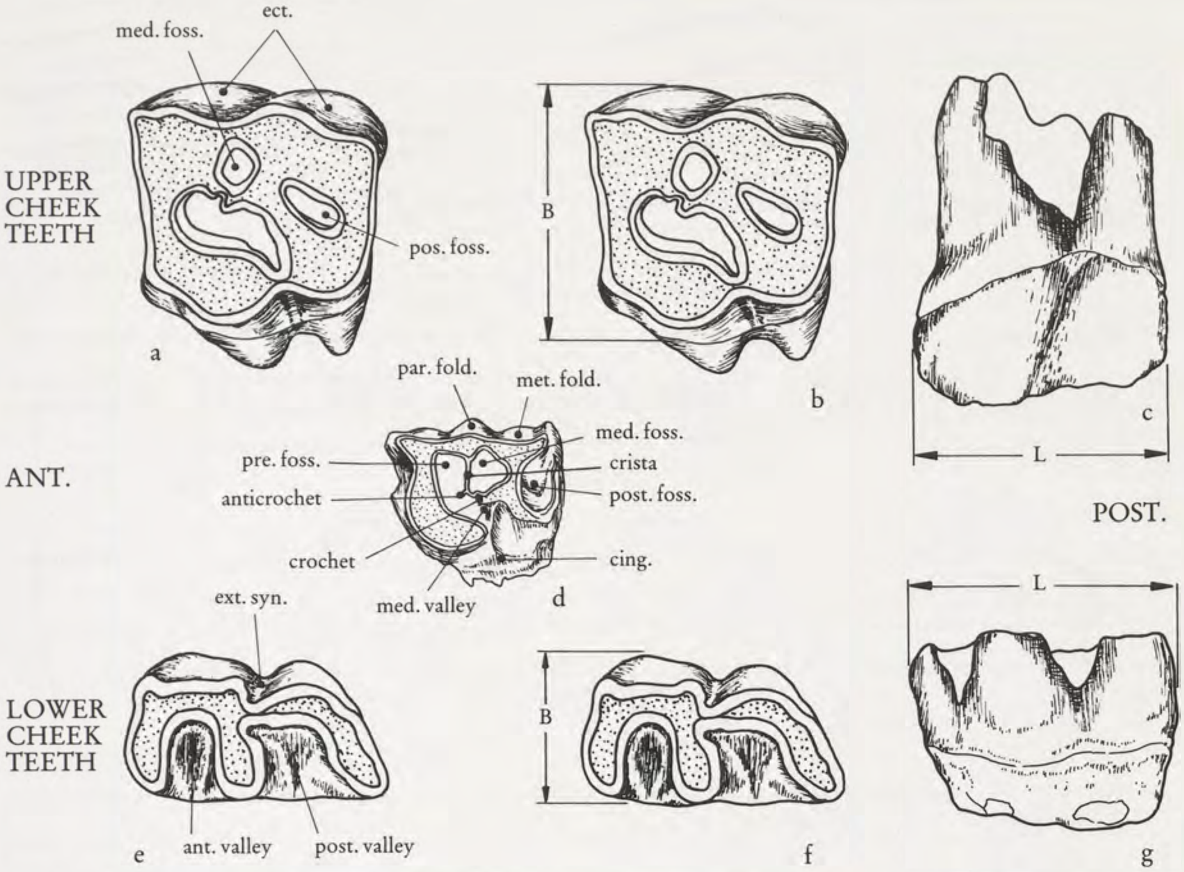


Fig. 30 Terminology used in the text to describe the cheek teeth of the Family *Rhinocerotidae*, and the measurements taken, using an upper (a, b and c) and lower (e, f and g) M1 or M2 and an upper dp2 (d) from woolly rhinoceros *Coelodonta antiquitatis* as examples. Upper cheek teeth. – a and d occlusal view. ect.: ectolophe; pr. foss.: prefossette; med. foss.: medifossette; post. foss.: post fossette; par. fold: paracone fold; met. fold: metacone fold; cing.: cingulum; med. valley: median valley. – b B: breadth of tooth. – c L: length of tooth (buccal view).
Lower cheek teeth. – e occlusal view. ant. valley: anterior valley; post. valley: posterior valley; ext. syn.: external syncline. – f B: breadth of tooth. – g L: length of tooth (buccal view).

Description

The upper dp 3 (Plate 24, a)
The tooth is small, low-crowned and has thin, smooth enamel. The ectolophe is rather flat, the paracone fold (Fig. 31, 1) is low and a small metacone fold is also present (Fig. 31, 2).
The median valley has a simple, arched form and a small cingulum at its base on the lingual side. A more distinct cingulum is present on the anterior side of the tooth. A crochet is present, and the medifossette is closed in this specimen. The posterior fossette is likewise closed.
The small size of the tooth excludes *D. mercki*. The low crown and the presence of a cingulum are more characteristic of *D. etruscus* than *D. hemitoechus*. The form of the ectolophe also resembles those forms of *D. etruscus* which have a flat ectolophe, such as the example of *D. e. brachycephalus* from Nauterie (Fig. 31). The tooth compares with the size-ranges of all three forms of *Dicerorhinus* given in Table 29.

Calcaneum
The proximal end of the find is damaged. The distal end is prominent as in *D. hemitoechus* (Fig. 32, a 1). When viewed caudally, the distal end appears more pointed as in *D. hemitoechus* (Fig. 32b). The caudal

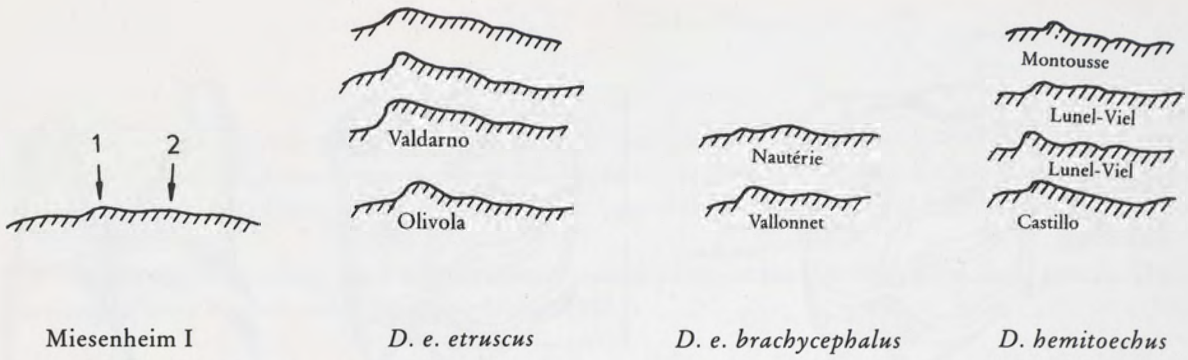


Fig. 31 Comparison of the ectolophe form of the upper dp3 from Miesenheim I with those of Pleistocene species of *Dicerorhinus* (after Guerin 1980, Part. II. *D. e. etruscus*: Fig. 57, page 456; *D. e. brachycephalus* and *D. hemitoechus*: Fig. 85, page 640). Numbers referred to in text. Not drawn to scale.

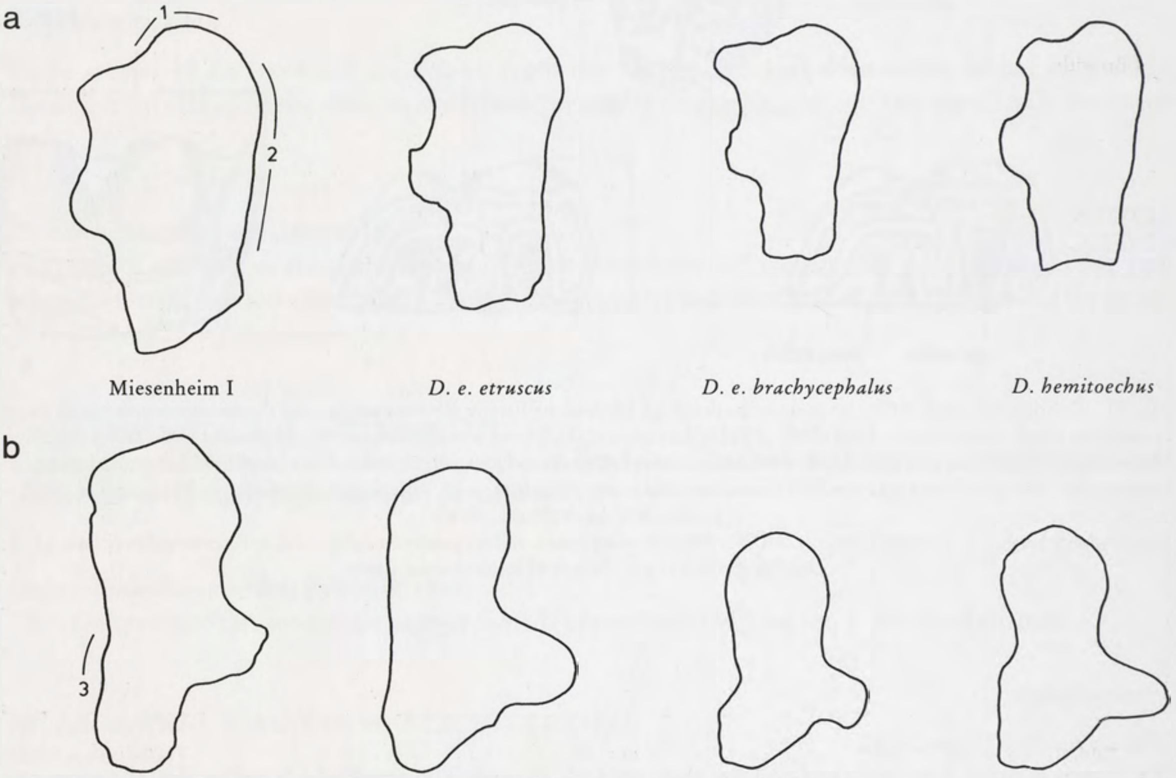


Fig. 32 Comparison of the Calcaneum from Miesenheim I with those of Pleistocene species of *Dicerorhinus*. – a Lateral view. – b Caudal view. – (After Guerin 1980, Part. II. *D. e. etruscus*: Fig. 75, page 529; *D. e. brachycephalus* and *D. hemitoechus*: Fig. 104, page 725). Numbers referred to in text. Not drawn to scale.

edge (Fig. 32, a 2) is flat as in *D. hemitoechus*; the caudal edge of both *D. e. etruscus* and *D. e. brachycephalus* being more rounded. The lateral edge of the sustentaculum diverges outwards as in *D. hemitoechus* and *D. e. brachycephalus* (Fig. 32, b 3).

The calcaneum falls into the size-variation of all three species of *Dicerorhinus* considered in Table 30. It is closer to *D. e. brachycephalus* in the distal breadth and closer to *D. hemitoechus* in the length. The specimen from the Mi 2 assemblage appears to be intermediate in morphology and size between *D. hemitoechus* and *D. e. brachycephalus*.

	Mi I	*D. e. etruscus**	*D. e. brachycephalus***	*D. hemitoechus***
Length	34.9	36.0 - 46.0 n = 11 x = 41.70	36.0 - 46.5 n = 9 x = 42.33	39.0 - 48.0 n = 22 x = 42.89
Breadth	37.4	36.0 - 46.0 n = 11 x = 41.77	33.5 - 46.5 n = 11 x = 41.77	39.0 - 44.5 n = 25 x = 41.78

Table 29 Length und breadth of upper dp 3 from Mi I compared with those of Pleistocene species of Dicerorhinus. – * After Guerin, 1980, Part II, 651 table 124; ** *ibid.*, 463 table 86.

	Mi I	*D. e. etruscus**	*D. e. brachycephalus***	*D. hemitoechus***
Length	121.5	109.0 - 130.0 n = 23 x = 118.72	110.0 - 131.0 n = 27 x = 118.76	104.0 - 139.0 n= 20 x = 120.43
Breadth	65.0	57.5 - 71.0 n = 25 x = 63.64	55.5 - 77.0 n = 24 x = 67.92	54.0 - 74.0 n = 18 x = 62.83

Table 30 Length and breadth of the calcaneum from Mi I and comparison with those of other Pleistocene species of *Dicerorhinus*. – * After Guerin, 1980, Part II, 530 Fig. 108; ** *ibid.*, 727 Fig. 146.

	Mi I	*D. e. etruscus**	*D. e. brachycephalus***	*D. hemitoechus***
Length	62.5	53.0 - 67.0 n = 25 x = 58.54	55.5 - 70.0 n = 11 x = 62.23	55.0 - 71.0 n = 9 x = 61.22
Breadth	39.3	36.0 - 48.0 n = 24 x = 41.25	37.0 - 44.0 n = 11 x = 40.86	38.0 - 53.0 n = 9 x = 44.39
Length of articulation	40.0	34.0 - 47.0 n = 23 x = 39.83	36.0 - 48.0 n = 8 x = 42.38	33.0 - 42.0 n = 7 x = 36.93
Greatest height	57.5	50.0 - 62.0 n = 23 x = 55.65	51.0 - 70.5 n = 11 x = 57.36	51.0 - 57.5 n = 7 x = 53.93

Table 31 Measurements of the cuboid from Mi 1 and comparison with those of other Pleistocene forms of *Dicerorhinus*. – * Guerin, 1980, 731 table 147; ** *ibid.*, 534 table 109.

	Mi I	*D. e. etruscus**	*D. e. brachycephalus***	*D. hemitoechus***
Proximal breadth	43.9	30.0 - 42.0 n = 25 x = 37.58	36.5 - 46.0 n = 8 x = 40.19	33.5 - 48.0 n = 9 x = 41.39
Proximal depth	37.5	33.0 - 41.0 n = 22 x = 36.32	33.5 - 43.5 n = 9 x = 38.28	33.5 - 46.5 n = 10 x = 40.40

Table 32 Size of the proximal end of the metatarsus IV from Mi I and comparison with other Pleistocene forms of *Dicerorhinus*. – * Guerin, 1980, 755 table 154; ** *ibid.*, 556 table 116.

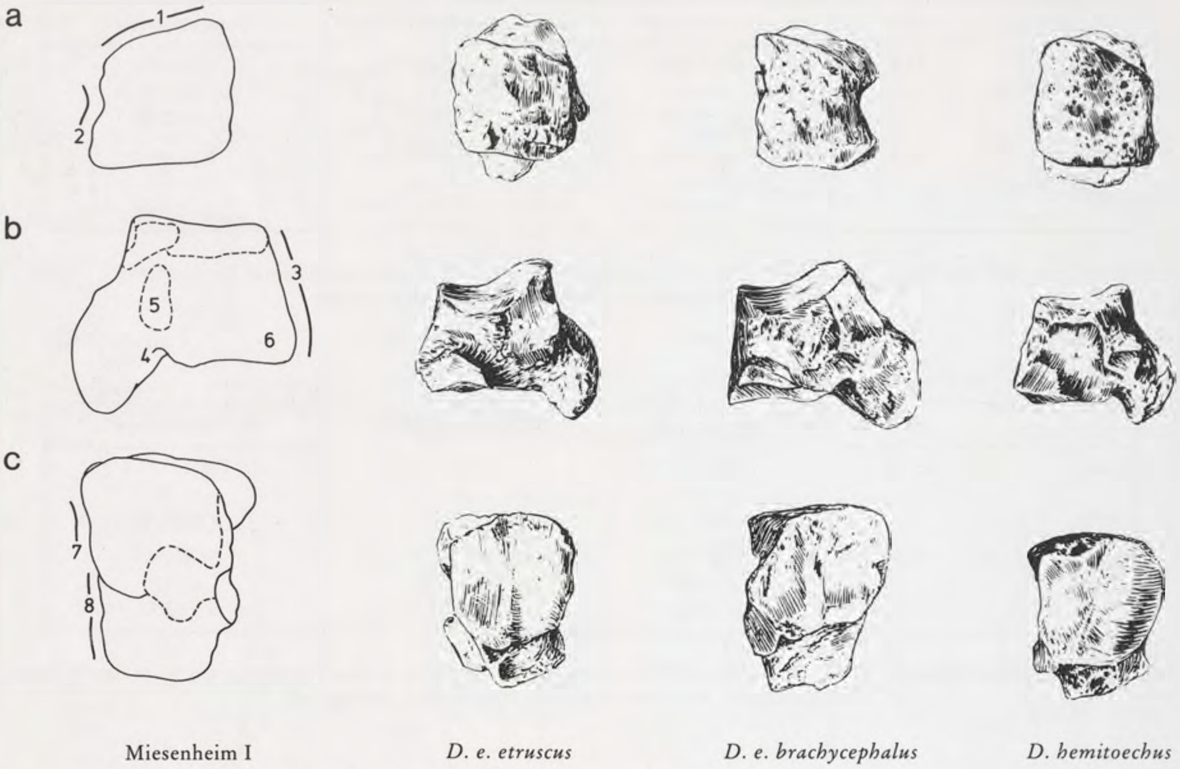


Fig. 33 Comparison of the Cuboid from Miesenheim I with those of Pleistocene species of *Dicerorhinus*. – a Anterior view. – b Medial view. – c Proximal view. – (After Guerin 1980, Part. II. *D. e. etruscus*: Fig. 76, page 533; *D. e. brachycephalus* and *D. hemitoechus*: Fig. 105, page 729). Numbers referred to in text. Not drawn to scale.

Cuboid

The find is slightly damaged on the proximal surface. The cuboid is small, it has a trapezoidal anterior face, the proximal edge of which slopes downwards to the medial side (Fig. 33, a 1). The outline of the anterior face is regular and has a slight indentation on the lateral side as in *D. hemitoechus* (Fig. 33, a 2).

The specimen from Mi 2 does not have the pronounced »waisting« of the anterior face as in *D. e. brachycephalus*.

When viewed from the medial side, the slope of the anterior face resembles that of *D. e. brachycephalus* and *D. hemitoechus*. (Fig. 33, b 3). The distal edge is marked by a notch towards the posterior side (Fig. 33, b 4), a feature also found on both *D. hemitoechus* and *D. e. brachycephalus*.

The proximal articulation (Fig. 33, b 5) is weathered, but appears to have been long and thin, and in this respect is similar to *D. e. brachycephalus* and *D. hemitoechus*. The distal articulation (Fig. 33, b 6) is missing on the Mi 2 specimen. The proximal surface is weathered, so that its original shape can no longer be seen. It has an indentation on the lateral side (Fig. 33,c 7) which also occurs in *D. e. etruscus*. The posterior part of the cuboid (Fig. 33, c 8), forms a straight axis with the body as seen in *D. e. brachycephalus*.

The specimen is closer in size to the average measurements of cuboids of *D. e. brachycephalus* (Table 31).

Metatarsus IV

The metatarsus is straight and slender. The triangular shape of the proximal surface (Fig. 34, a), and the position of the two medial articulations (Fig. 34, b) resemble those of *D. e. etruscus* and *D. e. brachycephalus*.

The metatarsus from Mi 1 compares in size with both *D. hemitoechus* and the etruscan forms (Table 32).

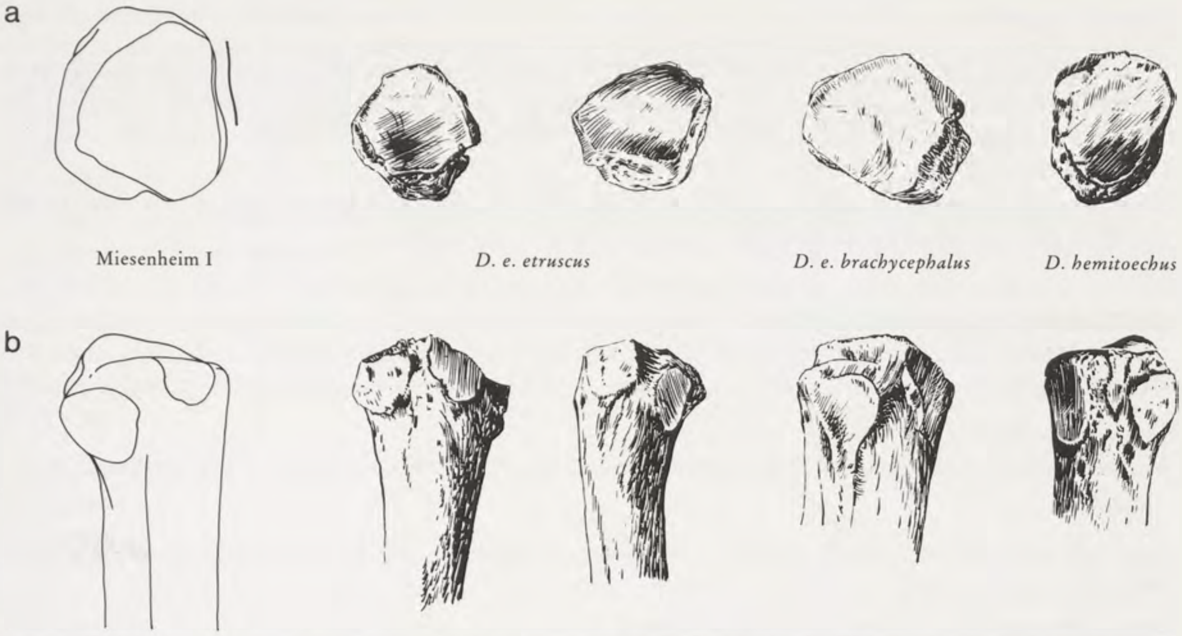


Fig. 34 Comparison of the Metatarsus IV (proximal end) from Miesenheim I with those of Pleistocene species of *Dicerorhinus*. – a Proximal view. – b Medial view. – (After Guerin 1980, Part. II. *D. e. etruscus*: Fig. 83, page 555; *D. e. brachycephalus* and *D. hemitoechus*: Fig. 112, page 752). Numbers referred to in text. Not drawn to scale.

Discussion

The problems of a definite identification on such a small amount of material and of individual variation are obvious.

However, the remains of *Dicerorhinus* from Mi 1 and Mi 2 show characteristics similar to *D. etruscus*, particularly the subspecies *D. e. brachycephalus* and, in some cases, *D. hemitoechus.*

The species *D. hemitoechus* evolved from *D. etruscus*, and the specimens from the Miesenheim locality may represent the intermediate form *D. e. brachycephalus*, or a form between *D. e. brachycephalus* and *D. hemitoechus*. They have been provisionally described as *Dicerorhinus etruscus* cf. *brachycephalus*. This revises previous descriptions of this material as belonging to *D. hemitoechus* (Bosinski et al., 1988).

Stratigraphic range

D. e. brachycephalus occurs, according to Guérin (1980), in the latter part of the Early Pleistocene and beginning of the Middle Pleistocene. The last known occurrence of this subspecies was at the end of the Elsterian. Primitive forms of *D. hemitoechus* first occur during the Elsterian (*ibid.*). Both forms occur together during the Elsterian only. If primitive forms of *D. hemitoechus* are already known in the Elsterian, then the evolution *D. e. brachycephalus* - *D. hemitoechus* must have taken place during this phase or even earlier. As only *D. hemitoechus* occurs in faunas dating to the Holsteinian and post-Holsteinian, then intermediate forms appear to have been restricted at least to the Elsterian.

The fossiliferous horizons at Miesenheim I have been dated to the Ariendorf Interglacial, which in turn has been correlated with the Holsteinian. The presence of a possible intermediate form of *Dicerorhinus* and its known stratigraphic range suggests that this locality is older than the Holsteinian, and supports van Kolfschotens view (1988), that the fossiliferous horizons at Miesenheim I belong to an interglacial of the Cromer complex (see Chapter 4).

Palaeoecology

D. e. brachycephalus has been recorded at localities throughout continental Europe and appears to have been an ubiquitous animal (Guérin, 1980). The low-crowned cheek teeth and the horizontal carriage of the head of this subspecies suggest that it was a browser and it appears to have frequented open forest or woodland (Guérin, *ibid.*).

Dicerorhinus etruscus cf. *brachycephalus* is recorded at Miesenheim I in an assemblage pollen-dated to the end of an interglacial, in association with open birch and pine woodland.

DICERORHINUS cf. *HEMITOECHUS*

(Falconer 1868)
Extinct rhinoceros

Plate 24,b c; Table 33.
Remains identified as belonging to *Dicerorhinus* cf. *hemitoechus* have been found at Tönchesberg, assemblage 2.

Material

– TÖNCHESBERG

Tö 2
An upper P3 sin. and an upper M2 sin.
A minimum of one individual is represented.

Description

Both teeth are high-crowned, which excludes the species *D. etruscus*. An identification as to *D. hemitoechus* or *D. mercki* was more problematic.

Upper P 3
The tooth is damaged on the anterior side and on the occlusal surface. The tooth is high-crowned (hypsodont) and the enamel is slightly wrinkled as is typical for *D. hemitoechus*. The lingual end of the medial valley is closed (Plate 24, b i). A weakly-defined cingulum is placed about half-way up the crown on the lingual side and the tooth possesses an equally high anterior cingulum. The posterior fossette is closed by a low, cingulum-like wall (Plate 24, b ii).

	Tö 2	*D. hemitoechus*[1]	*D. mercki*[1]
P^3			
Length	37.6	34.0-49.0 n = 42 x = 41.80	43.0-51.0 n = 8 x = 46.63
Breadth	47.7	43.0-57.0 n = 63 x = 48.20	50.0-62.0 n = 13 x = 57.23
M^2			
Length	65.5	54.5-66.5 n = 28 x = 59.86	53.0-71.0 n = 29 x = 64.92

Table 33 Length and breadth of the upper cheek teeth of *Dicerorhinus* from Tö 2 compared with those of *D. hemitoechus* and *D. mercki.* – [1] Guerin, 1980, 651 table 124.

The ectolophe is smooth and rounded. Guérin (in de Lumley, 1976), describes the premolars of *D. hemitoechus* as having an undulating ectoloph, which is not the case here. The tooth does not possess a paracone fold, but has a distinct metacone fold, a feature more typical of *D. mercki* than *D. hemitoechus*. The tooth compares in size with the ranges given for *D. hemitoechus* than *D. mercki* (Table 33).

Upper M 2

The lingual side of the tooth is missing and the base of the crown and parts of the occlusal surface are damaged. The tooth is high-crowned (hypsodont) and the enamel is very smooth. The tooth has an anterior cingulum (Plate 24, c iii). The median valley is a simple arch. The medifossette is open, although both crochet and crista are present (Plate 24, c i). The posterior fossette is partly closed by a low cingulum-like wall. The ectolophe has a paracone fold, which disappears about half-way down the crown (Plate 24, c ii).
The tooth is longer than the range given for *D. hemitoechus* and compares in the length with *D. mercki* (Table 33).

Discussion

The upper cheek teeth from Tö 2 are difficult to identify as to species. The upper P3 is, with its high crown, finely-wrinkled enamel and size more comparable to *D. hemitoechus*. The form of the ectolophe of this specimen is probably due to the variation in morphology often noticed amongst the genus *Dicerorhinus*. The upper M2 compares in the length more with *D. mercki*.
The possibility that each tooth represents a separate species is unlikely. The specimens are therefore provisionally described, on the basis of the size and morphology of the upper P3, as *Dicerorhinus* cf. *hemitoechus*.

Stratigraphic range

Guérin (1980), has recognised a »primitive« form of this species occurring during the Elsterian. The last occurrence of this species was during the Weichselian. Its presence in the Tö 2 assemblage, thought to date to the end of the Last Interglacial (=Eem) or to the beginning of the Last Cold Stage Weichselian, falls within the known stratigraphic range of this species in North-West Europe.

Palaeoecology

D. hemitoechus has been recorded in temperate faunas (interglacial/interstadial) in North-West Europe. The high-crowned cheek teeth and the low carriage of the skull indicate that the animal fed on grasses and herbs and it appears to have been associated with open woodland or local herbaceous vegetation during the interglacials (Stuart, 1982). This species occurs at the Tönchesberg in an assemblage thought to belong to the end of an interglacial or to an interstadial phase in association with coniferous woodland.

DICERORHINUS sp.

Two specimens from unit Gb at Kärlich have been previously identified as belonging to *D. etruscus* or *D. hemitoechus*. A closer identification was not possible and these finds are described here as *Dicerorhinus* sp.

Material

– KÄRLICH

Kä Gb
Mandible fragment with deciduous tooth; an upper M1 or M2.

Description

The mandible fragment is damaged and only part of a posterior lobe of a deciduous tooth, possibly a lower dp 3 or 4 remains. The find has already been described by F. Poplin as a lower dp 4 from either *D. hemitoechus* or *D. etruscus*.

The enamel of the tooth is slightly wrinkled, as in *D. hemitoechus*; the crown is low, characteristic of *D. etruscus.* The posterior lobe has an open »V« shaped valley when viewed from the side which is found on the lower deciduous teeth of both *D. hemitoechus* and *D. etruscus*. The upper M1 or M2 is embedded in a loess concretion and only the buccal side could be seen in any great detail. The enamel is very smooth and the tooth is relatively low-crowned. The median valley is open and there is a small pillar at the base of the valley on the lingual side.

Both specimens belong to the genus *Dicerorhinus*, but could not be further identified to species.

Genus *COELODONTA* (Bronn, 1831)

COELODONTA ANTIQUITATIS
(Blumenbach 1807)
Woolly rhinoceros

Plate 25A. B; Tables 34 - 39; Appendix II; Appendix III.

This species occurs frequently in faunal assemblages in the Neuwied Basin. A large amount of material has been recovered in particular from the Wannen assemblages.

Basic identification

Taken from Bouchud (in Lavocet, 1966) and Guérin (1980).

Dentition

The cheek teeth are large in size and hypsodont. They often possess an outer cement layer between the enamel infoldings of the occlusal surface and on the external walls. The teeth are also characterized by their rugose enamel. Typical of this species is the fusing of the crochet and crista forming an isolated enamel islet on the occlusal surface of both the upper deciduous and permanent cheek teeth. The upper permanent molars have a weak paracone fold and a developed mesostyle (Fig. 30). The lower cheek teeth are also hypsodont and have two lobes. When viewed from the lingual side, both deciduous and permanent teeth have a »V«-shaped anterior valley and a »V« or »U«- shaped posterior valley. As wear progresses, the anterior lobe takes on an angular and the posteror lobe a crescentic form on the occlusal surface (Fig 30).

Skull

Typical of this species is the ossification of the nasal bones.

Post-cranial bone

The bones, particularly the extremities, are large and robust. A further identification as to this species was based on characteristics given by the authors mentioned above and by Borsuk-Bialynicka (1973).

Material

– ARIENDORF

Ar Ch.
Mandible fragment sin. with lower M1 and M2 in jaw.
A minimum of one individual is represented. The mandible has been identified by F. Poplin (1975, page 121).

Ar 1
Skull fragment with upper molar 2 sin.; lower M2 dex.
A minimum of one individual is represented.

Ar 2
A lower P3 sin. and dex.; an upper M2 sin. and dex.; an unciform dex.
A minimum of two adult individuals is represented. This is based on the upper M2s, one example of which is very worn and the other in first stages of wear.

Ar 3
A cuboid.
A minimum of one individual is represented.
The specimen has been described by Poplin (1975, page 126) and featured in Guerin (1980, page 731, Table 147).

Unstratifiable finds
Possibly Ar 2 or Ar 3.
Maxillary fragment dex. with upper P3 - 4 and M1 - 2; maxillary fragment sin. with upper P3 - 4 and M1 - 3.
The specimens belong to the same adult individual.

– SCHWEINSKOPF

Sk 2
An upper M3 dex.; two scapulae sin.; one metacarpus III dex.; one metatarsus III dex.
A minimum of two individuals is represented.

Sk 4
An upper M2; fragmentary lower (pre)molars; proximal end of a radius sin.; proximal ends of two ulnae dex.; an ulna sin.; an ulna dex. (juvenile); a cuneiform dex.; a cuboid sin.; a metacarpus II dex.; a fragmentary metacarpus III dex.; a complete metacarpus III sin.; distal ends of two metacarpi sin.; two fragmentary metacarpi IV dex.
A minimum of two adults and one juvenile is represented.

– WANNEN

Wa 1
Mandible fragment sin. with lower dp 1 - 3 and fragment dp 4; an upper dp3 sin.; fragment of a juvenile? ulna sin.; a metacarpus II dex.; a metacarpus III dex., proximal end of a metacarpus III sin.; fragmentary metacarpus dex.; a metacarpus IV dex.; distal epiphysis of a tibia dex.; a metatarsus III dex.
A minimum of three individuals, one juvenile and two adults is represented.

Wa 2
Four lower dp2 dex.; four lower dp 3 dex.; maxillary fragment dex. with upper dp1 - 3 and fragment of dp4; maxillary fragment sin. with upper dp3; 3 upper dp1 dex.; 2 upper dp 1 sin.; 2 upper dp2 dex.; 4 upper dp2 sin.; 4 upper dp3 sin.; a dp4 sin.; maxillary fragment sin. with upper P2 and P3; maxillary fragment dex. with upper P2 - 4 and M1; an upper P4 and M1 sin.; P2 dex.; a lower M1(?) dex.; a lower M2 sin.; an upper M2 sin.; two radi dex.; a radius sin.; an ulna dex.; a naviculare dex.;an unciform sin.; a magnum dex.and sin.; a lunate sin.; a cuneiform sin.; a metacarpus II sin.;a metacarpus III sin.; a metacarpus IV dex.; two pelvis fragments sin.; distal end of a tibia sin.; a cuneiform dex.; a metatarsus dex.; a metatarsus IV dex.
A minimum of two adult and one juvenile individuals is represented.

Wa 3
A lower dp 2 and dp4 sin.; a dp2 dex.; a lower P3 sin.; an upper P4 and M2 dex.; an upper M1 dex.; an upper M3 dex.; an upper M3 sin.; a lower M1 sin.; a lower M1 or M2 sin.; a humerus dex.; 3 ulnae dex. and a distal ulna sin.; a scaphoid sin. and dex.; a lunate dex.; an unciform sin.; a cuneiform dex.; a calcaneus dex. and sin.; a cuboid dex.; an astragalus sin.; a metacarpus II dex.; two metacarpi III dex.; a metacarpus IV dex.; distal end of a tibia sin.; a phalange 1 and a phalange 2.
A minimum of one juvenile and three adults is represented.

Wa 4/5
Maxillary fragment sin. with upper dp1 - 3 and fragment dp 4; mandible fragment sin. with lower P4 - M3; lower P2 sin.; lower P3 sin.; lower M3 dex.; proximal end of radius dex.; 2 ulnae sin., one from a juvenile animal; a naviculare dex.; a scaphoid sin. and dex.; two lunates sin., one from a juvenile animal; one unciform dex., juvenile; one unciform sin.; a magnum sin.; a pisiform dex.; two cuneiforms sin.,

dp 1	Wa 2		Wa Pr III		*C. antiquitatis*[1]
Length	24.2-27.5 n = 3 x = 25.9		24.3		21.0-21.5 n = 3 x = 21.17
Breadth	18.1-21.5 n = 3 x = 21.0		21.7		17.0-18.0 n = 3 x = 17.67
dp 2	Wa 2	Wa 4/5	Wa Pr III	Hu 4	
Length	32.9-33.5 n = 3 x = 33.2	31.6	33.2	34.7	28.0-33.0 n = 27 x = 30.5
Breadth	30.0-33.0 n = 3 x = 31.73	33.4	31.8	32.5	26.0-32.5 n = 31 x = 29.35
dp 3	Wa 1	Wa 2	Wa 4/5	Wa Pr III	
Length	44.0	44.8-47.2 n = 4 x = 46.0	44.5	43.0	31.0-45.5 n = 27 x = 41.96
Breadth			39.0	38.0	31.5-42.0 n = 28 x = 37.11
lower dp 2	Wa 1	Wa 2	Wa 3		
Length	31.3	32.0-34.2 n = 2 x = 33.1	31.0		26.0-29.5 n = 11 x = 27.23
Breadth	16.4	17.3-18.5 n = 2 x = 17.9	17.7		15.0-18.5 n = 12 x = 16.33

Table 34 Comparative measurements of deciduous upper cheek teeth and lower dp2 from *C. antiquitatis*. – [1]Measurements taken from Guerin, 1980, 651. 657 table 124 and 126.

one from a juvenile animal; two metacarpi II dex.; a metacarpus III sin.; a metacarpus IV dex.; an astragalus sin. and dex.; a metatarsus III sin.; an anterior first phalange; two anterior second phalanges; an anterior third phalange; a posterior first phalange; a posterior second phalange.

A minimum of three individuals, one juvenile and two adults is represented.

Wa Pr III

Maxillary fragment sin. with upper dp1-3; lower M3 dex.; mandible sin. with lower P4-M3; two lower M2s dex.; two lower M3s dex.; proximal ends of two radi dex.; distal ends of two radi dex. from juvenile animals; a complete radius dex. and a radius sin from a juvenile animal; proximal end of an ulna dex.; two damaged ulnae sin. and dex.; a diaphysis fragment from an ulna dex.; a navicular dex.; a scaphoid dex. and two sin.; a lunate dex.; three unciforms dex.; a pisiform sin.; a cuneiform dex.; a magnum dex.; a metacarpus III dex.; two metacarpi IV dex.; a metacarpus IV sin.; distal ends of two tibiae dex., one tibia sin. and one juvenila tibia sin.; a cuboid dex.; two astragali dex.; a calcaneus dex.; a metatarsus III dex.; a metatarsus IV sin.; two posterior first phalanges;

A minimum of three adult and two juvenile individuals is represented.

– HUMMERICH

Hu 4

An upper dp2 sin.; a lower M2 dex.; a metatarsus II sin.

A minimum of two individuals, one juvenile and one adult is represented.

– GÖNNERSDORF

Two upper (pre) molar fragments.

The finds have been identified by Poplin (in Brunnacker (ed.), 1978, page 99).

<table>
<tr><th>M2</th><th>Ar 1</th><th>Ar 2</th><th>Ar 2 or 3</th><th>Wa 2</th><th>Wa Pr III</th><th><i>C. antiquitatis</i>[1]</th></tr>
<tr><td>Length</td><td>–</td><td>52.5</td><td>57.3</td><td>56.7</td><td>50.2 - 55.8
n = 2
x = 53.0</td><td>47.0 - 65.5
n = 59
x = 56.42</td></tr>
<tr><td>Breadth</td><td>58.9</td><td>51.0 - 55.2
n = 2
x = 53.5</td><td>53.8</td><td>63.0</td><td>63.4</td><td>45.0 - 63.0
n = 62
x = 55.79</td></tr>
<tr><td>M3</td><td colspan="2">Wa 3</td><td colspan="3">Wa Pr III</td><td></td></tr>
<tr><td>Length</td><td colspan="2">57.0 - 57.4
n = 2
x = 57.2</td><td colspan="3">66.0</td><td>44.0 - 70.0
n = 69
x = 58.0</td></tr>
<tr><td>Breadth</td><td colspan="2">51.0 - 57.0
n = 2
x = 54.0</td><td colspan="3">51.5</td><td>37.5 - 55.0
n = 42
x = 49.88</td></tr>
</table>

Table 35 Comparative measurements of upper permanent cheek teeth of *C. antiquitatis*. – [1]Measurements taken from Guerin, 1980, 651 table 124.

	Ar ch.	Sk 4	*C. antiquitatis*[2]
Length	54.2	57.2	42.5 - 58.5 n = 45 x = 50.69
Breadth	32.3	30.0	24.0 - 38.5 n = 52 x = 31.39

Table 36 Comparative measurements of lower M2 of *C. antiquitatis*. – [2]Measurements taken from Guerin, 1980, 657 table 126.

Description

The measurements of some of the deciduous and permanent cheek teeth of *C. antiquitatis* from the assemblages in the Neuwied Basin are compared with the size-variation given for these teeth by Guérin (1980) in Tables 34 - 36.

The deciduous cheek teeth

The material from the Wannen locality is unique in the amount of deciduous teeth found in the assemblages. The majority of these specimens are either unworn or show only slight traces of wear (Plate 25A).

The enamel of the deciduous upper and lower cheek teeth is not as rugose as on the permanent teeth, but still appears wrinkled. The morphology of the deciduous teeth is the same as that given in the basic identification and does not differ from those characteristics given for the deciduous teeth of this species by Guérin (1980, pages 642 and 655).

However, as both the upper and the lower dp1 are not found too often in Pleistocene assemblages, and as some morphological details seen on this material are considered to be rare, more detailed descriptions of the complete specimens of deciduous teeth from the Wannen and Hummerich assemblages are given in Appendix II.

Table 34 shows that the deciduous teeth from Wannen (all assemblages) and from Hu 4 are larger than the mean values for the deciduous dentition given by Guérin and are occasionally larger than the size-variation given for a particular tooth.

The permanent cheek teeth

The comparative measurements of the complete upper and lower permanent cheek teeth of C. *antiquitatis* from the Neuwied Basin assemblages are shown in Tables 35 and 36. The permanent molars compare with the measurements given by Guérin for this species.

Upper premolars

The premolars have low cingula on the anterior part of the tooth. An upper P4 from Ariendorf has a small dot of enamel in the centre of the medifossette (Plate 25 B, a).

Upper M2

The upper M2s all have a closed medifossette. The post fossettes are partly closed. One specimen from Wannen, has a high accessory column on the posterior side of the tooth. Occasionally lingual cingulums are present. An anterior cingulum is usually present. The median valley extends across the occlusal surface in some specimens (Plate 25B, a), where it attains the same height as the buccal edge of the medifossette.

Upper M3

All the upper third molars have closed medifossettes. The posterior fossette is generally closed by a low cingulum-like wall which often bears a cusp. An anterior cingulum is present. The accessory column on the posterior side is generally well-developed (Plate 25B, b i). Occasionally a small lingual cusp occurs at the base of the median valley.

The upper M3, possibly belonging to assemblage 2 or 3 at Ariendorf, appears sub-rectangular in form when viewed from above (Plate 25B, a). The remaining third molars are all triangular in form (Plate 25B, b, ii).

Lower permanent cheek teeth

The permanent lowers all have typical V-shaped anterior and U-shaped posterior valleys and pronounced external synclines as is usual in this species. Both anterior and posterior faces have cingula.

The skull fragment

The find, from Ar 1, has been recently damaged so that only the nasal bones and part of the frontal bones are preserved. The specimen shows the fused bony nasal septum characteristic for this species.

Post-cranial bone

The post-cranial bone has the same morphological characteristics as those given for this species by Guérin (1980). A single metatarsus IV from Wa 2 has two separate medial facettes on the proximal end.

Despite the large amount of post-cranial bone, especially from the Wannen assemblages, biometrical comparisons of this material between assemblages and localities are limited. This is in part due to the small sample of bones which could be measured and compared with one another, and the large size-range between individuals from the same assemblage. For example two radii from the Wa 2 assemblage have a variation in length of 50 mm. (Table 37). Although this lies within the range given by Guérin (1980) for the radius of C. *antiquitatis*, such large variations in size present problems with possible biostratigraphic interpretations as discussed below.

Tables 37 - 39 compare the size of some of the post-cranial bones of C. *antiquitatis* from the Neuwied Basin assemblages with the size-ranges given for this species by Guérin (*ibid.*).

The post-cranial bones of C. *antiquitatis* from the Neuwied Basin assemblages are generally larger than the mean value for this species given in the tables. The two small specimens of ulna from Wa 3 and Wa 4/5 and the height of an unciform from Wa 4/5 are the exception to this. The metacarpi and metatarsi vary in size. Post-cranial bones from Wa Pr III tended to fall consistently into the larger end and those from Wa 4/5 into the smaller end of the size-ranges given by Guérin (*ibid.*).

RADIUS	Sk 4	Wa 2	Wa Pr III	*C. antiquitatis*
Length	–	386.0-436.0 n = 2 x = 411.0	425.0-431.5 n = 2 x = 428.25	334.0-413.0 x = 380.35
Proximal breadth	115.5	112.0-119.1 n = 3 x = 115.56	112.3-125.2 n = 4 x = 118.72	97.0-126.0 x = 112.78
Breadth of diaphysis	–	63.8-64.0 n = 3 x = 63.93	63.0-71.1 n = 3 x = 67.7	54.0-75.5 x = 63.41

ULNA	Wa 3	Wa 4/5	
Length	483.0	485.5	456.0-543.0 x = 494.45
Breadth of diaphysis	49.5-59.8 n = 3 x = 54.8	59.0	44.0-68.0 x = 55.44

SCAPHOID	Wa 4/5	Wa Pr III	
Length	89.0-94.5 n = 2 x = 91.75	92.0-94.5 n = 2 x = 93.25	76.5-97.0 x = 88.39
Breadth	66.5-72.0 n = 2 x = 69.25	68.0-75.6 n = 2 x = 71.5	51.0-71.5 x = 60.15
Height	72.0-76.0 n = 2 x = 74.0	76.0-81.0 n = 2 x = 78.5	57.0-70.5 x = 64.14

UNCIFORM	Ar 2	Wa 2	Wa 3	Wa 4/5	Wa Pr III	
Breadth	83.0	84.2	84.3	68.1-82.1 n = 2 x = 75.1	77.8	62.0-84.0 x = 73.67
Height	59.5	61.5	61.0	50.5-61.5 n = 2 x = 56.0	54.0	45.0-59.5 x = 53.81

CUBOID	Ar 3	Sk 4	Wa 3	Wa Pr III	
Length	(74.7)	(70.0)	75.7	79.0	58.5-79.0 x = 70.99
Breadth	53.0	–	(50.1)	52.5	42.5-57.0 x = 48.75

Table 37 Comparative measurements of *C. antiquitatis* post-cranial material.

Discussion

Guérin (1980), has identified two subspecies of *Coelodonta antiquitatis*, the more primitive *C. antiquitatis praecursor* and the more evolved *C. antiquitatis antiquitatis*.

C. antiquitatis praecursor, identified at the site of La Fage (Correze, France) is characterized by its large, but slender build. This form only occurs in faunas dating to the Saalian (Guérin, 1980; page 617). The more stockily-built *C. antiquitatis antiquitatis* is associated with Weichselian faunas and occasionally occurs in Saalian faunas.

According to Guérin (*ibid.*), the shape of the upper third molar changes, from rectangular forms associated with faunas dating to the Saalian, to triangular forms associated with Weichselian faunas (*ibid.*, page 1023). However, amongst fossils found at Rhenen (Holland), Kolfschoten (1985) identified an upper third molar of triangular form in deposits displaced by the Saalian ice-sheets. Thus, the form of the upper third molar of *C. antiquitatis* does not appear to be of stratigraphic significance, as has been proposed by Guérin.

Guérin (*ibid.*, pages 1023 - 1026), considers the changes in the size of the radius and metatarsus III as being biostratigraphically significant. According to this author, the metatarsus III of the Weichselian form of *C. antiquitatis* shows a tendancy to become shorter and stockier. Guérin (1978, table IVc), gives the following measurements (mean value) of specimens of this bone from the site of Achenheim (France) as being typical of the Weichselian form of *C. antiquitatis.*

When the measurements of the metatarsi III from Achenheim are compared with those from the Neuwied Basin assemblages in Table 39 (disregarding the example from Wa 1, as the length of the find is missing), it can be seen that of the three remaining specimens, those from Sk 2 and Wannen 4/5 are similar in size to the Achenheim ones. The Schweinskopf specimen is slightly longer and the one from Wannen is shorter than the Achenheim examples. Both are »stocky«, especially the Wannen specimen, and resemble in this aspect, the Weichselian form. The third specimen, from Wannen Pr III, is extremely long in comparison to the Achenheim examples, but does show a relative increase in the breadth of both proximal and distal ends.

Guérin also considers the radius to be longer and stouter in the Weichselian form of *C. antiquitatis* than the Saalian form. The measurements given in Table 37 for the radius shows that all of the specimens from Wa Pr III and some of those from Wa 2 are longer than the range given for this species by Guérin. The specimens from Wa Pr III are, according to the breadth of diaphysis, very stout; those from Wa 2 compare with the mean value given for this species. The measurable radii from the Neuwied Basin assemblages compare closely with Guérins Weichselian form. On the other hand, a specimen from the Wa 2 assemblage is very short (see absolute measurements in Appendix III).

Unfortunately, none of the assemblages thought to date to the Saalian, such as Ar 1 or Ar 2 have produced enough measurable post-cranial bones for comparison. The single unciform from Ar 2 (Table 37) showed no great difference in size when compared to the same bone from other Neuwied Basin assemblages.

Sk 2 and 4, tentatively dated to the Saalian, have produced some metapodial specimens (Tables 38 and 39), which compare more in size with those described as being typical of the Weichselian form of *C. antiquitatis.*

Assemblages dating to the beginning of the Weichselian, such as Hu 4 and Ar 3, have also produced only a few post-cranial remains from this species. A metatarsus II from Hu 4 is rather slender in comparison to the mean value given by Guérin for this bone (length Hu 4: 157.0; average length 148.53; breadth diaphysis Hu 4: 29.5; average: 31.08).

On the whole, attempts to identify post-cranial bone of *C. antiquitatis* from the Neuwied Basin assemblages to subspecies on the basis of size, and further to attempt to use this to date the assemblages were inconclusive. Practically all of the measurable juvenile and adult post-cranial bone tended to be from large, robust individuals and thus compared with Guérins Weichselian form regardless of the age of the deposit from which they came.

Some specimens, such as the slender metatarsus II from Hu 4 (beginning Weichselian) even appear to contradict Guérins theory. The remains of *C. antiquitatis* from the Neuwied basin assemblages could not be further identified to subspecies.

Metacarpus II	Sk 4	Wa 1	Wa 2	Wa 4/5	*C. antiquitatis*
Length	166.0	176.0	161.0	162.5	148 - 180.0 n = 60 x = 164.18
Proximal breadth	45.5	–	–	51.5	41.0 - 65.0 n = 61 x = 52.93
Breadth of diaphysis	41.3	45.5	51.3	39.2	31.5 - 50.0 n = 60 x = 42.38
Distal breadth	49.3	56.6	49.4	45.6	37.5 - 57.0 n = 55 x = 48.80
Metacarpus III	Sk 2	Wa 1	Wa 2	Wa 3	
Length	194.0	200.0	202.0	202.0	162.0 - 213.0 n = 79 x = 189.03
Metacarpus IV	Wa 1	Wa 3	Wa 4/5	Wa Pr III	
Length	151.0	157.0	151.0	167.0	126.5 - 176.5 n = 59 x = 151.3

Table 38 Size of the metacarpals of *C. antiquitatis* from the Neuwied Basin assemblages compared with those from other localities in Europe.

Metatarsus III	Wa 1	Wa 4/5	Wa Pr III	Sk 2	*C. antiquitatis*
Length	–	157.0	186.0	169.0	143.0 - 183.0 n = 77 x = 166.54
Proximal breadth	61.3	55.7	61.5	55.0	48.0 - 65.0 n = 84 x = 57.21
Breadth of diaphysis	44.3	42.2	–	46.0	39.5 - 57.0 n = 80 x = 47.16
Distal breadth	53.0	50.1	62.2	51.7	48.0 - 65.5 n = 76 x = 54.91
Metatarsus IV	Wa 2		Wa Pr III (?)		
Length	157.0		148.0		127.0 - 155.0 n = 40 x = 144.85
Breadth of diaphysis	24.9		29.1		24.0 - 40.0 n = 40 x = 30.56
Distal breadth	(35.8)		37.6		31.0 - 41.0 n = 36 x = 36.10

Table 39 Size of the metatarsals of *C. antiquitatis* from the Neuwied Basin assemblages compared with those from other localities in Europe.

Stratigraphic range

The oldest known occurrence of *C. antiquitatis* in Europe is in faunas dating to the Saalian (Guérin, 1980). It is, however, known from three sites (Bad Frankenhausen, G.D.R.; Bornhausen and Neuekrug, Harz region, Germany) which are thought to date to the Elsterian (Sickenberg, Kahlke, 1962; in Butzer & Isaacs [eds.] 1975). There does, however, appear to be some disagreement about the dating of these localities and the presence of *C. antiquitatis* in the assemblages (pers. comm. T. van Kolfschoten). *C. antiquitatis* was a common element of Weichselian faunas and continued to exist in North-West Europe until the end of the Late Pleistocene.

The oldest occurrence of *C. antiquitatis* in the Neuwied Basin is in the channel assemblage (Ar Ch.) and assemblage 1 at Ariendorf. Both are located in loess deposits dating to the Third Cold Stage BP, which in turn has been correlated with an older phase of the Saalian (see Chapter 4). This species also occurs at Wannen and Schweinskopf in assemblages thought to date to the Second Cold Stage BP, which in turn has been correlated with a younger phase of the Saalian. *C. antiquitatis* is present in the Hu 4 assemblage dating to the beginning of the Last Cold Stage BP (=Weichselian) and the last appearance of this species in this region was at the Late Weichselian locality of Gönnersdorf, in an assemblage dated to about 12,500 BP.

The stratigraphic range of *C. antiquitatis* in the Neuwied Basin assemblages is confined to assemblages considered to be post-Holsteinian in age to late Weichselian. There is no evidence so far for this species from assemblages thought to be older than the Holsteinian, and in this sense the presence of *C. antiquitatis* in the Neuwied Basin assemblages supports the theory that this species first occurred in Europe during the Saalian.

Palaeoecology

C. antiquitatis is usually associated with cold-stage faunas and is a typical element of the open steppe, its diet having consisted of low-growing grasses and herbs. It is also known to have occurred at the end of the Last Interglacial and during the Chelford Interstadial in England (Stuart, 1982).

In the Neuwied Basin region, *C. antiquitatis* occurs predominantly in assemblages located in cold stage deposits: in the Ar 1 and Ar 2 assemblages it is associated with an open steppe or steppe-tundra environment. This species also occurs in faunas located in interstadial soils such as Ar 3 and Hu 4. At Gönnersdorf, it occurs in a fauna dating to the end of the Bölling Interstadial.

***RHINOCEROTIDAE* sp.**

Unidentifiable rhinoceros

Material

– HUMMERICH

Hu 1

Fragmentary post-cranial bone only.

– TÖNCHESBERG

Tö 1

Proximal fragment of an ulna.

A minimum of one individual is represented.

CHAPTER 8
ORDER ARTIODACTYLA

Family *SUIDAE* (Gray, 1821)

Genus *SUS* (Linnaeus, 1758)

SUS SCROFA
(Linnaeus, 1758)
Wild pig

The remains of *Sus scrofa* have only identified from the Kä 1 assemblage to date.

Material

– KÄRLICH

Kä 1
Distal end of a tibia dex.
Measurements: Greatest breadth of distal joint: 36.4
A minimum of one individual is represented.

Description and Discussion

The distal joint of the tibia is very eroded, so that an identification to species was based on the form of the diaphysis. The diaphysis is triangular in cross-section, with a prominent lateral edge and is markedly concave on the anterior face above the distal joint as is characteristic for pig.

The Middle and Late Pleistocene wild pigs have all been referred to *Sus scrofa* (Stuart, 1982).

Stratigraphic range

Sus scrofa first occurs during the Cromer complex. It was present in the Cromerian fauna of West Runton (Stuart, 1975; 1981), and at other lower Middle Pleistocene localities, probably dating to this phase and the Elsterian, such as Mauer, Mosbach and Süssenborn. *Sus scrofa* has also been recorded at the site of Vallonet cave (Maritime Alps, France), dated to the Cromer complex (Delpech in de Lumley, 1976, page 384). This species still exists in Europe and forms part of the natural fauna of the Neuwied Basin region today. Its occurrence in the Kä 1 assemblage falls within the known stratigraphic range of this species, despite the problems associated with the age of the deposit itself (Chapter 4).

Palaeoecology

Sus scrofa appears to have occurred only in interglacial Pleistocene faunas in North-West Europe, in association with temperate forests. *Sus scrofa* is, however, also known from Mesolithic assemblages in England in association with regional birch-pine forest (Stuart, 1982). It also appeared sporadically in cold stage faunas in southern France, but was more common at sites where warmer conditions prevailed (Delpech, in de Lumley, 1976).

Sus scrofa is recorded from the Kä 1 interglacial assemblage, in association with an open birch and mixed oak forest. Its presence in this assemblage is consistent with its known occurrence in Pleistocene faunas.

Family *CERVIDAE* (Gray, 1821)

Basic identification

Antler
Antlers are carried by the male animals (Fig. 35); the exception to this being reindeer *(Rangifer)*, in which both sexes have antlers. The cycle of regeneration of the antlers of both red deer and reindeer, as described by Schmid (1972), can also be used to establish the season in which deer were present in the Neuwied Basin and, more provisionally, the season of deposition of the assemblage from which the specimens have been recovered.

Dentition
The upper and lower cheek teeth are brachyodont with selenodont enamel patterns (Fig. 37).

Post-cranial bone
The functional metacarpus and metatarsus are formed by the fusion of the bones of the two main digits (III and IV). The bones of the second and fifth digits are degenerate. Further identification to species is based primarily on the size of the post-cranial bone.

Genus *CERVUS* (Linnaeus,1758)

CERVUS ELAPHUS
(Linnaeus 1758)
Red deer

Plates 26A. B; 27A; Figs. 38 - 40; Tables 40 - 45; Appendix I; Appendix III.
Remains of *Cervus elaphus* occur frequently in the Middle and Late Pleistocene assemblages in the Neuwied Basin region. The species has a long stratigraphic record in this area and is often one of the dominant species in the faunal assemblages.

Basic identification

The antlers of *Cervus elaphus* are characterized by the rugose »pearling« of the outer surface of the beam, tines and the burr. The antlers of the living red deer have, in adult individuals, two basal tines (brow and bez tine), a trez tine and a crown at the upper end of the beam, consisting of an antler cup with tines around the edge (Fig. 35). The first-year antler consists of a single spike, and older males often carry degenerate antlers. Complete antlers are rarely preserved in the Neuwied Basin assemblages; only two specimens have been found to date in which the upper part of the beam is preserved. The shed antlers of this species recovered in the Neuwied Basin assemblages all have a similar pattern of preservation, in which the shed antler base with the bases of brow and bez tines (if present) and part of the beam, occasionally up to the base of the trez tine, are all that remain. Whether this is the result of deliberate breakage by early man, as has been proposed for antlers found at many archaeological sites (eg. Mania, 1986), or whether it is simply due to post-depositional factors will not be discussed here. It did mean, however, that antlers described as belonging to red deer had to be identified using characteristics of the basal part, which can show much individual variation.
The antlers of the living red deer have a basal tine development consisting of a brow tine, placed behind the burr on the anterior side of the beam, and a bez tine placed behind and slightly lateral to the brow tine (Fig. 35). The beam and the tines are circular in section. A trez tine may be present; occasionally the bez tine is missing.

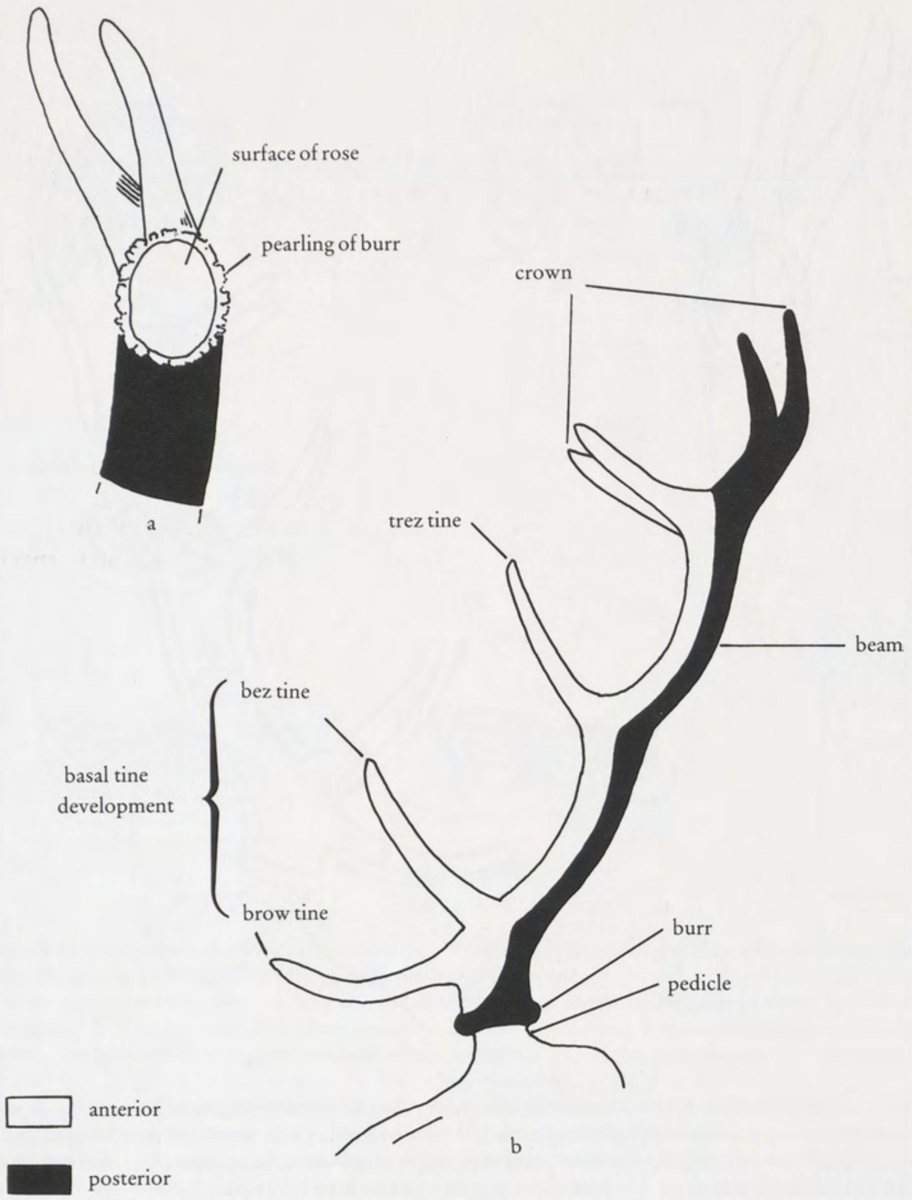


Fig. 35 Terminology used in the text to describe shed antlers and antler frontlets of the Family *Cervidae* (Genera *Cervus*; *Megaloceros*), using red deer antler as an example. – a Shed antler base (seen from below). – b Antler frontlet with complete beam (lateral view).

Even though the fossil red deer antlers from the Neuwied Basin assemblages can be quite large in size (Table 45), they are not as massive as those of giant deer (genus *Megaloceros*) (Table 48).

When viewed from the front, the beam of red deer antler rises at an angle to the base, whereas in *Megaloceros* and fallow deer (Genus *Dama*), the beam is carried in a more horizontal position. Further, Dama does not possess a bez tine and the basal tine development in *Megaloceros* is distinguishable from that of red deer (page 299).

Dentition

The cheek teeth are of typical cervid form. They are larger than those of *Dama* and smaller than those of *Megaloceros* and elk (*Alces*). Characteristic of this species is the rugose enamel.

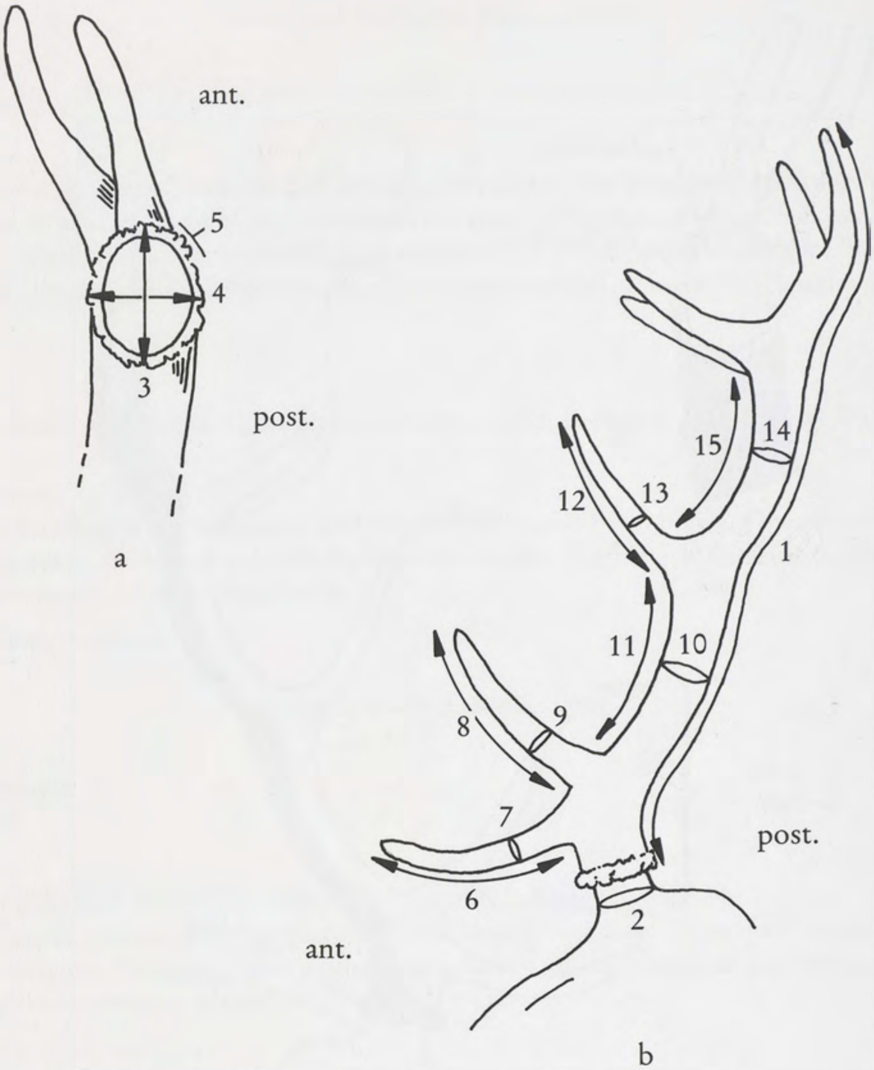


Fig. 36 Measurements taken on shed antler and antler frontlets of the Family *Cervidae* (Genera *Cervus*; *Megaloceros*), using red deer antler as an example. – a Shed antler base (seen from below). – b Antler frontlet with complete beam (lateral view). – 1 Greatest length of beam. Taken from base of rose to tip of crown on posterior edge, or to point at which beam is broken (eg. 230. 0+mm) indicates that the beam was originally longer. – 2 Circumference of pedicle (antler frontlets only). – 3 Antero-posterior breadth of shed antler base (rose) including burr. When burr is eroded taken on widest part and given in brackets. – 4 Medio-lateral breadth of shed base including burr. – 5 Circumference of shed base, measured on burr. – 6 Length of brow tine. Measured along anterior edge from base to tip, or to point where broken. – 7 Circumference of brow tine. – 8 Length of bez tine (as 6). – 9 Circumference of bez tine (as 7). – 10 Circumference of beam above bez tine and below trez tine (if present). – 11 Distance between base (posterior side) of bez tine and base (anterior side) of trez tine. – 12 Length of trez tine (as 6). – 13 Circumference of trez tine (as 7). – 14 Circumference of beam above trez tine and below crown. – 15 Distance between base of trez tine and base of crown (as 11).

Mi 2	Urbar	Recent[1]
18.1	15.7	14.9-16.9 n = 2

Table 40 Length of upper dp 2 of *Cervus elaphus* from localities in the Neuwied Basin and comparison with those of recent red deer. – [1]Monrepos collection.

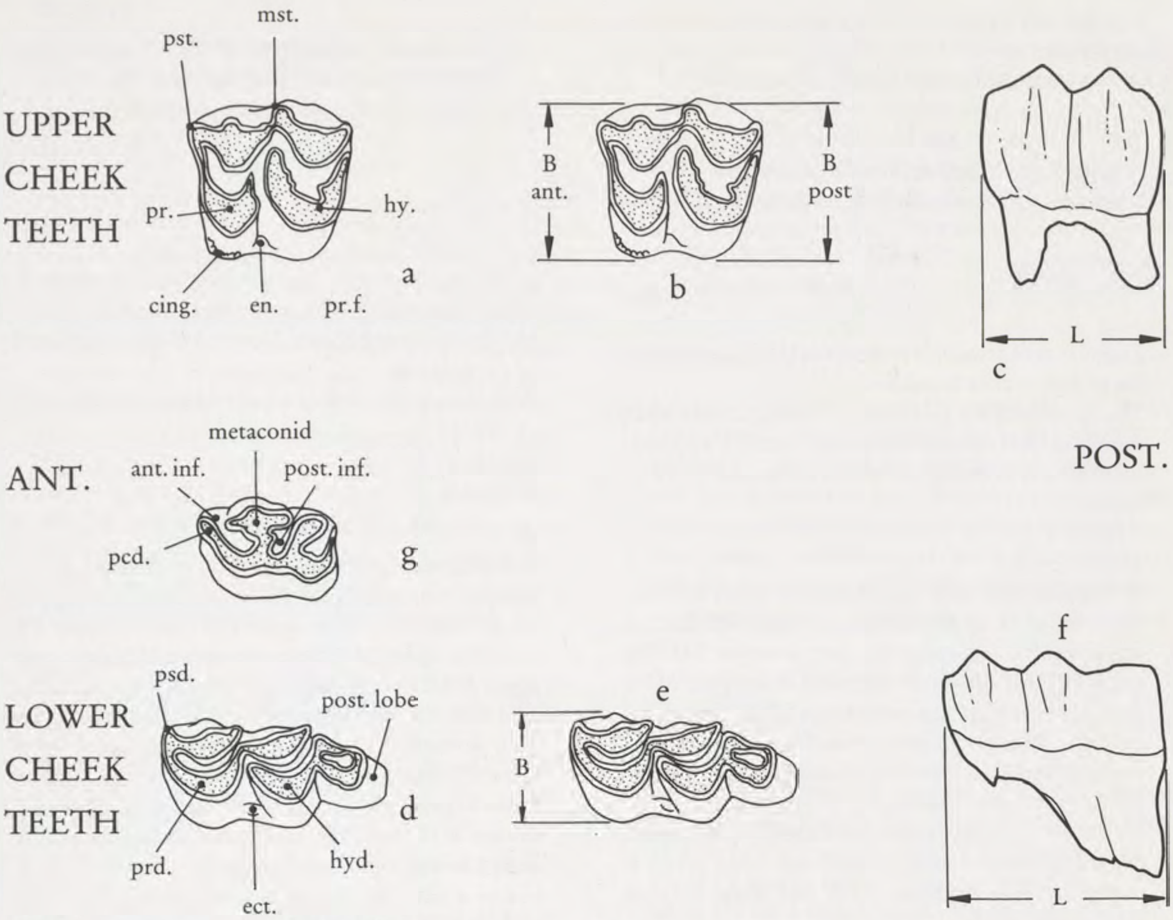


Fig. 37 Terminology used in the text to describe the dentition of the Family *Cervidae* and the measurements taken, using an upper and lower molar and a lower premolar of red deer *Cervus elaphus* as example.

Upper cheek teeth. a (occlusal view). mst.: mesostyle; pst.: parastyle; pr. f.: protocone fold; pr.: protocone; hy.: hypocone; cing.: cingulum; en.: entostyle. – b B ant.: breadth of tooth on anterior lobe (at base of crown). B post.: breadth of tooth on the posterior lobe (at base of crown). The breadth of the upper premolars, which possess only one lobe, are measured as in e), below. – c L length of tooth (at base of crown).

Lower cheek teeth. – d (occlusal view). psd.: parastylid; prd.: protoconid; hyp.: hypoconid; ect.: ectostylid; post. lobe: posterior lobe. – e B: breadth of tooth (at base of crown). – f L: length of tooth (at base of crown) (lingual view). – g Terminology used for lower P4 (occlusal view). pcd.: paraconid; mtd.: metaconid; ant. infolding: anterior infolding; post. infolding: posterior infolding.

Post-cranial bone

The post-cranial bone is of typical cervid form. A further identification to *Cervus elaphus* was based mainly on size, the bones of red deer are larger than those of roe deer (*Capreolus*) and smaller than those of elk (*Alces*) and extinct giant deer (*Megaloceros*).

Material

– KÄRLICH

Kä F
Mandible fragment with lower cheek tooth row; an astragalus sin. and dex.
The astragali are of different size, representing two individuals.

Kä Ga
Fragment of a tine; a calcaneum sin.
A minimum of one individual is represented.

Kä Gb
Mandible fragment sin. with lower P2 - 4 and M1;

fragmentary upper or lower cheek teeth; base of a shed antler.
A minimum of one individual is represented.

Kä 1
A lower M1 sin. and dex; a shed antler base.
A minimum of one individual is represented.

– Miesenheim I

Mi 1
Fragments of a femur, a metatarsus III/IV, an astragalus and an os centrotarsale sin.
The specimens are probably all from the same adult individual and some of them were found in anatomical position. A minimum of one individual is represented.

Mi 2
A fragment of a shed antler dex.; an upper dp2 sin.; fragment of an upper dp4 s/d.; an upper P3 dex.; an upper P4 dex.; an upper M1 dex.; an upper M3 dex. and sin. (latter unworn); fragment of an upper M1/2 dex.; a lower M1 dex.; a metacarpus III/IV dex.; distal end of a tibia sin.; a metatarsus III/IV sin.; two os centrotarsale sin.; four first phalanges; four second phalanges; a third phalange.
Two adult individuals are represented by the two left os centrotarsale; a third juvenile individual is represented by the deciduous teeth and some unfused post-cranial material.

– Leutesdorf

Horizon 18
Fragment of a pelvis.

Horizon 17/18
Brow and bez tine fragments.

The specimens from this locality have already been identified and published by F. Poplin (in Brunnacker et al. 1974, pp. 206 - 210).

– Ariendorf

Ar 1
Three shed antler sin.; distal end of a metacarpus III/IV s/d.; a first phalange; distal end of a first phalange.
A minimum of one individual is represented.

Ar 2
Three shed antler sin.; two shed antler s/d.; cranium fragment (occiput); an antler frontlet.
A minimum of one individual is represented.

Ar 3
A shed antler dex.; distal end of a humerus sin.; proximal end of a radius sin.; two astragali dex.
A minimum of two individuals is represented.

– Schweinskopf

Sk 4
A shed antler dex.; fragment of antler frontlet; mandible fragment sin. with lower P3 - 4 and M1; a lower M1 sin.; a lower M2 sin.; a lower M3 dex.; distal end of a scapula sin.
A minimum of two individuals is represented.

– Wannen

Wa 1
A shed antler dex.; two shed antlers sin.; two antler frontlets sin. and dex.; an antler frontlet sin.; an upper P2 sin. and dex.; three upper P3s dex.; an upper P4 dex.; two upper M1s dex.; two upper M2s dex.; two upper M1/2 sin.; an upper M3 dex.; a lower dp3 sin.; mandible sin. with lower M1 - 3 and a mandible dex. with lower M1 - 3 from the same individual; two lower P2s dex.; two lower P4s sin.; a lower M1 dex.; a lower M1 sin.; a lower M2 sin.; three lower M1/2 sin.; a lower M1/2 dex.; a lower M1/2 s/d.; two lower M3s dex.; a lower M3 sin.; a complete radius sin.; distal end of a tibia dex.; an os malleolare dex.; proximal end of a metacarpus III/IV sin.; proximal ends of two metatarsi III/IV dex.; an os centrotarsale dex.; two astragali dex.; two first phalanges s/d.
Based on the number and state of wear of the teeth, at least one juvenile and five adult individuals are represented.

Wa 2
A shed antler dex.; mandible sin. with lower dp3 - 4 and M1 and mandible dex. with lower dp2 - 4 and M1 from the same individual; distal end of a humerus dex.; fragment of a juvenile tibia s/d.
A minimum of one juvenile and possibly one adult individual is represented.

Wa 3
A shed antler dex. and sin.; an upper dp3 dex.; a mandible with lower dp3, dp4 and M1; a lower M1 sin.; a complete juvenile humerus; proximal and distal ends of a tibia sin.; a metatarsus III/IV sin.; an astragalus sin.; two calcanei sin.; two second phalanges.
A minimum of two individuals is represented.

Wa 4/5
Distal end of a radius sin.; an astragalus dex.

Wa Pr III
Distal ends of two metacarpii III/IV s/d.
A minimum of two individuals is represented.

– HUMMERICH

Hu 4
Seven shed antler bases dex.; three shed antler bases sin.; an antler frontlet sin. and dex. from the same individual; an antler frontlet dex.; a mandible dex. with complete lower cheek tooth row; an upper P4 sin.; an upper P3 s/d.; distal end of scapula dex.; distal ends of three humeri dex. and one humerus sin.; distal and proximal ends of three radii dex. and one radius sin.; one complete metacarpus III/IV dex.; proximal ends of two metacarpi III/IV; distal ends of two metacarpi III/IV; distal end of a femur dex.; distal ends of two tibiae dex.; distal ends of four tibiae sin.; a calcaneum dex.; an astragalus dex.; three astragali sin.; two os centrotarsale dex.
A minimum of four individuals is represented.

Hu 5
Distal end of a humerus dex.; distal end of a radius dex.
A minimum of one individual is represented.

– TÖNCHESBERG

Tö 2
Twenty shed antler bases dex.; fourteen shed antler bases sin.; two shed antler bases s/d.; one antler frontlet sin.; an upper M2 and M3 dex.; distal end of scapula sin.; a calcaneum sin.
A minimum of one individual is represented.

– METTERNICH

The remains of red deer identified by Hofer (1937) were not seen during this study.

– GÖNNERSDORF

Post-cranial remains from *Cervus elaphus* have been recovered from the concentration described as belonging to a summer settlement phase at this site (Poplin, in Brunnacker (ed.), 1978). From the winter settlement phase only the canines of this species, intended to be worn as a pendant, have been recovered.

– ANDERNACH

An 1
Only canines, intended to be worn as part of a pendant, have been found.

An 2
An upper dp4 sin.; an upper P2 dex.; an upper P3 dex.; an upper P4 sin.; an upper M1/2 dex.; an upper M3; three lower M3s sin.; distal end of a metacarpus III/IV sin.; distal end of a metatarsus III/IV sin.; a first phalange; two second phalanges; a third phalange.
A minimum of six individuals, five adult and one juvenile, is represented. The remains have been identified by M. Street (in press). Only the complete specimens are listed above.

– NIEDERBIEBER

An antler frontlet fragment; mandible dex. with lower P4 and M1 - 2; mandible sin. with lower P3 - 4 and M1 - 3; mandibles sin. and dex. with lower dp4 and M1 - 2 from the same individual; a lower M2 dex.; an upper M1/2 sin.; proximal end of radius sin.; distal ends of two tibiae dex. and a tibia sin.; distal end of a metacarpus III/IV s/d.; three astragali dex.; an astragalus sin.; a calcaneum sin.; an os maleolare sin.
A minimum of four individuals is represented.

– URBAR

An upper dp2 and dp3; an upper dp3 sin.; an upper dp2 sin.; a maxillary fragment dex. with upper M2 - 3; a maxillary fragment dex. with upper P3 - 4; an upper P2 sin.; an upper P3 sin.; an upper P4 dex.; an upper M1 sin. and dex.; an M2 dex.; an upper M3 sin.; mandible sin. with lower P2 - 4 and M1 - 2 and a mandible dex. with lower P2 - 4 from the same individual; a mandible sin. with lower P2 - 4 and M1 - 3; a mandible dex. with lower M2 - 3; three lower P2s sin.; a lower P3 sin.; two lower P4 dex.; a lower M3 dex.; proximal ends of a radio-ulna dex.; distal ends of three metatarsi III/IV; three astragali sin.; one astragalus dex.; proximal end of a first phalange.
A minimum of seven individuals is represented. This is based upon the number of cheek teeth and the state of wear of the individual teeth.

– MIESENHEIM II

A lower dp4 dex.
A minimum of one individual is represented.
The tooth has been identified and published by M. Street (1986).

CERVUS cf. *ELAPHUS:*

– KÄRLICH

Kä C
Fragment of an antler frontlet.
A minimum of one individual is represented.

Only a part of the short pedicle and a fragment of the burr are preserved. The pearling of the burr may indicate red deer. The find was too fragmentary for a more exact identification.

Description

Because the amount of material from this species recovered from the Neuwied Basin assemblages is large, the specimens are described and discussed in sections, for example, lower Middle Pleistocene, upper Middle Pleistocene etc.

– Lower Middle Pleistocene assemblages

– –Antler

The units Kä C - Gb and the assemblages Mi 1 and Mi 2 have produced remains identified as *Cervus elaphus*. The majority of the specimens from Kärlich are in a poor state of preservation; the antler from Kä C could only be described as *Cervus* cf. *elaphus*.

The shed antler fragment from Mi 2 consists of a small portion of the parietal bone, the pedicle, the burr, and the base of the brow tine. The pedicle is long and slender as is usual for a young animal. The pearling of the burr is characteristic of this species.

– – Dentition

Deciduous and permanent cheek teeth from this species have been recovered from Miesenheim I only. The size of the upper M1 and M3 from the adult individual and the unerupted upper M3 from a younger individual are smaller than those specimens from the other Neuwied Basin assemblages (Table 41). The upper dp2 from this assemblage is large in comparison to the specimen from the Late Pleistocene assemblage at Urbar and the recent specimens (Table 40).

The cheek teeth of *C. elaphus* from the Mi 1 and Mi 2 assemblages have the same morphology as the specimens from the living animal. The upper M3s both have a robust entostyle between hypocone and protocone.

– – Post-cranial bone

Only a single calcaneum from Kä Gb and an astragalus from Kä F could be measured. The size of these specimens is comparable to those found in the younger assemblages (See absolute measurements in Appendix III).

Most of the post-cranial bones from the Miesenheim I assemblages are too fragmentary to be measured and only the tibia fragments and the two metatarsals can be described further.

The tibia is larger than the mean value given for the distal breadth of this bone from recent red deer (Table 44). It is slightly larger than those examples found in the Wannen and Hummerich assemblages, and is smaller than those from the Late Pleistocene assemblage at Niederbieber. The metatarsals from both assemblages are both longer than the recent examples and the specimen from Wa 4.

The red deer from the Miesenheim I assemblages was somewhat larger in body-size than the recent red deer. The cheek teeth from the two adult individuals are, however, small in relation to body-size, although the upper dp2 does indicate that »large« dental-size was also present amongst other individuals in this population.

– – Discussion

Red deer from the Cromerian fauna at Voigtstedt and at Mosbach, dating to the end of the Cromer and beginning of the Elsterian (Kahlke, 1959; 1956), have been described as *Cervus elaphus acoronatus* (Beninde, 1937), due to the form of the antler, which consistently ends in a simple two-point fork instead of a crown.

	Mi 2	Wa 1	Tö 2	An 2	Niederbieber	Urbar	Recent[1]
M1	18.8	22.7-23.0 n = 2	–	–	–	22.5-23.5 n = 2	18.8-19.2 n = 2
M2	–	23.8-25.3 n = 2	24.0	–	24.9	23.0-25.1 n = 3 x = 24.36	–
M3	21.0-22.5 n = 2	25.2	–	28.0	–	29.5	21.5

Table 41 Length of upper M1 -M3 of *Cervus elaphus* from localities in the Neuwied Basin and comparison with those of recent red deer. [1] Monrepos collection.

The oldest known occurrence of coronate red deer, *Cervus elaphus elaphus*, is from faunas dating to the Holsteinian, and the transition from acoronate to coronate form is presumed to have taken place during the Elsterian (Lister, 1984 a; 1986). Differences in body-size between the two subspecies are not known. The antler remains from the lower Middle Pleistocene assemblages at Kärlich and Miesenheim I are too fragmentary to be identified to subspecies. The possibility that the specimens from Kärlich and Miesenheim I belong to the lower Middle Pleistocene species described by Kahlke (1959), as *Cervus elaphoides* is not considered here. The validity of this species, based on the form of the antler only, has been criticised (Lister, 1986).

– Upper Middle Pleistocene assemblages and assemblages dating to the beginning of the Late Pleistocene

In this section, the red deer remains from Ar 1 and Ar 2, dating to the Saalian, and the assemblages from the volcano localities, dating to a younger phase of the Saalian or to the beginning of the Weichselian are described and discussed together. The sparse remains of red deer from Leutesdorf are not described further.

– – Antler

The red deer antlers from these assemblages forms a large corpus of material. Seventy-eight specimens, consisting of sixty-eight shed antler bases and ten antler frontlets are were described and measured.

The individual descriptions and absolute measurements of the shed antlers and antler frontlets from this section are given in Appendix I. Fig. 36 shows how the measurements were taken. Table 45 gives the most frequently occurring measurements.

Only two specimens, one from Ar 2 and one from Tö 2, retained the upper part of the beam. The specimen from Ar 2 consists of an extremely robust shed antler sin., with an almost complete brow tine and the bases of both bez and trez tines (Plate 27A, a; description Appendix I). The crown is placed antero-posterior to the axis of the beam, and consists of a large cup, as in the antler of prime adult individuals of the extant populations, with three tines preserved on the anterior side and two on the posterior side. The specimen from Tö 2 consists of a rather weakly-built shed antler sin. (description Appendix I). The brow and bez tines are both complete and the base of the trez tine is preserved. Above the trez tine, the beam curves towards the anterior side and ends in a fork of two tines, one placed to the lateral side and one to the medial side of the beam.

The earliest known occurrence of the coronate *C. elaphus elaphus* is in faunas dating to the Holsteinian. The Ar 2 assemblage is located in a loess bed dating to the end of the Second Cold Stage BP, which in turn has been correlated with a younger phase of the Saalian. The presence of a coronate shed antler in the Ar 2 assemblage falls within the known stratigraphic range for this subspecies. This is the earliest record of coronate red deer in a Neuwied Basin assemblage so far.

Because of the problems associated with ageing antlers of red deer (Wagenknecht, 1983), attempts were not made to separate the antlers according to age before measuring. Thus, the large range in size of the antlers from some assemblages, for example, Tö 2, is due to the presence of both weakly-built antlers, presumably including those belonging to either young or very old males, and robust examples from prime adult individuals in the sample. The large variation in size also indicates that the antlers are probably representative of those populations living at the time, and that the samples do not appear to be biased by selection of a particular antler size by early man.

Robust antlers occur in the Ar 2, Wa 1, Hu 4 and Tö 2 assemblages. Two of these, Wa 1 and Ar 2, are faunas located in cold stage deposits; at Ar 2 in association with an open steppe environment. The assemblages Tö 2 and Hu 4 are both located in palaeosols formed under temperate conditions. A molluscan fauna and mammalian microfauna from Tö 2 indicate a warm climate and open environment. Thus, large antler size amongst the fossil populations in the Neuwied Basin region does not appear to be indicative of adaptation to a particular climatic phase.

Lister (1984a), states that variation in body-size between recent populations is attributable to the effects of habitat quality. Lister (ibid), quotes an example given by Huxley (1931), whereby small red deer, raised on the Scottish moors, increased in mean body-weight and antler size and complexity, when exported to the lush meadows of New Zealand. The common palaeoenvironmental factor between those assemblages in the Neuwied Basin where robust antlers occur, is the presence of a predominantly open (presumably grassland) environment (Chapter 4). It would appear that the open environment, and rich herbaceous vegetation present during both these cold and warm stages provided, as in the recent example quoted above, both the habitat and food source condusive to this kind of antler growth. Unfortunately, antlers from assemblages known to have been deposited during phases in which a wooded environment dominated, such as at Miesenheim I and Kä 1, are either poorly-preserved or too few in number to be of comparative use in this case.

The number of shed antlers in the Ar 2, Wa 1, Hu 4 and Tö 2 assemblages indicates that red deer is underrepresented by the amount of post-cranial material also found in the assemblages. This underepresentation is particularly marked in the Hu 4 (MNI 4; 10 shed antlers) and Tö 2 (MNI 1; 34 shed antlers) assemblages, both of which appear to have been deposited during a temperate climatic phase. It may be that there is a connection between a warm climate, which would have intensified habitat quality, resulting in an increase in the numbers of animals living during these warmer phases in comparison to those living during the cold stages. This argumentation is rather speculative as the shed antlers from Hu 4 and Tö 2 could simply be the result of over-enthusiastic collecting by early man or other agents. It is, however, a point that should be reconsidered when the sample size of antler from these and other assemblages is larger.

The largest fossil antlers are from Ar 2, and one of these specimens shows some characteristics usually associated with the antlers of giant deer of the genus *Megaloceros*. The surface of the beam is smooth and the pearling of the rose is weakly-developed. The surface of the rose also protrudes beyond the burr in a way normally only seen on the megacerine antler found in the Neuwied Basin assemblages. However, the position of the brow and bez tines on the beam, whereby the brow tine is placed behind the burr and the bez tine behind and slightly lateral to the brow tine, are typical of recent *C. elaphus* antlers and also occur on the fossil specimens described below (Plate 27A, b).

Morphologically, the fossil antlers from the Middle and Late Pleistocene assemblages in the Neuwied Basin showed no differences when compared to the recent specimens. The shed surface of the rose is slightly convex in the majority of the fossil specimens and this also appeared on all of the recent red deer antlers seen. Occasionally flat or concave shed surfaces or more rarely those with a »boss« in the middle occur amongst the fossil antlers. The form of the surface of the rose appears to have no connection with the size of the antler. The pearling of the burr varies in the fossil sample between examples with very weak pearling to those with developed pearling and is also not associated with the size of the antler.

Brow tines are present on fifty-three out of fifty-four specimens of fossil antler. The brow tine is placed on the anterior edge either directly above the burr or at a slight distance (generally between 5 and 10 mm.) above this. On one fossil specimen the brow tine is placed 36.0 mm. above the burr. The recent examples seen all possess a brow tine, but the position of the tine on the beam is more variable than that found amongst the fossil sample. Bez tines are present on forty-two out of forty-seven specimens of fossil antler. Only two examples did not possess a bez tine. The bez tines are placed either directly above or slightly (5 - 10 mm.)

above the brow tine. Usually the bez tine is placed lateral to the brow tine or, as in one specimen, in the same axis. These characteristics are also present on the recent red deer antlers.

The size of the brow and bez tines appears to be associated with the size of the antler. Small, weakly-developed antlers in the fossil sample, generally possess small, short tines, whereas the large, robust antlers have large, robust tines. In the robust antler, the brow and bez tines are both broad, and are oval in section at their bases, a characteristic also found on the larger recent examples. In the largest fossil examples, there is a thickening of the beam between the anterior base of the bez tine and the burr, giving the impression that the tine rises directly from the rose. This can sometimes be so pronounced that the form of the rose is also affected, and results in a concavity on the lateral side, so that when viewed from below, the shed surface is kidney-shaped instead of circular. A trez tine occurs on only ten specimens out of thirty-one examples of fossil antlers. When present, it is placed on the anterior edge of the beam as in the recent examples.

The beams of the fossil antlers are circular in section as in the recent examples. An anterior edge or ridge, beginning at the base of the bez tine, or brow tine if the bez is not present, and running along the length of the beam to the base of the trez tine is present on fifteen specimens of fossil antler. Weakly-developed ridges are present on a further nine fossil specimens.

Although very pronounced anterior ridges only occur on the robust antlers, this characteristic does occur on weakly-built examples. The remaining fossil antlers all have the typical circular cross-section found on the recent specimens.

Further characteristics, such as the formation of »bosses« or small button-like swellings, are generally present on the beam in the region of the basal tines of the fossil antlers. These characteristics are found especially on the more robust antlers and are often situated at the base of either the brow or the bez tine or on the anterior edge of the beam. They only occurred on one specimen of recent antler in the collection.

Only one example of pathological fossil antler has been recorded to date. This specimen is from the Wannen locality. The specimen is a robust shed antler dex., and consists of the shed base and part of the beam. Both brow and bez tines are more or less complete and show a developed twisting (corkscrewing). This is probably a result of hormonal or metabolic disturbances during growth of the antler (Wagenknecht, 1983). The rest of the beam is normally developed.

– – Dentition

Both the upper and lower permanent cheek teeth of *C. elaphus* from assemblages in this section show a large variation in size (Tables 41 and 42). Because of the small sample size, little could be said about these finds. The fossil specimens compare in size with the larger specimens from recent red deer, and are in some cases even larger.

The morphology of the cheek teeth show no differences when compared to those of recent red deer. An upper M1 from Wa 1 has a weak protoconal fold (Plate 26A, a i). Ectostylids are absent on the lower cheek teeth from Wa 1 and Hu 4 (Plate 26B, a and b).

– – Post-cranial bone

The post-cranial bones shows no interpretable differences in size between assemblages at the same locality or between localities (Table 44). The body-size of the fossil red deer from the assemblages in this section tends to be slightly larger than the mean value given for the recent red deer. The metacarpus III/IV from Hu 4 is longer than those of recent red deer (Table 44).

To summarise, the red deer from assemblages dating to the upper Middle and beginning of the Late Pleistocene tend to be slightly larger in body and dental size than recent red deer. The antlers from these assemblages, although having the same morphology as the recent animal, were also capable of reaching extremely large proportions and being more robust.

The sparse remains of *C. elaphus* from the Kä 1 assemblage, which could date to the upper Middle Pleistocene or be older (Chapter 4), show no differences in either size or morphology when compared to the recent material.

	Kä 1	Wa 1	Sk 4	Hu 4	An 2	Niederbieber	Urbar	Recent[1]
P 2	–	13.0 - 16.3 n = 2	–	13.0	–	–	11.7 - 14.0 n = 6 x = 12.83	11.3 - 12.6 n = 5 x = 12.12
P 3	–	–	17.8	14.5 - 16.3 n = 2	–	19.2	14.6 - 17.4 n = 4 x = 16.42	14.8 - 16.4 n = 6 x = 15.68
P 4	–	19.1	12.7	–	–	20.1	19.0 - 20.7 n = 6 x = 19.62	15.7 - 18.8 n = 6 x = 17.16
M 1	23.5	Wa 3: 21.4 Wa 1: 21.2 - 21.4 n = 2	23.0	–	–	23.1 - 26.8 n = 4 x = 24.06	25.4 - 27.5 n = 2	17.7 - 20.4 n = 6 x = 19.01
M 2	–	21.4 - 24.5 n = 4 x = 23.35	26.1	22.8	–	27.4 - 30.0 n = 5 x = 28.78	–	22.4 - 26.2 n = 6 x = 23.4
M 3	–	29.5 - 34.3 n = 7 x = 32.07	35.0	32.0	34.0 - (38.5)* n = 3 x = 35.8	34.2	35.2 - 36.7 n = 3 x = 36.6	27.5 - 32.5 n = 6 x = 30.66

Table 42 Length of lower cheek teeth of *Cervus elaphus* from localities in the Neuwied Basin and comparison with those of recent red deer. – [1] Recent comparative collection stored at Monrepos; * Measurement in brackets taken from Poplin, 1972. The length of the tooth was measured at the occlusal surface in this case.

	Wa 6	Hu 4	Niederbieber	Urbar	Recent[1]
Length P 2 - P 4	–	49.0	–	52.3	42.2 - 45.3 n = 6 x = 43.3
Length M 1 - M 3	81.5	75.7	(87.0)	85.5	67.6 - 78.3 n = 6 x = 71.72
Length P 2 - M 3	–	127.0	–	136.7	110.5 - 123.5 n = 6 x = 113.4

Table 43 Lower tooth row lengths of *Cervus elaphus* and comparison with those of recent red deer. – [1] Recent comparative collection at Monrepos.

– Late Weichselian assemblages

The red deer remains described in this section are from assemblages dating to the Alleröd Interstadial. The remains of red deer from Gönnersdorf and An 1 (Bölling Interstadial) consists only of incisors (see material lists). Unpublished post-cranial bones of this species from Gönnersdorf were not seen during the course of this study and are therefore not mentioned here.

– – Antler

An antler frontlet from a young individual found at Niederbieber (Winter, 1986), and an antler beam from Urbar are both too fragmentary to be described further (Appendix I).

Mi 2	Hu 4	Wa 6	Wa 4	Niederbieber	Recent[1]
57.4	50.7 - 56.3 n = 4 x = 52.8	54.5	54.0	55.9 - 64.0 n = 3 x = 59.6	38.0 - 63.0 n = 822 x = 50.2

Table 44a Breadth of the distal tibia of *Cervus elaphus* and comparison with those of recent red deer. – [1]Taken from Chaix & Desse (after Jequier), 1981, 150 - 151.

Metacarpus						
Length	Recent[1] 256.0 - 272.0	Hu 4 292.0				
Metatarsus	Recent[1]	Mi 1	Mi 2	Wa 4	An	Ur
Length	277.0 - 311.0	318.0	(317.0)	(295.0)	–	–
Breadth	32.0 - 52.0	40.5	45.5	44.1	46.0	45.0 - 52.0

Table 44b Size of metacarpus and metatarsus of fossil *Cervus elaphus* from the Neuwied Basin localities and comparison with those of recent red deer. – [1]Taken from Chaix & Desse (after Jequier), 1981, 150 - 151.

– – Dentition

The deciduous and permanent upper and lower cheek teeth and the length of the lower cheek teeth row of individuals from these assemblages are all large (Tables 40 - 43). The permanent upper and lower cheek teeth from these assemblages are larger than those of recent red deer and most of the fossil specimens from the older assemblages. The cheek teeth from Urbar appear to be the largest amongst those from the Alleröd assemblages. The exception to this was a single lower M3 from the An 2 assemblage, which had been measured at the crown and was therefore longer than the other specimens.

The dental morphology of *C. elaphus* from the Alleröd Interstadial assemblages is no different to that of recent red deer. As might be expected from their large size, the upper cheek teeth of *C. elaphus* from the Alleröd assemblages tend to have more developed, robustly-built entostyles and pronounced cingula (Plate 26A, a ii. 26B, c and d). Extremely long ectostylids occur on most of the lower molars, attaining on one example, a lower M1 from Urbar, a height of 11.0 mm. The lower M3s also possess a second pillar between hypoconid and the posterior lobe (Plate 26B, c and d).

– – Post-cranial bone

The lack of well-preserved post-cranial bones from the Alleröd assemblages made a comparison between this material and that from the older assemblages and recent red deer difficult. Of those bones that could be measured, the three tibiae from Niederbieber and the metatarsals from Andernach and Urbar are all larger than the mean value for these bones from the recent specimens (Table 44).

Summary

The remains of *C. elaphus* from the Middle and Late Pleistocene assemblages in the Neuwied Basin region show variations in both body and dental size as have already been observed in Pleistocene red deer (Lister, 1986). The red deer from the lower Middle Pleistocene deposits at Kärlich and the Miesenheim I assemblages are larger in body-size than the recent red deer specimens, although some individuals from Miesenheim I are small in dental-size. The form of the antler from these localities is not known.

C. elaphus from assemblages dating to the upper Middle and beginning of the Late Pleistocene periods also tend to be larger in both dental and body-size than recent red deer. Several specimens of shed antlers and

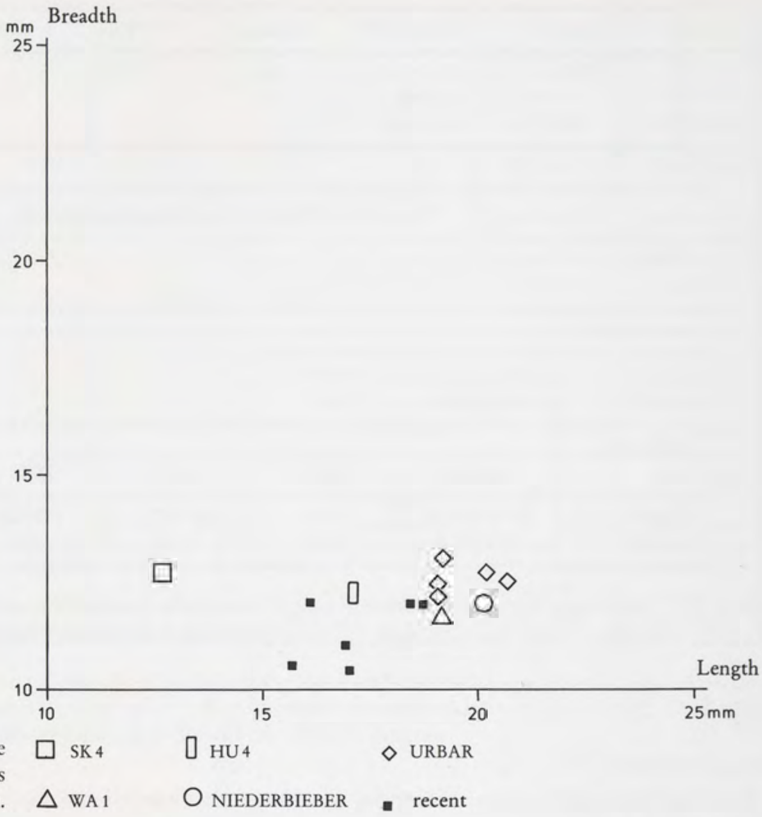


Fig. 38 Length plotted against breadth of the lower P4 of *Cervus elaphus* from assemblages in the Neuwied Basin region.

antler frontlets show that during this phase antler could be extremely large, exceeding that of recent individuals in both size and robustness.

C. elaphus from assemblages dating to the Alleröd Interstadial are larger in both dental and body-size. The size and form of the antlers are not known.

Figs. 38 - 40 plot the length against the breadth of the lower P4, M2 and M3 of *C. elaphus* from the Neuwied Basin assemblages and those of recent red deer. The figures show that, as has been discussed above, most of the fossil specimens are larger than those of recent red deer.

A general increase in size, particularly in the lower M3, is also indicated in the fossil material, from the comparatively small teeth from Wa 1 and Hu 4, to the large lower M3s from the Alleröd assemblages. Fig. 40 shows that this increase was expressed more in the length of the tooth than in the breadth of the tooth. Some examples from Urbar being hardly any broader than the »smallest« examples from Wa 1, but being up to six or seven millimetres longer in comparison.

Morphology of the lower P4

Variations in the morphology of the lower P4 were noticed in both the recent and fossil samples. The lingual side of this tooth can show considerable variation amongst the cervids (Janis & Lister, 1985). The anterior part of the lingual side of the lower P4 of *C. elaphus* is characterized in some cases by the fusion of the metaconid with the paraconid (Fig. 37). In other examples, this fusion has not taken place so that the metaconid and paraconid are separated by a lingual infolding. Only one fossil lower P4 from Wa 1 (Plate 26A, b iii) possesses such an infolding. The remaining fossil lower P4s, all have a fused metaconid and paraconid (Plate 26A, b i and ii). A fused metaconid and paraconid is also present in the recent sample, where it occurs in nine out of twelve lower P4s seen.

The cycle of regeneration in the antler of red deer

Red deer carry antler from September to February/March (Schmid, 1972). In the assemblages Kä C, Mi 2,

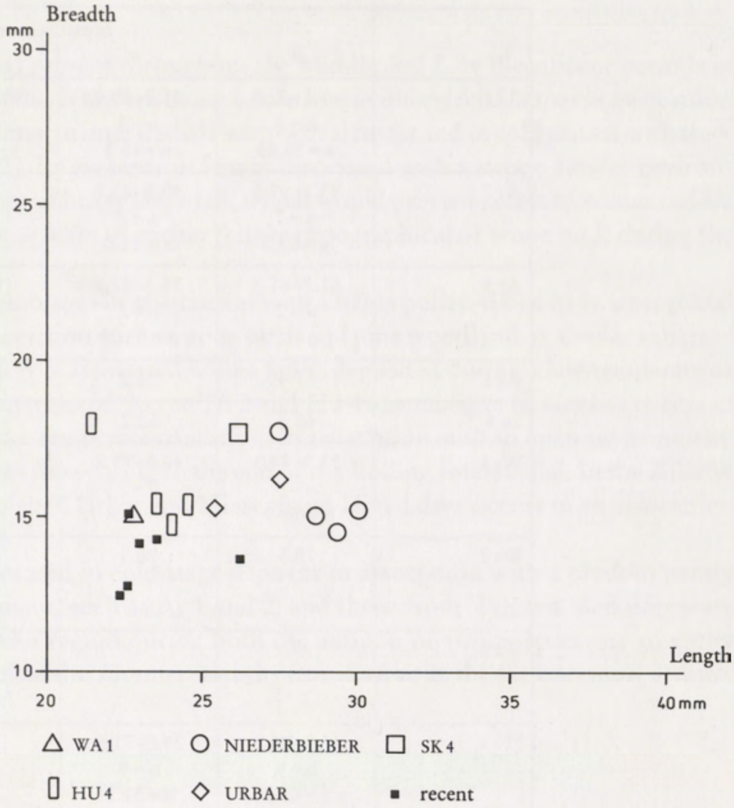


Fig. 39 Length plotted against breadth of the lower M2 of *Cervus elaphus* from assemblages in the Neuwied Basin region.

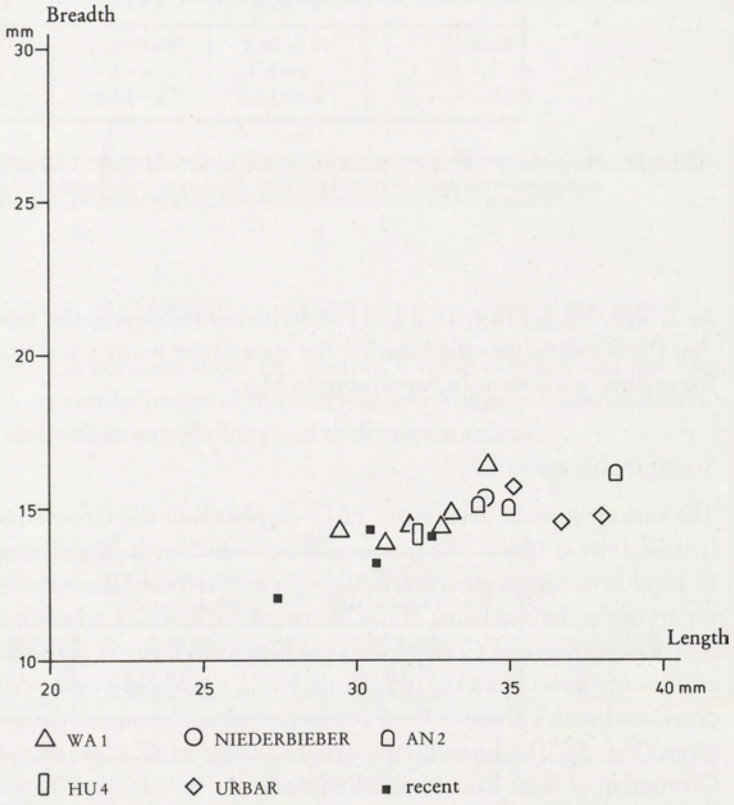


Fig. 40 Length plotted against breadth of the lower M3 of *Cervus elaphus* from assemblages in the Neuwied Basin region.

	Measurements			
	3	4	5	10
Ar 1	45.2 - 72.5 n = 3 x = 58.85	31.2 - 59.4 n = 3 x = 45.3	182.0 . 210.0 n = 2 x = 196.0	80.0 - 145.0 n = 2 x = 112.5
Ar 2	43.1 - 91.5 n = 7 x = 67.3	40.8 - 85.2 n = 7 x = 63.0	–	120.0 - 196.0 n = 3 x = 158.0
Ar 3	61.2 - 61.5 n = 2 x = 61.35	53.3 - 57.2 n = 2 x = 55.25	(185.0)	132.0
Kä 1	67.4	55.2	195.0	72.0
Sk 4	68.3	52.2	–	–
Wa 1	53.5 - 84.5 n = 3 x = 68.9	46.5 - 79.2 n = 2 x = 62.8	–	285.0
Wa 2	75.5	76.5	–	130.0 - 157.0 n = 2 x = 143.5
Wa 3	–	–	–	133.0 - 155.0 n = 2 x = 144.0
Hu 4	43.7 - 86.8 n = 9 x = 62.2	34.0 - 71.5 n = 9 x = 52.7	–	90.0 - 171.0 n = 7 x = 130.5
Tö 2	46.3 - 84.5 n = 36 x = 65.4	37.6 - 77.5 n = 35 x = 57.5	128.0 - 253.0 n = 33 x = 190.5	103.0 - 166.0 n = 21 x = 134.5
Recent[1]	49.6 - 76.2 n = 5 x = 62.9	44.0 - 70.0 n = 5 x = 57.0	143.0 - 228.0 n = 3 x = 185.5	82.0 - 140.0 n = 2 x = 111.0

Table 45 Size of *Cervus elaphus* antlers from the Neuwied Basin assemblages (based on absolute measurements in Appendix I) compared with those of recent red deer. For key to measurements taken see Fig. 36. – [1] Monrepos collection.

Ar 2, Sk 4, Wa 1, Hu 4, Tö 2 and Niederbieber red deer antler frontlets have been recorded. They indicate that these individuals died during the autumn or winter, and that red deer were present in the Neuwied Basin during the months September to March.

Stratigraphic range

The earliest known occurrence of *C. elaphus* is in the Cromerian faunas of West Runton and Voigtstedt (Lister, 1984 a; 1986). The species still exists in North-West Europe.

C. elaphus occurs in most assemblages in the Neuwied Basin dating to the Middle and Late Pleistocene and is part of the natural fauna of the Neuwied Basin today, where it inhabits open, deciduous woodland. The oldest occurrence of *C. elaphus* in the Neuwied Basin is at the Kärlich locality in unit F. The fragment of an antler frontlet from the older unit, Kä C, could only be described as *Cervus* cf. *elaphus*. Kä F has been correlated with a phase in the Cromer complex, although a closer correlation within this period cannot be given (Fig. 3). The known stratigraphic range of *C. elaphus* indicates that Kä F could be as old as the Cromerian of West Runton and Voigtstedt.

Palaeoecology

C. elaphus is a ubiquitous species. It was present throughout the Middle and Late Pleistocene periods in both warm and cold stage faunas. *C. elaphus* is known to have occurred in interglacial faunas in association with both temperate and coniferous forests, in interstadials with boreal forest and in cold phases with treeless herbaceous vegetation (Stuart, 1982). Its presence in faunas associated with a steppe-tundra environment is probably indicative of the absence of heavy snowfall, which would prevent access to winter fodder (Stuart, *ibid.*) and to the presence of some form of shelter (either topographical or woodland) during the cold winters.

C. elaphus occurs in the Mi 1 and 2 assemblages in association with a fauna pollen-dated to an interglacial phase, and in the Mi 2 assemblage in association with an open birch and pine woodland. A similar situation has been recorded at Kä 1, where red deer is associated with a fauna deposited during a late temperate or post temperate phase at the end of an interglacial. In the Tö 2 and Hu 4 assemblages *C. elaphus* occurs in assemblages located in soils formed under temperate conditions in association with an open environment. At Gönnersdorf, this species occurs in a fauna dating to the end of the Bölling Interstadial. In the Alleröd Interstadial faunas from An 2, Niederbieber, Urbar and Miesenheim II, red deer occurs in an association with open woodland.

C. elaphus is also recorded in faunas located in cold stage deposits in association with a predominantly open steppe or steppe-tundra environmant, such as Ar 1 and 2, and those from Wannen. Red deer were apparently present in the Neuwied Basin region during both the autumn or winter (presence of antler frontlets in some assemblages) and during the summer months (association at the Gönnersdorf locality with a summer settlement phase).

Genus *DAMA* (Frisch, 1775)

DAMA DAMA
(Linnaeus 1758)
Fallow deer

Plate 27B, a; Table 46.

Fragments of teeth identified as belonging to *Dama dama* were recovered from the Hummerich locality. More fragmentary remains from Kärlich and Tönchesberg are identified as cf. *Dama dama*.

Basic identification

Dentition

The cheek teeth of recent *D. dama* fall in size between those of red deer, *Cervus elaphus*, and roe deer, *Capreolus capreolus*. *D. dama* cheek teeth are similar in size to those of reindeer *Rangifer tarandus*, but can be distinguished from those of this species by their morphology and their rugose enamel.

	Hu 4	*D. d. clactoniana* (Swanscombe)[1]	Recent (Richmond Park)[2]
Length	25.5	24.9-27.0 n = 7 x = 25.9	20.7-24.0 n = 16 x = 22.15

Table 46 Comparison of the length of the lower M3 of *Dama* from Hu 4 with those of *D. d. clactoniana* and recent fallow deer. [1]After Lister, 1986, table 1; [2]Pers. comm., A. Lister.

Post-cranial bone

The post-cranial bones of *Dama dama* are of typical cervid form. An identification to this species is generally based on size.

Material

– HUMMERICH

Hu 4
Mandible fragment with lower third molar dex.
A minimum of one individual is represented.

cf. *Dama dama:*

– KÄRLICH

Kä Gb
Fragment of a lower premolar or molar.
A minimum of one individual is represented.
The specimen has been identified as cf. *Dama* by F. Poplin.

Kä H
Distal end of a tibia dex.
Greatest breadth of distal end: 36.0 mm.
A minimum of one individual is represented.

– TÖNCHESBERG

Tö 2
A lower M1 or M2 sin. Length: 19.0 mm.; breadth: 10.1.
A minimum of one individual is represented.

Description

Dentition

The infundibulum of the posterior lobe of the lower M3 from Hu 4 opens into that of the hypoconid (Plate 19a i). This characteristic is also present on the lower M3 of *Dama* sp. from the locality of Weimar-Ehringsdorf (Kahlke, 1975b, page 228).

The lower M1 or M2 from Tö 2 has an ectostylid between hypoconid and protoconid. The anterior face of the tooth has a well-developed cingulum. The size of the tooth shows that this specimen could also belong to *Dama dama*.

The fragment of a lower premolar or molar from Kä Gb could, following the basic identification for *Dama dama* teeth (see above), also belong to this species. A closer identification was not possible.

Post-cranial bone

The tibia fragment from Kä H is slightly larger in the breadth of the distal end than those of the robust *Capreolus capreolus* (roe deer) from Miesenheim 1 (Table 53) and smaller than those of *Cervus elaphus* (red deer) from other localities in the Neuwied Basin region (Table 44).

Discussion

Fossil fallow deer from English localities, such as Clacton and Swanscombe, possibly the equivalent of the Holsteinian, have been assigned to the subspecies *Dama dama clactoniana*, due to their large body-size and the form of the antlers, which differ from those of the living *Dama dama* (Lister. 1984a, 1986). Fallow deer remains from the Last Interglacial (=Eemian) in Europe are generally referred to the living *Dama dama dama*.

Table 46 compares the length of the lower M3 from Hu 4 with those of *D. d. clactoniana* from Swanscombe (England) and recent fallow deer (Richmond Park collection, England; pers. comm. A. Lister, 1989). The Hu 4 specimen compares with the mean value given for *D. d. clactoniana*, and is longer than the recent lower M3s. However, the living fallow deer on the Continent tend to be larger than those in England (pers. comm. A. Lister, 1989), and it may be that this also applies to the fossil forms.

The Hu 4 specimen is comparable in the length to a lower M3 from the Weimar-Ehringsdorf locality (G. D. R.), described as *Dama* sp. (length of lower M3 =25.8 mm.) (Kahlke, 1975b, page 228). The Hu 4 specimen is described here as *Dama dama*.

Stratigraphic range

The earliest known occurrence of *Dama* is in the Cromerian fauna of the West Runton Freshwater Beds (Azzaroli, 1953; Lister, 1984a, 1986). The species still occurs in Europe and is occasionally seen wild in the Neuwied Basin region, where its presence is due to man's influence.

The possible presence of *Dama* in Kä Gb and the known stratigraphic range of this genus indicates that this unit could be as old as the Cromerian of West Runton. Fragmentary lower cheek teeth from Tö 2 have been identified as cf. *Dama*. This assemblage has been correlated with either the end of the Last Interglacial (= Eem) or beginning of the Last Cold Stage BP (=Weichselian). The lower M3 from Hu 4 has been identified as *Dama dama*; this assemblage may belong to an interstadial at the beginning of the Last Cold Stage BP. This is the last occurrence of this species in Pleistocene assemblages in the Neuwied Basin.

Palaeoecology

Dama is intolerant of cold climate and was restricted to interglacials in association with temperate forest during the Middle and Late Pleistocene periods in England (Stuart,1982). It does occur occasionally in cold stage and interstadial faunas in more southerly latitudes, such as southern France (Delpech & Heintz, in de Lumley [ed.] 1976). Lister (1984a, 1986) suggests that *Dama* was restricted to more southerly latitudes during the cold stages in Northern and Western Europe.

The remains of *Dama* in Kä Gb and Kä H are probably derived from warm stage deposits within these units. The assemblages at Tönchesberg and Hummerich, in which *Dama* occurs are both located in warm stage deposits. At Tö 2, a mammalian microfauna and a molluscan fauna indicative of a warm climate and an open environment have been recovered. These assemblages have been correlated with either the end of the Last Interglacial or an interstadial at the beginning of the Last Cold Stage BP. As has been stated above, this species is known to occur in interstadial faunas in more southerly latitudes (Delpech & Heintz, in de Lumley, 1976). Thus, the presence of *Dama* in the Tö 2 and Hu 4 assemblages indicates that either these assemblages do date to the Last Interglacial, or that *Dama dama* was able to survive during interstadials in the Middle Rhine region, which indicates that the climate during these phases was warm enough for this species (see Chapter 9 for further discussion of this problem).

Genus *MEGALOCEROS* (Brookes, 1828)

Remains identified as belonging to extinct giant deer (*Megaloceros* sp.) are rare elements in the Middle and Late Pleistocene assemblages from the Neuwied Basin.

Megacerine remains are known to date from Kärlich, Ariendorf and Schweinskopf and represent two species, *Megaloceros verticornis* and *Megaloceros giganteus*.

Basic identification

Antler

As with the majority of fossil cervid antlers found at the Neuwied Basin localities, complete beams were not preserved. An identification as to genus and species was therefore confined to the characteristics of the basal part.

Megacerine antlers are characterized generally by their large size and massive beams. In comparison to the

antlers of red deer (*Cervus elaphus*) found in assemblages in this region, the outer surface of the megacerine antlers is smoother and the pearling of the burr is, in some cases, not as well-developed. The curvature of the beam above the burr, corresponding to the horizontal attitude of the antler when carried (Lister, 1987), is characteristic of *Megaloceros* and can also be used to distinguish megacerine antlers from those of red deer. The basal tine development consists of a single tine or two tines. The latter, however, do not conform to the usual pattern of basal tine development seen in the antlers of *Cervus elaphus* (see page 282).
The three species of Middle and Late Pleistocene megacerines *Megaloceros savini*, *Megaloceros verticornis* and *Megaloceros giganteus* can be identified by the form of their antlers and, particularly useful for an identification of the incomplete specimens from the Neuwied Basin localities, show morphological differences between the species in the basal tine development.
Of the two lower Middle Pleistocene species, *M.savini* had relatively small antlers (see Table 47) with a single spoon-shaped basal tine rising together with the beam from the rose (Kahlke, 1969). The antlers of *M. verticornis* were larger (Table 47), with two basal tines, consisting of a rudimentary lower tine and a prominent upper tine (Kahlke, 1959/1960; 1969). The rudimentary lower tine is missing on some specimens (*ibid.*). The upper Middle and Late Pleistocene species, *M. giganteus*, possessed the largest antlers with a single basal tine placed low down at the base of the beam.

Mandible and lower dentition

Megacerine mandibles are characterized by a thickening of the jaw below the lower M2 and M3 (Plate 28a ii), a characteristic not present in the mandibles of other large cervids, such as red deer or elk.
The megacerine dentition is of typical cervid form. The cheek teeth are similar to those of red deer (*Cervus elaphus*) in their morphology and rugose enamel. They are, however, much larger in size; the size of the megacerine lower cheek teeth from Sk 4 surpassing those of the largest red deer specimens found in the late Weichselian assemblages in the Neuwied Basin (compare Tables 42 and 50). The lower M3 in red deer often bears a posterior cuspule which is not present on the same tooth from a megacerine (Lister, 1987).
A possible morphological distinction between the lower P4 of red deer and *Megaloceros giganteus* has been described by von Koenigswald (1974, page 97), and is discussed in more detail below (see *Megaloceros giganteus*).
The dentition of elk (*Alces alces*), the only other large cervid present at the localities discussed in the Neuwied Basin is, with its smooth enamel and molarisation of the lower premolars, morphologically distinct from that of the megacerines (see page 313).

MEGALOCEROS VERTICORNIS

(Dawkins 1872)
Extinct giant deer

Plate 27B, b; Tables 47 and 49.

Material

– KÄRLICH

Kä F
A shed antler base dex. The beam is preserved to a length of about 230 mm. and has a single tine rising about 80 mm. behind the burr on the anterior side of the beam.
The specimen has been mentioned by Würges (1981, page 24) and has been identified by F. Poplin as *Praemegaceros verticornis*. Lister (1986) states that this name has been shown by Azzaroli (1953) to be invalid and that this species should now be referred to *Megaloceros verticornis*.
A minimum number of individuals is not given on shed antler alone.

Kä E or F
Shed antler bases from two separate individuals. Both specimens possess a single basal tine rising on the anterior side of the beam at a distance of 45 mm. and 30 mm. behind the rose respectively. The finds were discovered in 1969 and were described and published by Karlheinz Rothausen in 1970. The

	Kä F	Kä E/F[1]		*M. verticornis*		*M. savini*
	F 195	P 402	P 403	Voigtstedt[2]	Mosbach[3]	Süssenborn[4]
Circumference of rose:	243.0	229.0	179.0	213 - 251 n = 4 x = 232	256	221.0
Circumference of beam below tine:	182.0	217.0	174.0	–	154 - 214 n = 4 x = 184	162.0

Table 47 Measurements of the shed antler from Kä E/F and Kä F compared with those of the lower Middle Pleistocene megacerines. – [1]Rothausen, 1970, 309; [2]Kahlke, 1958, 16; [3]Kahlke, 1960, 35 - 36; [4]Kahlke, 1969, 590.

	Ar	*M. g. antecedens* Steinheim[1]	*M. giganteus* Weimar-Ehringsdorf[2]
Circumference of rose:	(295.0)	205.0 - 290.0 n = 3 x = 247.5	318.0
Circumference of beam below tine:	224.0	–	252.0

Table 48 Measurements of the shed antler from Ar Ch. compared with those of *M. g. antecedens* and *M. giganteus*. [1] Berckhemer, 1941, table 1; [2] Kahlke, 1975b, 209.

finds are stored in the Palaeontological Institute of the University of Mainz.
Because of the poor state of preservation of the specimens, Rothausen (*ibid.*) was not prepared to give a definite identification as to species, and described the antlers as belonging to the »*Praemegaceros*« group (*M. verticornis* is meant here).

Kä Gb
Mandible fragment sin. with lower M1 and M2.
The specimens have been identified by F. Poplin as *Praemegaceros verticornis* =*Megaloceros verticornis*.

Description and Disussion

Antler

The shed antler bases from Kä F and Kä E/F all possess a single prominent basal tine rising at a distance behind the burr on the anterior side of the beam (Plate 27B, b). This characteristic is typical of the species *Megaloceros verticornis*. Rothausen (1970), used the same characteristic to provisionally identify the specimens from Kä E/F.
Table 47 compares the size of the antlers from Kärlich with those of the lower Middle Pleistocene species *M. verticornis* and *M. savini*. The antlers from Kä F and Kä E/F are large and compare in size with those of *M. verticornis* from the localities of Voigtstedt (G.D.R.) and Mosbach (F.R.G.). The exception to this is the specimen P 403 from Kä E/F, which compares in the circumference of the rose with the smaller *M. savini* antler from Süssenborn. This specimen shows, however, none of the characteristics of basal tine development associated with *M. savini*.
The specimens from Kärlich are therefore described as belonging to *M. verticornis*. The smaller specimen (P403) is, on the basis of its morphology, also referred to this species.

Dentition

The lower M1 and M2 from Kä Gb showed no particular morphological details. Table 49 compares the length and breadth of these specimens with those of *M. verticornis*, *M. savini* and *M. giganteus*. The speci-

	Kä Gb	*M. verticornis* Süssenborn[1]	*M. savini* Süssenborn[2]	*M. giganteus* Late Pleistocene (Ireland)[3]
M1 Length	22.5	22.3 - 25.4 n = 7 x = 23.85	26.0	28.5 - 29.5
M2 Length	25.5	25.1 - 26.3 n = 10 x = 25.7	29.0	30.9 - 33.0

Table 49 Measurements of the lower M1 and M2 from Kä Gb compared with those of other megacerines. – [1]Kahlke, 1969, 576; [2]*ibid.*, 591; [3]Soergel, 1927, 396.

mens from Kä Gb are small and compare with the mean value of those of *M. verticornis*, in this case from the site of Süssenborn. The specimens from Kä Gb are therefore identified as being comparable to the species *M. verticornis*.

Stratigraphic range

Both *Megaloceros verticornis* and *Megaloceros savini* occurred in lower Middle Pleistocene faunas throughout Europe and appear to have had the same stratigraphic range (Lister, 1986). The earliest known occurrences of these species are from the Cromerian assemblages of West Runton and Voigtstedt (*ibid.*). They also occurred in the fauna from Mosbach, dated to the late Cromerian and early Elsterian. Both species probably became extinct sometime during the latter part of the Elsterian and are absent in faunas dating to the Holsteinian and post-Holsteinian periods (Lister, *ibid.*)

The antler from Kä F and the lower molars from Kä Gb verify the presence of *M. verticornis* as provisionally proposed by Rothausen (1970) in the lower Kärlich sequence, and extend the range of the species at this locality into the younger Kä Gb horizon.

Rothausen (*ibid.*), concluded that Kä E/F probably dated to the early part of the Elsterian due to the stratigraphic range of *M. verticornis* and the presence of a microfauna, possibly originating from the same horizon as the antlers and thought at the time to be »post-Cromerian« in age (after Heller) (*ibid.*, page 315). According to the stratigraphy at the Kärlich locality, Kä E, F and Gb have been dated to the Seventh to Fourth Cold Stages BP respectively. The Fourth Cold Stage BP has been tentatively correlated with the Elsterian. The Seventh and Sixth Cold Stages BP have not been definitely correlated, they are thought to represent stages within the Cromer complex (Fig. 3).

	Sk 4	*M. verticornis* Voigtstedt[1]	Weimar-Ehringsdorf[2]	*M. giganteus* Weinberghöhle[3]	Late Pleistocene (Ireland[4]
P4 Length	(23.5)	20.9 - 22.8 n = 7 x = 21.74	–	24.9 - 27.8 n = 3 x = 26.35	–
M3 Length	42.8	36.5 - 40.9 n = 10 x = 39.13	40.3 - 46.2 n = 10 x = 42.6	42.0 - 43.5 n = 3 x = 42.75	39.0 - 41.9

Table 50 Measurements of isolated lower teeth of *M. giganteus* from Sk 4 compared with those of *M. verticornis* and *M. giganteus* from other localities. – [1] Kahlke, 1958, 24 and 25; [2] Kahlke, 1975b, 212, Lower travertine; [3] v. Koenigswald, 1974, 96; [4] Soergel, 1927, 396.

The present knowledge about the stratigraphic range of *M. verticornis* indicates that Kä F, and possibly Kä E, could be as old as the Cromerian of West Runton and Voigtstedt and that Kä Gb is younger than the Holsteinian.

Palaeoecology

The palaeoecology of this species is not particularly well known. It has been recorded in faunas associated with regional temperate forest in England (Stuart, 1982).

MEGALOCEROS cf. *GIGANTEUS*

(Blumenbach 1803)
Extinct giant deer

Plate 28; Tables 48 and 50.

Material

– ARIENDORF

Ar Ch.
A shed antler base sin. The beam is preserved to a length of about 430.0 mm. The single basal tine has been broken off.
The antler has been identified by Poplin (in Brunnacker et al., 1975, page 121) as belonging to *Megaloceros* cf. *giganteus*. The measurements given in Table 48 are my own observations.

– SCHWEINSKOPF

Sk 4
Mandible fragment dex. with complete, but damaged, lower cheek-tooth row; a lower third molar sin. belonging to the same individual.

Measurements:
P3 Length: 20.8 Breadth: 13.0
P4 Length: (23.5) Breadth: 16.5
M1 Length: (25.2)
M2 Length: 42.8 Breadth: 21.1

A minimum of one individual is represented.

Description

Antler

The antler from Ar Ch. is poorly-preserved. The position of the missing basal tine low down towards the base of the beam and the large size of the beam (Table 48, the original circumference of the burr must have been in the range 300+ mm.), indicate the species *M. giganteus*. Poplin (1975), prefers to determine the specimen as *Megaloceros* cf. *giganteus*.

Mandible and lower cheek teeth

The mandible from Sk 4 shows the typical thickening below the lower molars, characteristic of the megacerines (Plate 28, a ii). The lower P2 - M3 are preserved, but have been damaged post-depositionally. The ascending ramus has been broken off at its base. The lower molars all possess an ectostylid between protoconid and hypoconid; basal cingulums are not present on any of the teeth (Plate 28,a i).

As has been stated above, v. Koenigswald (1974) has proposed a distinction between *M. giganteus* and red deer (*Cervus elaphus*) based on the morphology of the lower P4. He refers to the two posterior lingual infoldings of the lower P4 (Fig. 37 g). These infoldings are, as wear begins, open in both species. As wear progresses, the second (posterior) infolding closes in red deer, the first remains open because of its greater depth. In *M. giganteus* the opposite occurs, whereby the first infolding is shallow and closes soon after wear begins, the second (posterior) infolding remaining open due to its greater depth (*ibid.* Plate 27, figs. 6 and 7).

The lower P4 in the Sk 4 mandible is not as worn as the one described by v. Koenigswald and therefore both infoldings are still open lingually (Plate 28, a iii). In the lingual view, however, it could be seen that the infoldings do correspond to the above description for *M. giganteus*, whereby the first infolding is closed just below the occlusal surface and the second infolding is open almost down to the base of the crown.
The lower P4 and M3 (Table 50) from Sk 4 are larger than those of *M. verticornis*. The lower M3 compares in length with those of *M. giganteus* from the localities of Weimar-Ehringsdorf and Weinberghöhle, and is slightly larger than those of Late Pleistocene specimens from Ireland.

Discussion

Berckhemer (1941), identified the megacerine remains from the locality at Steinheim (F.R.G.) as belonging to a subspecies *Megaloceros giganteus antecedens* due to their small body-size and the form of the antler, particularly the large, flat basal tine. Poplin (in Brunnacker et al., 1975), sees the antler from Ar Ch. as being too large and the base of the brow tine too small to belong to *M. g. antecedens*. Table 48 shows that the Ar Ch. specimen is larger than antlers of *M. g. antecedens* from Steinheim and falls in size between these and an example of *M. giganteus* antler from Weimar-Ehringsdorf (G.D.R.). The antler from Ar Ch. is described here as *M.* cf. *giganteus*.
Morphologically, the cheek teeth of all the species of *Megaloceros* are very similar. Berckhemers (1941), attempts to distinguish morphologically between the teeth of *M. g. antecedens* from Steinheim and *M. giganteus* from Late Pleistocene localities have been criticised as being based on characteristics which show too much individual variation (v. Koenigswald, 1974).

Stratigraphic range

The earliest known occurrence of *Megaloceros giganteus* is in faunas dating to the Holsteinian. Recent finds may show that this species already existed in the late Elsterian. The species became extinct during the Late Pleistocene at around 11,000 BP (Lister, 1986).
The oldest occurrence of this species in the Neuwied Basin faunas is in the Ar Ch. assemblage. This assemblage is located in deposits derived possibly from a loess bed at this site dating to the Third Cold Stage BP, which in turn has been correlated with an older phase of the Saalian. The Sk 4 assemblage is located in deposits thought to date to the Second Cold Stage BP, which in turn has been correlated with a younger Saalian phase. The occurence of *Megaloceros giganteus* in the Neuwied Basin assemblages thus falls within the known stratigraphic range of this species in Europe.

Palaeoecology

Megaloceros giganteus is known to have occurred in both warm and cold stage faunas during the upper Middle and Late Pleistocene periods. Both occurrences of this species in the Neuwied basin are from faunas located in cold stage deposits. The fauna in the Ar Ch. deposit is certainly derived, and it is not known whether the antler was originally deposited in loess or reworked into loess after burial.

Genus *CAPREOLUS* (Frisch, 1775)

CAPREOLUS CAPREOLUS
(Linnaeus 1758)
Roe deer

Plate 29A, a; Tables 51 - 53; Appendix III.
The remains of roe deer have been recovered from assemblages at Miesenheim I and Hummerich.

Basic identification

Antler

Roe deer antlers are much smaller than those of the other cervids and consist of an upright, short beam with, in adult males, an anterior and a posterior tine at the top. Basal tines are missing. Typical for this species is the extremely rugose surface of the beam, particularly towards the base on the inner (medial) sides and the burr, which makes identification of even very fragmentary pieces possible.

Dentition

The cheek teeth are of typical cervid form and are distinguished from those of red deer (*Cervus elaphus*) or fallow deer (*Dama dama*) by their small size.

Post-cranial bone

An identification as to this species is generally based on the small size of the post-cranial bones.

Material

– MIESENHEIM I

Mi 2

Four shed antler dex. (two complete examples from adult individuals, see below); three shed antler sin.; one fragmentary shed antler s/d. a lower P3 dex.; a lower P4 dex.; a lower M3 sin. and dex.; an upper P2 dex.; an upper P3 sin. and dex.; an upper P4 sin. and dex.; three upper M1 dex. an upper M1 sin. (not erupted); two upper M2 sin.; three upper M2 dex.; two upper M3 dex.; distal end of a humerus dex. and sin.; proximal end of a radius dex.; distal end of a tibia dex.; distal end of a metatarsus or carpus; an os centrotarsale sin. and dex.; a calcaneum dex.; an astragalus dex.; a metatarsus III/IV dex.; six complete and two fragmentary first phalanges; three second phalanges; two third phalanges.

The minimum number of individuals based on the list above is four; anatomical refitting and closer comparison of the wear stages of the individual cheek teeth showed that seven individuals are actually present (six mature and one juvenile individual).

– HUMMERICH

Hu 4

Shed antler base s/d; fragment of antler beam; fragment of a metatarsus III/IV; fragments from two humeri sin.

A minimum of two individuals is present.

Description

Antler

The antlers from Mi 2 show a wide range in size (Appendix III), due to the presence of both weakly-developed first-year antler and fully-developed antler from mature males amongst the sample. The complete antler from an adult individual (Table 51) is large in comparison with the antler of recent roe. Most of the specimens have flat or convex shed surfaces and the pearling of the burr is placed low towards the base. One example of first-year antler has a burr placed high on the beam and two antlers have a shed surface slanting to the axis of the beam.

Of the complete antlers, one specimen (Plate 29A, a i) is from a mature individual of two or more years of age (Bouchud, 1966) and shows the typical fully-developed roe deer antler with an anterior, upper and posterior tine. The pearling of burr and beam is not particularly well-developed on this example. The beam is circular above the burr and flattens slightly towards the top as in the recent roe deer antler. The anterior tine is long and slightly pointed and the posterior tine is short and curved.

The second complete antler is also from an older animal (Plate 29A, a ii). The beam is long and the pearling of burr and beam is the same as on the example described above. However, this example has no tine development and ends in a simple point, as is more typical for the first years growth in this species. Antlers of

	Mi 2 54/54, 4	*C. süssenbornensis* Süssenborn[1]	*C. capreolus* Ehringsdorf[2]	*C. capreolus* Recent[3]
1.	238.0	198.0 - 312.0 n = 2	245.0	198.0
2.	130.0	134.0 - 135.0 n = 2	–	–
3.	41.6	45.0 - 47.0 n = 2	37.2	40.7
4.	40.9	–	–	–
5.	86.0	75.0 - 94.0	–	83.0
6.	110.0	79.0 - 121.0 n = 3	–	110.0
7.	78.0	48.0 - 78.0 n = 3	–	32.0
8.	68.0	42.0 - 101.0 n = 3	69.9	54.0
9.	35.0	37.0 - 71.0 n = 2	51.3	39.0

Table 51 Measurements of the complete antler of *Capreolus capreolus* from Mi 2 and comparison with those of fossil and recent roe deer. – 1 - 9 see Fig. 36. – [1]After Kahlke, 1969; [2]after Kahlke, 1975a; [3]Monrepos collection.

this form are, however, often carried by old males and considering the size of this find (Appendix III), this is very likely to be the case here. Characteristic of both of these examples is the curvature of the beam as it rises above the rose, bending first inwards towards the medial side and then outwards (lateral) again.

One specimen of antler from Mi 2 shows pathological growth (Plate 29A, a iii). The antler is much larger in size than the other examples and consists of the base and part of the beam. The beam shows the typical rough surface characteristic of this species, although the pearling of the burr is missing, probably because of the weathered condition of the find. The beam is curved, a condition not normally found in this species. A small, broken tine is located on the beam slightly above the rose.

Dentition

The cheek teeth from Mi 2 show no morphological differences when compared to those of recent roe deer. The lower P3 has a vertical outer groove on the anterior part of the hypoconid, a characteristic also present on the recent material.

One of the upper first molars has a small doubled entostyle between hypocone and protocone on the lingual side. An enamel fold is present, joining the anterior and posterior lobes at the base on the buccal side. This characteristic also appeared on the recent material, but only occurs on this particular specimen from Mi 2. The upper second and third molars all possess a fairly well-developed entostyle on the lingual side. This is attached to the base of the hypocone and occasionally continues onto the protocone in the form of a low cingulum. Small cingulums are found on the upper molars only, particularly the upper M2s and M3s and are placed on the posterior face of the teeth.

Both the upper and lower cheek teeth of *Capreolus capreolus* from Miesenheim tend to be larger than those from recent roe deer (Table 52).

Post-cranial bone

The post-cranial bones from Mi 2 show a large range in size from one individual to another. The remains of one adult individual (Table 53) are much larger than those of recent roe deer, but showed no morphological differences. A possible identification to *Dama* (fallow deer) could, however, be ruled out here as the bone was much more slender than the metatarsus of *Dama*. The metatarsus from Hu 4, although not measurable, is similar in size to that of the recent roe deer.

	Mi 2	*C. süssenbornensis* Süssenborn[1]	*C. capreolus* Ehringsdorf[2]	*C. capreolus* Recent[3]
P4				
Length	8.0 - 9.5 n = 4 x = 8.75	9.7 - 9.8 n = 2	8.6	8.3
Breadth	10.5 - 11.3 n = 3 x = 10.9	11.9 - 13.0 n = 2	–	9.9
M1				
Length	10.7 - 14.6 n = 4 x = 12.6	11.8	11.0 - 11.2 n = 2	10.9
Breadth				
ant.	9.5 - 13.6 n = 4 x = 11.55	–	12.1 - 12.8 n = 2	11.4
post.	9.8 - 12.9 n = 4 x = 11.3	12.7	11.9 - 12.6 n = 2	10.2
M2				
Length	12.4 - 14.4 n = 4 x = 13.4	11.2 - 13.1 n = 2	10.9	10.6
Breadth				
ant.	12.0 - 13.8 n = 4 x = 12.9	12.5 - 13.8 n = 2	13.6	12.6
post.	11.1 - 13.5 n = 5 x = 12.3	12.2 - 13.1 n = 2	12.3	11.8

Table 52 Length and breadth of the upper cheek of *Capreolus capreolus* from Mi 2 and comparison with those of fossil and recent roe deer. – [1]Kahlke, 1969; [2]Kahlke, 1975a; [3]Monrepos collection.

Discussion

Kahlke (1956), referred roe deer remains from the localities of Süssenborn, Voigtstedt and Mosbach to *Capreolus süssenbornensis*, due to their large body-size, a more pronounced flattening of the antler and the morphology of the lower P3. Lister (1986) states that this is not sufficient evidence for taxonomic distinction.

Morphologically, the roe deer remains from both Mi 2 and Hu 4 showed no differences when compared to those of recent roe deer. More obvious is the large size of some of the antler, cheek teeth and post-cranial bones in the Mi 2 assemblage (Tables 51 - 53), especially when compared with those of the recent roe deer. The post-cranial bones from Mi 2 all belong to the largest individual(s) found to date at the site and compare closely in size with those from the Süssenborn locality. The tibia from Mi 2 is even larger than the one from Süssenborn. Large size appears to be characteristic of most fossil roe deer remains (Table 51 - 53), and in this aspect, they approach the size of the living Siberian roe deer *Capreolus capreolus pygargus*. As there are no morphological differences between the roe deer from the Neuwied Basin assemblages and the recent animal, the roe deer remains from Mi 2 and from Hu 4 are described as *Capreolus capreolus*.

Stratigraphic range

The earliest known occurrence of *Capreolus capreolus* was during the Cromerian (Lister, 1984), occurring at localities such as West Runton in England (Azzaroli, 1953; Stuart, 1975) and Voigtstedt in East Germany

TIBIA		*C. süssenbornensis*	*C. capreolus*	*C. capreolus*
	Mi 2	Süssenborn[1]	Ehringsdorf[2]	Recent[3]
Distal breadth	35.0	29.9	24.9 - 27.6 n = 2	26.3
ASTRAGALUS				
Lateral length	34.8	mean = 36.5 n = 6	mean = 29.4 n = 3	28.4
Medial length	32.9	–	–	27.5
Distal breadth	21.5	mean = 22.5 n = 5	mean = 17.6 n = 3	18.3
CALCANEUM				
Length	78.0	–	68.3	57.0
Breadth	25.6	22.5	19.4	18.9

METATARSUS III/IV	Mi 2	Recent
	51/50, 14	n = 2
Length	255.0	190.0 - 191.0
Breadth proximal end	24.7	18.5 - 20.0
Breadth diaphysis	15.1	12.0 - 13.3
Breadth distal end	28.7	22.3 - 25.1

Table 53 Size of post-cranial bone of *Capreolus capreolus* from Mi 2 and comparison with those of fossil and recent roe deer. [1]Kahlke, 1969; [2]Kahlke, 1975a; [3]Monrepos collection.

(Kahlke, 1956). The species still exists in North-West Europe and is part of the natural fauna of the Neuwied Basin today.

The assemblages at Miesenheim I have been dated either to the Holstein Interglacial or to an interglacial of the Cromer complex. The Hu 4 assemblage has been dated to the beginning of the Last Cold Stage BP (= Weichselian). The presence of roe deer in these assemblages falls within the known stratigraphic range of this species.

Palaeoecology

Capreolus capreolus appears to have been restricted to warm stage faunas in North-West Europe. The only records of this species in cold stage faunas are those found in southerly latitudes, such as southern France (Delpech & Heintz, in de Lumley [ed.], 1976). This species is known to have occurred in interglacial faunas (Lister, 1986; Stuart, 1982), and has recently been recorded in an interstadial fauna at the Maastricht-Belvédère locality in Holland (v. Kolfschoten & Roebroeks, 1985).

Roe deer occurs today in association with deciduous and coniferous forests (Stuart, 1982). Availability of cover in the form of woodland with dense undergrowth, shrubs and thickets, is important for this species, as are adjacent, open areas for grazing (Lister, 1984). This is the typical habitat of this species in the Neuwied Basin today.

Capreolus capreolus is associated with a fauna pollen-dated to the end of an interglacial in association with open birch and pine woodland at Miesenheim I. The Hu 4 assemblage is located in a soil formed under temperate, possibly interstadial conditions. Roe deer does not occur in any of the faunas in cold stage deposits in this region, and its occurrence at the Hummerich and Miesenheim I is consistent with the known occurrences of this species in North-West Europe.

Genus *RANGIFER* (Smith 1827 and Frisch 1775)

RANGIFER TARANDUS

(Linnaeus 1758)
Reindeer

Plate 29A, b; Tables 54 - 56.
Reindeer occurs in faunas from assemblages at Ariendorf, Wannen, Schweinskopf, Hummerich, Gönnersdorf and Andernach.

Basic identification

Antler

Complete antler were not preserved in the Ariendorf, Schweinskopf, Wannen and Hummerich assemblages, so an identification to this species was restricted to characteristics of the basal part of the beam. The basal tine development in this species consists of a brow tine, placed low towards the base of the antler and a second tine placed behind this.

Typical of reindeer antler is the smooth outer surface of the beam and tines and the often reduced pearling of the burr. The walls of the beam of *Rangifer tarandus* antlers are thin in comparison to those of red deer (*Cervus elaphus*) antlers (Schmid, 1972). Antler are carried by both sexes. An identification as to male or female individuals can be made based upon the form of the shed antler base. In the female, the surface of the antler base is usually concave and in the male it is usually convex.

Recent *Rangifer tarandus* has two ecotypes, a tundra and a woodland form (Jacobi, 1931; Banfield, 1961). These are distinguished by their antler form, body-size, the morphology of the skull and some post-cranial bones (Banfield, 1961; Delpech, 1983). Only the characteristics of the antler were relevant for the small amount of material of *Rangifer tarandus* from the Neuwied Basin localities, the tundra form having robust antler with cylindrical beams and the woodland form having more lightly-built antler with a flattened, oval beam (see also discussion below).

Dentition

The teeth are of typical cervid form (Fig. 37), but differ from those of *Cervus elaphus* in their smaller size, smooth enamel and the more pronounced folding of the enamel on the buccal (maxillary) and lingual (mandibular) faces. The premolars are relatively large and are narrower bucco-lingually than those of *C. elaphus*.

The molarisation of the lower P3 and P4 is typical for this species and for elk (*Alces alces*, see page 313). The lower P3 and P4 can be distinguished from one another by the presence of a bifurcation at the end of the parastylid on the lingual side of the P3, which the P4 does not possess (Fig. 37).

Post-cranial bone

The identification of the post-cranial bones was based on size and morphological characteristics given by Bouchud (in Lavocet ed. 1966, pp. 244 - 277). Typical of *Rangifer tarandus* are the splayed distal epiphyses and pronounced posterior groove of the metapodia and the round proximal epiphysis of the first phalange.

Material

– ARIENDORF

Ar Ch.
Antler frontlet dex.
The specimen has been described by Poplin (in Brunnacker et al., 1975), as being from *Rangifer tarandus*.
A minimum of one individual is represented.

– SCHWEINSKOPF

Sk 3
A shed antler base (Plate 29A, b).
The shed surface of the antler is concave, as is usual in female reindeer (Sturdy, 1975). The circumference of the beam is 48 mm.
Minimum number of individuals is not given on shed antler alone.

Sk 4
A shed antler base, circumference of beam is 81.0 mm.; antler frontlets sin. and dex.; an upper P2 sin.; two upper P3s dex.; two upper P4s sin.; a lower P2 dex.; a lower P3 dex.; two lower P3s sin.; two lower P4s sin.; a lower M1 dex.; a lower M2 sin. and dex.; three lower M3s sin.; distal end of a humerus sin.; proximal ends of radius sin. and dex.; an astragalus sin.
A minimum of three individuals is represented.

– WANNEN

Wa 3
Fragment of an antler frontlet; a complete metacarpus III/IV sin.
A minimum of one individual is represented.

Wa 4/5
Distal end of a humerus sin.; a complete radio-ulna; a metacarpus I or IV sin.; scapula fragments.
A minimum of one individual is represented.

– HUMMERICH

Hu 5
A single first phalange.
A minimum of one individual is represented.

– TÖNCHESBERG

Tö 1
Fragment of a shed antler.

– GÖNNERSDORF

Only the measurements of a few specimens of cheek teeth of *Rangifer tarandus* are included from this assemblage (Tables 54 and 55). Reindeer are present in both the winter and summer settlement phases at Gönnersdorf. In the winter settlement, this is one of the dominant species (minimum of four individuals). The minimum number of individuals is not given for the summer settlement phase, but Poplin (in Brunnacker (ed.), 1978) says that *Rangifer tarandus* was no longer dominant in this fauna.

– ANDERNACH

An 1
Reindeer is present at the site in this assemblage only. Further information is not available at present (Street, in prep.).

Description

Antler

The antler fragment from the Ar Ch. assemblage has been identified as *Rangifer tarandus* because the section of the beam is slightly flattened as is usual in the woodland ecotype (Poplin, in Brunnacker et al., 1975). The specimen is, however, more characteristic of red deer antlers in its basal tine development, but does have the thin beam walls more characteristic of reindeer antlers. The pearling of the beam, typical of red deer antlers is, on the other hand, missing on this specimen. This find is, however, so poorly-preserved that it should not be taken as definite evidence of the presence of *Rangifer tarandus* in this assemblage.
The antler from Sk 3, Sk 4 and Wa 3 all have the flattened beam typical of the recent woodland ecotype. Poplin (1976, page 54) describes the Gönnersdorf antler as being of cylindrical form typical of the recent tundra ecotype.

Dentition

The length and breadth of the upper and lower cheek teeth of *Rangifer tarandus* from Sk 4 and Gönnersdorf are given in tables 54 and 55.
The lower M1 from Sk 4 has an ectostylid between the protoconid and hypoconid which almost reaches to the occlusal surface. An ectostylid is also present on the lower M1 from Gönnersdorf.
One of the lower third molars from Sk 4 has two enamel islets on the posterior lobe, which the other examples from this assemblage and from Gönnersdorf do not possess.

Sk 4	P2	P3		P4	
	(11/58, 85)	(13/60, 14)	(9/57, 18)	(14/54, 9)	(13/97, 40)
Length	14.9	15.5	15.4	14.0	15.5
Breadth	14.9	16.4	14.2	16.1	15.8

M 1	Sk 4			Gö
	(14/57, 59)	(10/58, 11)	(13/55, 59)	(23d, 22)
Length	17.2	16.8	19.5	17.6
Breadth				
ant. lobe	14.5	14.4	15.6	15.2
post. lobe	14.2	15.0	16.5	16.6

Table 54 Absolute and comparative measurements of upper cheek teeth (P2 -M1) of *Rangifer tarandus.*

Discussion

Little is known about the evolution of European reindeer and attempts to identify subspecies have not been successful (Lister, 1986).

Bouchud (in Lavocet [ed.], 1966), identified three forms of reindeer from Weichselian localities in S.W. France based on the form of their antler. Animals comparable with the recent tundra and woodland forms were identified, and a further, more gracile, tundra form (*R. tarandus* var. *minor*) was identified on the size of the astragalus.

However, the interpretation of Pleistocene reindeer as belonging to tundra or woodland ecotypes, based on the form of the antler, has been criticised. Pleistocene faunas are known where both antler types occur together in the same assemblage. For example, antlers of both tundra and woodland ecotypes have been recovered from a Late Pleistocene interstadial faunal assemblage at the locality of Königsaue (G.D.R.) (Mania and Toepfer, 1973). Observations on recent animals have shown that some individuals carry antler of »tundra« type one year and antler of »woodland« type the next (Delpech, 1983, page 152).

The reindeer antlers from the localities of Schweinskopf and Wannen all have the flat oval beam characteristic of the woodland ecotype. Those from the Gönnersdorf locality (excavation 1968) being all of tundra form. However, as the possible palaeoecological interpretation of the antler form amongst Pleistocene reindeer is still unclear, an over-interpretation of the results from the sparse material from the Neuwied Basin assemblages should be avoided.

The teeth and post-cranial bones of *Rangifer tarandus* from the Neuwied Basin assemblages show no interpretable differences in size or morphology, other than those occurring between individuals (Tables 54 - 56).

Male reindeer carry antlers from September to December and females from September to May or June (Schmid, 1972). The shed antler base from a female individual has been recorded from the Sk 3 assemblage (Plate 29A, b). Females shed their antler in May or June, and it can probably be assumed that this specimen was brought to the site sometime during the summer months. The Sk 3 assemblage has been provisionally dated to a younger phase of the Saalian, and this specimen indicates that reindeer were present at least during the summer months in the Neuwied Basin at this time. Poplin (1976), has identified antlers of both male and female individuals at Gönnersdorf. This assemblage has been pollen-dated to the end of the Bölling Interstadial. The antlers found here indicate that reindeer were present throughout the year in the Neuwied Basin during the Late Weichselian phase.

Stratigraphic range

The earliest known occurrence of *Rangifer tarandus* is at the locality of Süssenborn (G.D.R.). Originally thought to be of early Mindel (=Elsterian) age (Kahlke, 1969), this locality is now thought to be older (Lister, 1986). Reindeer remains are also known from several Elsterian and Saalian faunas in Europe

Sk 4	P2	P3			P4	
	(13/57, 50)	(12/57, 40)	(12/58, 14)	(11/57, 8)	(9/61, 5)	(10/55, 5)
Length	13.2	15.3	15.0	16.3	17.1	16.4
Breadth	8.0	10.4	10.4	10.8	11.8	10.8

	M1		M2			M3		
	Sk 4	Gö	Sk 4		Gö	Sk 4		
	(12/62, 9)	(9d/71)	(0/53)	(12/62, 6)	(13 st. 6)	(9/61, 4)	(14/58, 1)	(6/49, 3)
Length	18.2	19.0	19.6	20.2	21.0	23.0	23.2	–
Breadth	–	10.9	12.4	12.5	11.8	10.3	9.6	10.6

Table 55 Absolute and comparative measurements of lower cheek teeth (P2 -M3) of *Rangifer tarandus.*

	Wa 2/3	Sk 4		Gö
HUMERUS				
		(11/51, 3)		(23/12)
Greatest breadth of distal end:	44.2	45.3		43.0
RADIUS				
		(11/52, 24)	(13/52, 2)	(50d/80)
Greatest length:	(235/0)	–	–	–
Breadth of proximal end:	43.9	50.1	52.0	49.3
Breadth of distal end:	39.9	–	–	–
METACARPUS III/IV				Wa 4
	(95/50, 9)			(98/50, 25)
Greatest length	172.0			189.0
Breadth of proximal end:	33.2			35.5
Breadth of distal end:	39.2			42.6
ASTRAGALUS				
		10/49, 14		
Lateral length:		51.2		
Medial length:		46.3		
Breadth distal:		30.1		

Table 56 Measurements of post-cranial bones of *Rangifer tarandus.*

(Kahlke, 1975a; Lister, 1986). In France, this species began to dominate faunas at the end of the Saalian (Delpech and Heintz, 1976), and it is a common element of faunas throughout the Weichselian. The species still exists in Northern Europe today.

The earliest, but rather dubious, occurrence of *Rangifer tarandus* in the Neuwied Basin is in the channel assemblage at Ariendorf. This assemblage is located in deposits probably derived from a loess bed dating to the Third Cold Stage BP, which in turn has been correlated with an older phase of the Saalian.

Rangifer tarandus also occurs in assemblages at Schweinskopf and Wannen dating to the Second Cold Stage BP (Wa 3, Sk 3 and Sk 4), which has been correlated with a younger Saalian phase, and to the Last Cold Stage BP (Wa 4/5, Hu 5), which has been correlated with Weichselian. *Rangifer tarandus* was also present in the Late Weichselian assemblages of Gönnersdorf and Andernach.

Palaeoecology

Rangifer tarandus was a common element of Middle and Late Pleistocene cold stage faunas throughout Europe (Kahlke, 1975b), extending its range as far south as northern Spain during the Last Cold Stage (Altuna, 1972).

In England, this species occurs in cold stage faunas, generally in association with an open, steppe-tundra environment. It was, however, also present in faunas dating to the early Weichselian interstadials, such as Chelford in England (Stuart, 1982) and at Königsaue in the G.D.R. (Mania & Toepfer, 1973), in association with boreal forest. It can be assumed that the presence of reindeer in a faunal assemblage makes an interglacial age unlikely, except in the far north (Lister, 1986).

Recent *Rangifer tarandus* occurs throughout most of the tundra and taiga of Eurasia and N. America (Stuart, 1982) and also ranges into boreal coniferous forests (Weniger, 1982). It can tolerate high summer temperatures and a depth of snow up to 80 or 90 cms. in winter. However, cold conditions with alternating dry and humid phases in association with brief and frequent rises in temperature are unfavourable for this animal (Delpech, 1983).

Rangifer tarandus occurs in faunas in cold stage deposits at Sk 3 and 4, Wa 3 and 4/5 and Hu 5. A shed antler from a female individual in the Sk 3 assemblage indicates that at this time, reindeer were present during May or June in the Neuwied Basin. At the Gönnersdorf locality, reindeer is one of the dominant species associated with a winter settlement phase at the site and occurs, but is no longer one of the dominant species, in the summer settlement phase. The Gönnersdorf assemblage has been pollen-dated to the end of the Bölling Interstadial, in association with predominantly steppe conditions. *Rangifer tarandus* occurs in cold stage and interstadial faunas in the Neuwied Basin region, and is therfore consistent with its known occurrence in North-West Europe.

Genus *ALCES* (Gray, 1821)

Remains identified as belonging to *Alces* have been found at four localities in the Neuwied Basin region to date. *Alces alces* has been identified at Gönnersdorf (Poplin, in Brunnacker (ed.), 1978), Andernach (Street, in press) and Niederbieber (Loftus, R. 1984; Loftus, J. 1985; Husman, H. 1988). *Alces* sp. occurs at Kärlich.

Basic identification

Dentition

The following description is based on Desbrosse and Prat (1974). The cheek teeth of *Alces* are low-crowned and much larger than those of *Cervus elaphus* (red deer). They can be distinguished from those of *Megaloceros* by their smooth enamel and the comparatively large size of the premolars (Plate 29B, i).

The upper cheek teeth of *Alces* have a prominent parastyle and mesostyle, which does not occur in those of *C.elaphus* or *Megaloceros*. The entostyle rises from the hypocone, a feature not found *C. elaphus* or *Megaloceros*. The protoconal fold of the upper molars of *Alces* is more developed than that found in those of either *C.elaphus* or *Megaloceros*.

The molarisation of the lower premolars, particularly the lower P4 (Plate 29B) is characteristic for this species and *Rangifer tarandus*. The lower P4 of *Alces* and *Rangifer* are easily distinguished from each other on the basis of size.

Post-cranial bone

The post-cranial bones are of typical cervid form, but are much larger than those of *C. elaphus* (compare Tables 43 and 58).

ALCES ALCES

(Linnaeus, 1758)
Elk

Plate 29B; Tables 57 and 58.

		An 2	Niederbieber	
			dex.	sin.
P2				
	Length	20.5	18.8	19.0
	Breadth	16.0	14.9	14.0
P3				
	Length	27.5	24.2	–
	Breadth	16.0	17.4	–
P4				
	Length	31.0	27.8	27.5
	Breadth	21.0	19.4	19.9
M1				
	Length	–	25.0	25.8
	Breadth	–	19.6	19.3
M2				
	Length	–	28.0	28.3
	Breadth	–	20.5	20.5

	Niederbieber	Recent *Alces alces* (male)[3]
Length P2 - P4	70.0	74.0

Table 57a Length and breadth of the lower dentition of *Alces alces* from An 2[1] and Niederbieber[2]. – [1]Taken from Street (in press); [2]Own observations. Taken in mandible on lingual side; [3]Desbrosse & Prat, 1974, 148.

An 2	M1	M2
Length	27.0	28.5
Breadth		
ant.	27.7	31.0
post.	25.8	30.0

Table 57b Length and breadth of the upper M1 and M2 of *Alces alces* from An 2[1]. – [1] Taken from Street (in press).

Material

– GÖNNERSDORF

Fragments of post-cranial bones have been mentioned by Poplin (in Brunnacker (ed.), 1978).

– ANDERNACH

An 2
Maxillary fragment with upper M1 and M2 dex.; a lower P2, P3 and P4 sin. A minimum of one individual is represented.
The remains of *Alces* from this assemblage have been identified by M. Street (in press). A complete material list, including the very fragmentary post-cranial material will be published elsewhere. Only the complete specimens of cheek teeth are included here.

– NIEDERBIEBER

Mandible fragments with lower P2 - M2 sin. and dex.; fragments from two pelves dex.; distal end of a tibia sin.; a complete and fragmentary os malleolare sin.; an astragalus; fragments of other post-cranial material.
A minimum of two individuals is represented.

Description

Dentition

The upper and lower cheek teeth have all the characteristics described in the basic identification. The enamel of the specimens from An 2 and Niederbieber is slightly rugose on the lingual sides (upper cheek teeth)

TIBIA	
Greatest breadth of distal end:	67.9
OS MALLEOLARE	
Greatest breadth:	37.5
OS CENTROTARSALE	
Greatest breadth:	63.4
PELVIS	
Breadth of acetabulum:	62.6
ASTRAGALUS	
Lateral length:	73.5
Medial length:	67.7
Lateral breadth:	39.2
Medial breadth:	41.4
Distal breadth:	47.2

Table 58 Measurements of post-cranial bones of *Alces alces* from Niederbieber.

and on the buccal sides (lower cheek teeth) (Plate 29B, iii), as was also noted on material studied by Desbrosse and Prat (1974).

The upper M1 and M2 from Andernach both have a short entostyle between hypocone and protocone, a well-developed protocone fold and weakly-formed cingulums on the anterior faces.

Both the lower M1 and M2 from Niederbieber have an ectostylid between hypoconid and protoconid; a basal cingulum is absent (Plate 29B, iii). The lower premolars from Niederbieber are smaller than those from An 2, but this is probably only due to size-differences between individuals (Table 57).

Post-cranial bone

The size of the post-cranial bones from the Niederbieber assemblage is given in Table 58.

Discussion

The length of the P2 - P4 of the Niederbieber mandible is similar to that of a recent male *Alces alces* (Table 57). The cheek teeth from An 2 also compared well with recent specimens (Street, in press). During the later part of the Late Pleistocene period, only one form of elk, the extant *Alces alces* is recognised. The assemblages from Niederbieber and An 2 are both definitely dated to the latter part of the Last Cold Stage BP (= Late Weichselian), and the remains of elk from these localities is comparable to the recent animal, so that this material can be referred to *Alces alces*.

Stratigraphic range

Alces alces is believed to have evolved from the lower Middle Pleistocene form *Alces latifrons,* but the exact time of this »transition« is not known (Lister, 1986). Definite evidence of the presence of *Alces alces* is only known from the later part of the Weichselian (Delpech and Heintz, in de Lumley (ed.), 1976; Lister, 1986; Stuart, 1982). This species still exists in North Europe today.

As stated above, remains of elk similar in size to the recent animal *Alces alces* only occur in assemblages dating to the end of the last cold stage (=Late Weichselian) such as Gönnersdorf, An 2 and Niederbieber.

Palaeoecology

Alces is known to have occurred in interglacial faunas in association with a temperate forest flora (Kahlke, 1975b; 1976) and interstadials in association with birch woodland (Stuart, 1982).

The living *Alces alces* occurred sporadically throughout Europe as far south as northern Spain and Italy during the Late Weichselian, after which it gradually retreated to its present habitat in Fenno-Scandinavia (Willms, 1987). It exists today in the taiga of Eurasia and also extends into the northern part of the temperate forest zone (Stuart, 1982). This species inhabits open woodland with dense undergrowth and frequents marshy woods, seeking out higher, drier ground in winter (v.d. Brink, 1967). *Alces alces* occurs in the Neuwied Basin region at the locality of Gönnersdorf in an assemblage dating to the end of the Bölling Interstadial. It also occurs in Alleröd Interstadial assemblages, such as An 2 and Niederbieber. Pollen assemblages from other localities dating to this phase indicate birch and pine woodland, with open, herbaceous vegetation. At the majority of the Alleröd localities locally damp conditions have been recorded, so that the occurrence of *Alces alces* at these localities is consistent with the known occurrence of this species during the European Pleistocene period and with the ecology of this species today.

Family *BOVIDAE* (Gray, 1821)

(Genus *Bos* sp. or *Bison* sp.)

The remains of large bovids (*Bos* sp. or *Bison* sp.) are commonly found in the Neuwied Basin assemblages. The difficulties involved with their identification as species (see below) means that their use in stratigraphic or palaeoecological interpretations is limited.

Basic identification

Dentition

The cheek teeth of the large bovids can be distinguished from those of the cervids by their large size, selenodont occlusal surfaces and high crowns (hypsodont). The enamel of the cheek teeth is rugose, and the upper and lower molars generally have an accessory column (entostyle/ectostylid, Fig. 41) between the two lobes.

Post-cranial bone

The post-cranial bone of the large bovids is characterized by its large, robust form. The anterior sulcus on the metapodia (Metacarpus III/IV; Metatarsus III/IV) extends onto the distal epiphysis in the large bovids but not in the cervids (Schmid, 1972).

Distinction *Bos* sp. and *Bison* sp.

The distinction between *Bos* sp. and *Bison* sp. is, in the absence of horn-cores, skull and vertebra, difficult. The identification of the large bovid remains from the Neuwied Basin assemblages was based on characteristics of the metapodia and astragalus as described by Schertz (1936).

Metapodia

In *Bos* sp., the outer sides of both metacarpus and metatarsus continue smoothly down onto the distal epiphysis (Fig. 42a and c). In *Bison* sp., the outer sides diverge outwards above the distal epiphysis, so that the distal end has a »shouldered« appearance (Fig. 42b and d; Plate 31A, a and b).

Astragalus

When viewed from the lateral side, the notch towards the distal end of the astragalus in *Bos* sp. is shallow (Fig. 42e and g) and in *Bison* sp. is deeper (Fig. 42f). The astragalus of *Bos* sp. is generally higher in relation to its length; those from *Bison* sp. being longer and not so high.
Based on these criteria, the large bovids from Hu 4, Tö 2, and possibly Urbar were identified as belonging

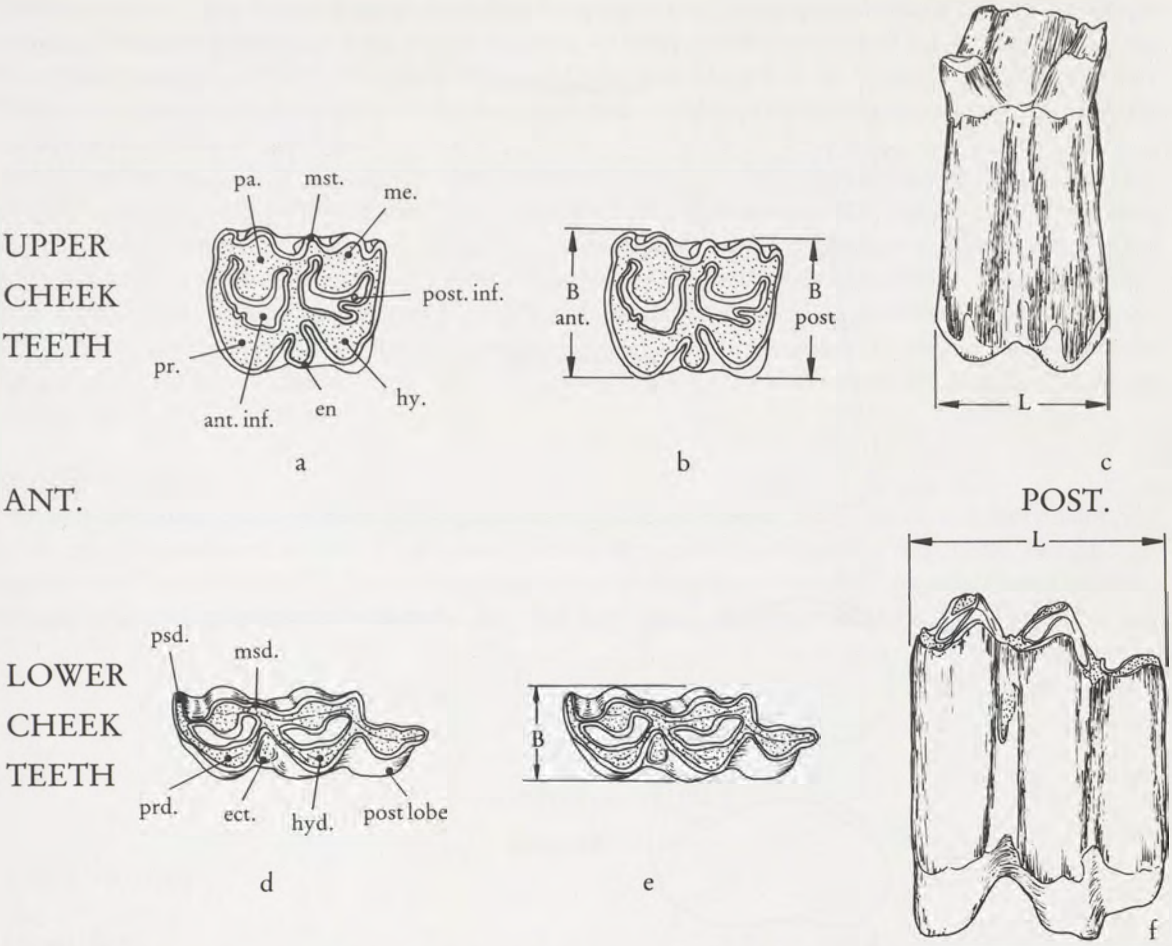


Fig. 41 Terminology used in the text to describe the dentition of the Family *Bovidae* (Sub-families *Bovinae, Ovibovinae, Caprinae* and *Antilopinae*) and the measurements taken, using an upper and lower molar of *Bos primigenius* as example.
Upper cheek teeth. – a (occlusal view). pa.: paracone; me.: metacone; mst.: mesostyle; ant. inf.: anterior infundibulum; post inf.: posterior infundibulum; pr.: protocone; en.: entostyle; hy.: hypocone. – b B: ant. breadth of tooth on the anterior lobe (at widest part). B post.: breadth of tooth on the posterior lobe (at widest part). – c L: length of tooth.
Lower cheek teeth. – d psd.: parastylid; msd.: metastylid; prd.: protoconid; ect.: ectostylid; hyd.: hypoconid; post. lobe: posterior lobe. – e B: breadth of tooth (at widest part). – f L: length of tooth.

to *Bos primigenius* and those from Ar 2 and 3 as *Bison priscus*. In the remaining assemblages, the identification *Bos* sp. or *Bison* sp. was more difficult because of either the lack of, or poor state of preservation of these foot-bones.

Other post-cranial bone

Recently, Martin (1987), has attempted to distinguish between the post-cranial bones (eg. humerus, femur) of *Bos* sp., *Bison* sp. and other large Artiodactyla. However, the characteristics given are only of use when the available material is well-preserved, which does not apply to the specimens recovered in the Neuwied Basin assemblages.

Dentition

Attempts to identify *Bos* sp. or *Bison* sp. on the morphology of the upper and lower cheek teeth, frequently found in fossil assemblages, have not been particularly successful to date. A distinction based on dental-

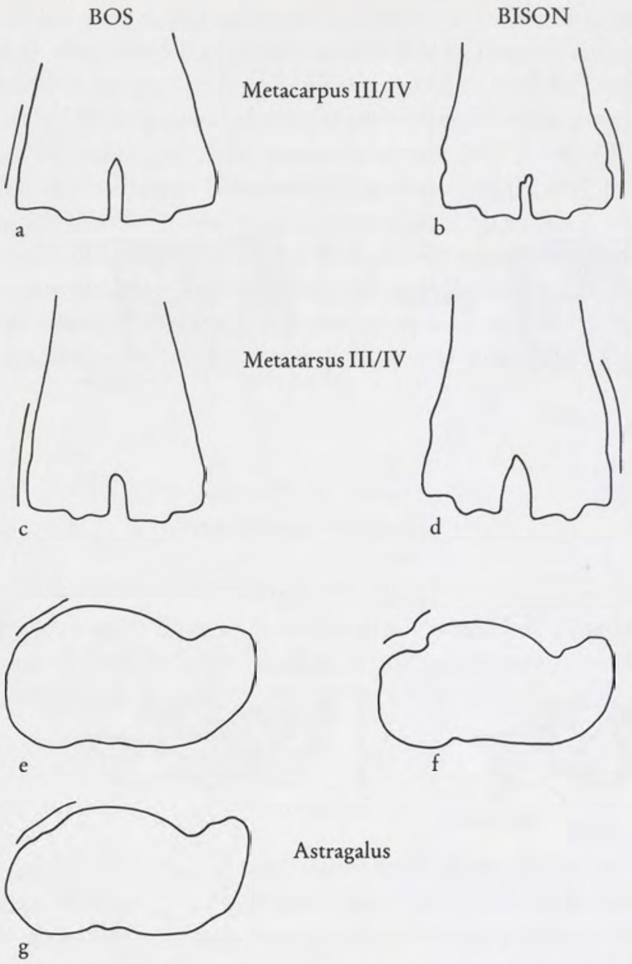


Fig. 42 Distinction *Bos* sp. or *Bison* sp. on the distal metacarpus III/IV and metatarsus III/IV and the astragalus. – a Hu Str. 109. – b *B. priscus*, Steinheim, after Scherk 1936, page 48, fig. 2 and 3. – c Tö 2 13/72, 14. – d Ar 2 88/10, 1. – e Tö 2 15/76, 4. – f *B. priscus*, Steinheim, Scherk, page 55, fig. 11. – g Hu 4 67/75, 2.

size is only possible when a large amount of material is present, and some of the morphological characteristics given, for example by Delpech (1983), can occur in both species.

A comparison of some of the dental characteristics described by Delpech (*ibid.*) with examples of bovid cheek teeth from assemblages in the study area shows the difficulties that can occur.

i) In *Bos* sp., the bases of the two lobes (Fig. 41, protocone and hypocone) on the upper molars, and particularly the third molar, project more or less equally on the lingual side. In *Bison* sp., the base of the protocone protrudes further to the lingual side than the base of the hypocone (Delpech, 1983; after N. Byrne, 1979).

Taking an upper third molar from Tö 2 as an example (Plate 30B, a i) it can be seen that this find has, in this respect, the characteristics described as being more typical of *Bison* sp., despite the fact that all the metapodia recovered from this assemblage have been identified as *Bos primigenius*. On the upper first and second molars from the same individual, both protocone and hypocone project equally to the lingual side. The upper molar from Ar 1 (Plate 30B, b i) also has this characteristic, but because of the lack of metapodia in this assemblage, the upper molar could not be identified reliably to species.

ii) The accessory pillar (entostyle/ectostylid) is long and stout in *Bos* sp. and short and »pinched« at its base in *Bison* sp. Unfortunately the original length of the pillar can only be seen on teeth in the first stages of wear; in worn teeth this pillar has become integrated into the occlusal surface.

The upper third molar from Tö 2 described above is from a young adult individual and is in the first stages of wear. The entostyle is very long, almost reaching to the occlusal surface, and robust, protruding out from the lingual side of the tooth (Plate 30B, i and Plates 30A and 30B, d for examples of a lower molar). Thus, this characteristic does appear to be associated with the species *Bos primigenius*, as identified by the metapodia from this assemblage.

The lower first molar from Sk 4, is the only unworn tooth with a short, thin ectostylid (Plate 30B,c) described as being more typical of *Bison* sp. However, the same tooth from a recent juvenile cow (*Bos taurus*) (collection Monrepos) showed exactly the same morphological detail. Unfortunately, cheek teeth have not been recovered from those assemblages where *Bison* sp. has been definitely identified by the metapodia.

The examples given show that although some of the characteristics qouted do seem to correspond to a particular species, a distinction *Bos* sp. or *Bison* sp. on cheek teeth alone is hardly possible. Therefore the large bovid remains from assemblages where identifiable metapodia do not occur are described as *Bos* sp. or *Bison* sp.

Sexual dimorphism

Sexual dimorphism occurs in both *Bos* sp. and *Bison* sp., the males being much larger than the females. The post-cranial bone described here is too sparse to show any siginificant results in this aspect. Two poorly-preserved calcanei from the Tö 2 assemblage and two tibiae from from Hu 4 did, however, show a large difference in size when compared with each other, and may have been from male and female animals.

Genus *BISON* (Smith, 1827)

BISON PRISCUS

(Bojanus 1827)
Extinct bison

Plate 31A; Table 59; Appendix III.

The remains of *Bison priscus* have been identified in assemblages at Ariendorf and Gönnersdorf.

Material

–ARIENDORF

Ar 2

A metatarsus dex. from an adult individual; a metacarpus dex. from a juvenile animal.

A minimum of two individuals is represented.

Ar 3

Proximal end of a metacarpus sin; a cervical vertebra and fragments of a metapodia, the latter described by Poplin (in Brunnacker *et al,* 1975, page 114 - 128).

A minimum of two individuals is represented.

– GÖNNERSDORF

One individual represented, based on rib fragments. The material has been provisionally identified by

Description and Discussion

Brugal (1984), has recognised three subspecies of *Bison priscus*. *B. priscus priscus* is known only from the lower Middle Pleistocene localities of Mosbach and Mauer, *B. priscus mediator* occurs in Saalian faunal assemblages such as Chatillon-st.-Jean (France) and a third new subspecies (not named) has been recognized from assemblages dating to the Eemian Interglacial and Weichselian.

The metatarsus from Ar 2 is large (Table 59) and falls into the larger end of the size-variation given by

		B. priscus		*B. schoetensacki*	*B. p. mediator*
	Ar 2	Mosbach/Mauer male[1]	Mosbach/Mauer female[1]	Mauer[1]	Chatillon-St.-Jean[2]
Greatest length	312.0	302.0 - 316.6 n = 3	292.0 - 302.8 n = 2	291.1	288.0 - 313.0
Proximal breadth	76.5	67.1 - 70.5 n = 3	61.4	49.6	68.0 - 74.0
Breadth of diaphysis	48.5	47.8 - 48.8 n = 3	44.3 - 44.0 n = 2	36.0	46.0 - 55.6
Distal breadth	91.0	84.2 - 88.3 n = 3	80.4 - 81.8 n = 2	65.7	77.0 - 86.0

Table 59 Size of metatarsii of *Bison* from Ar 2 and comparison with those of other species of *Bison*. – [1]After Schertz, 1936; [2]after Mourer-Chauvire, 1972, table XII.

Schertz (1936), for male *B. priscus* from the early Middle Pleistocene faunas at Mosbach and Mauer. It is much larger than the Early and lower Middle Pleistocene form *B. schoetensacki*.

The Ar 2 find also compares in size with measurements given for sixteen metatarsii from *Bison priscus* from the Saalian assemblage of Chatillon-st.-Jean which, according to Brugal (1984), belong to the subspecies *B. p. mediator*.

Stratigraphic range

The first known occurrence of *Bison priscus* in Europe is in lower Middle Pleistocene faunas such as those found at Mauer, Mosbach and Süssenborn. This species continued to exist throughout the Middle and Late Pleistocene, and became extinct at the end of the Pleistocene (Kurtén, 1968).

The Ar 2 and 3 assemblages have been dated to a younger phase of the Saalian and the beginning of the Weichselian respectively. The occurrence of *B. priscus* in these assemblages falls into the known stratigraphic range for this species.

Palaeoecology

Bison priscus is known to have occurred in both warm and cold- stage faunas. It occurred in cold stage faunas in association with regional herbaceous vegetation, in interstadials in association with boreal forest and in interglacials with locally deforested environments (Stuart, 1982).

Bison priscus occurs in the Ar 2 assemblage in association with open steppe environment. The Ar 3 fauna is located in a soil thought to have formed under interstadial conditions in which cool climatic conditions predominated. At Gönnersdorf this species occurs in an assemblage pollen-dated to the end of the Bölling Interstadial.

Of the recent bison, the European *Bison bonasus* is a browser living in mixed woodlands with some open areas (v. d. Brink, 1967) and the American bison *Bison bison* is a grazer, preferring open grassland, but also ranging into forested areas (Stuart, 1982). Depth of snow does not seem to present a problem to the latter species, and depths of up to 100 cms. can be tolerated (Heptner & Naumov, 1966).

Hu 4	
51/84, 10 77.6	42/82, 35 84.0

Table 60 Distal breadth of the tibiae of *Bos primigenius* from Hu 4.

Genus *BOS* (Linnaeus, 1758)

BOS PRIMIGENIUS
(Bojanus 1827)
Aurochs

Plates 30A.B; 31A; Tables 60 - 61; Appendix III.
The remains of aurochs occur in assemblages at the Hummerich and Tönchesberg; remains identified as cf. *Bos primigenius* occur at Kärlich and Urbar. The remains of *Bos primigenius* were identified using the characteristics of the foot-bones given in the basic identification (Fig. 42). The remaining large bovid material (cheek teeth; post-cranial bone) from these assemblages was, in the absence of a second species of large bovid, also assigned to *Bos primigenius*.

Material

– HUMMERICH

Hu 4
Maxillary fragment dex. with upper dp2 - 4; maxillary fragment dex. with upper dp3 and 4; mandible fragment dex. with lower dp3 and 4 and molar 1 just erupting; 1 upper third molar; 1 upper M1 and M2 from the same individual; mandible sin. with lower P4 and M1 - 3; mandible fragment dex. with lower M2 and M3, both mandibles belong to the same individual; mandible sin. with lower P3 - 4 and M1 - 3; lower M2 dex.; distal ends of three tibiae dex.; a complete, but damaged, metacarpus III/IV sin.; distal ends of a metacarpus III/IV sin. and two metacarpi III/IV s/d; proximal ends of two metacarpi III/IV dex. and one metacarpus III/IV sin.; proximal end of a juvenile metatarsus III/IV s/d.; a calcaneum dex.; two astragali sin. and one dex.; three os centrotarsale dex.; one first phalange ant. and post.; one second phalange; one third phalange. Two juvenile and at least two adult individuals are represented. A third adult may be represented by the third tibia, if these are all from adult animals.

– TÖNCHESBERG

Tö 2
Upper P2 -P4 sin., P2 and P4 dex., M1 and M2 sin., M1 and M3 dex. from same adult individual; an upper M2 dex. and P4 dex. from a second adult individual; fragment of pelvis; distal end of a metacarpus III/IV sin. and dex.; complete metatarsus III/IV sin.; one os centrotarsale sin.; an astragalus dex. A minimum of two individuals is represented. A third adult, possibly female, individual is indicated by the presence of a smaller calcaneum.

METACARPUS III/IV	Hu 4				Tö 2
	63/79, 6	Str. 109	Str. 105	55/67, 3	12/76,44
Greatest length	278.0	–	–	–	–
Distal breadth	–	95.5	99.2	91.0	91.9
		49/83,1	42/84,13		
Proximal breadth	–	88.8	89.7	–	–

METATARSUS III/IV	Tö 2	
	13/72, 14	14/79, 21
Greatest length	312.0	–
Proximal breadth	(72.0)	–
Breadth diaphysis	(47.07	–
Distal breadth	84.3	80.8

Table 61 Length and breadth of metapodia of *Bos primigenius* from Hu 4 and Tö 2.

cf. *Bos Primigenius:*

– KÄRLICH

Kä 1

Fragment of a metatarsus; proximal end of a tibia dex.; fragment cervical vertebra (Turner in Kroeger et al., 1988). Maxillary fragment with upper P2 - 4, the find has already been described by Lanser (in Brunnacker et al 1980, page 305) as *Bos* sp. or *Bison* sp. This specimen belongs very likely to this assemblage and is therefore considered to be from cf. *Bos primigenius*.
A minimum of one individual is represented.
Brugal (pers. comm.) considers the metatarsus III/IV to belong to *Bos primigenius*, and the material has therefore been described as belonging to this species in Kröger (in press). The material is, however, referred in this study to cf. *Bos primigenius* as the the specimens are considered to be too fragmentary to be definitely identified.

– URBAR

Distal end of a metacarpus or tarsus III/IV. The specimen is poorly preserved, but the form of the distal end resembles those of *Bos primigenius* rather than *Bison* sp.
A minimum of one individual is represented.

Discussion

The remains of *Bos primigenius* have a large range in both size and morphology (Brugal, 1984). The measurements given in Table 61 show that the specimens of metacarpus III/IV from Hu 4 and Tö 2 are similar in size. The difference in size between the two tibiae from Hu 4 is probably due to sexual dimorphism (the remaining absolute measurements on the material from *Bos primigenius* are to be found in Appendix III).

Stratigraphic range

The first known occurrence of *Bos primigenius* is still unclear. This species was considered to have occurred for the first time during the Holstein Interglacial in Europe (Kurtén, 1968). Its presence, for example, at the »Holsteinian« locality of Steinheim in West Germany, appeared to support this. However, as the dating of this particular locality needs revising (Cook et al., 1982; van Kolfschoten, pers. comm.), it can no longer be used as definite evidence of the presence of *Bos primigenius* at this time. In France, this species first occurs in faunas dating to the beginning of the Saalian phase (Brugal, 1984). The presence of this species appears to indicate at least a post-Holsteinian age for an assemblage. *Bos primigenius* became extinct in the seventeenth century in Poland (Stuart, 1982).
Bos primigenius has been definitely identified in the Tö 2 and Hu 4 assemblages. These assemblages are considered to date to either the end of the Last Interglacial (=Eemian) or beginning of the Last Cold Stage BP (=Weichselian) and therefore fall within the known stratigraphic range for this species.
Remains described as cf. *Bos primigenius* occur in the Kä 1 assemblage. If the identification is correct, then the known stratigraphic range of this species indicates that this assemblage should be at least post-Holsteinian in age. The remains from Urbar are from an assemblage dating to the Late Weichselian and also fall within the known stratigraphic range of this species.

Palaeoecology

Bos primigenius generally occurred in interglacial faunas in North-West Europe. This species occurs at the localities of Hummerich and Tönchesberg in assemblages located in warm stage palaeosols, in association, at Tö 2 with a warm molluscan fauna indicating an open environment. At Kärlich, cf. *Bos primigenius*, is associated with an interglacial faunal assemblage (Kä 1). This assemblage was deposited towards the end of an interglacial in the late temperate or post temperate phase. Remains possibly attributable to *Bos primigenius* from Urbar are associated with the open, pine and birch forest of the Alleröd Interstadial.

BOS sp. or *BISON* sp.

Unidentifiable large bovid

Material

– KÄRLICH

Kä Gb

Mandible sin. with lower M2 and M3; mandible fragment sin. with lower M2 and M3; a lower M2 and M3 dex.; a complete radius and fragment of proximal ulna; distal ends of two metacarpi.
A minimum of two individuals is represented.

Kä H

An upper P3/4; two upper third molars dex.; an upper molar sin.; an upper M2 and M3 sin.
A minimum of two individuals is represented.

Kä J

Distal end of a tibia sin.; an upper M1 or 2; fragment of an upper molar; distal humerus fragment.
The material has been identified by Lanser as *Bos* sp. (in Brunnacker et al, 1980, page 307).
A minimum of one individual is represented.

– MIESENHEIM I

Mi 2

A calcaneum dex.
A minimum of one individual is represented.

– ARIENDORF

Ar 1

Mandible fragment dex. with lower M1 - 3; two lower third molars sin.; one upper third molar dex.; distal end of a tibia sin.; an astragalus sin.
Three adult individuals are represented by the lower third molars, which are all in different stages of wear.

– WANNEN

Wa 1

A radius dex.; fragment of a metacarpus or metatarsus sin. or dex, juvenile; a calcaneum sin. and an astragalus dex.
A minimum of two individuals is represented.

Wa 3

A juvenile metatarsus dex.
A minimum of one individual is represented.

– SCHWEINSKOPF

Sk 4

A lower M1 or M2; fragmentary post-cranial material from a juvenile and an adult(?) individual.
A minimum of two individuals is represented.

– HUMMERICH

Hu 5

Proximal end of a metacarpus III/IV dex.
A minimum of one individual is represented.

– TÖNCHESBERG

Tö 1

An upper M3 dex.; an os centrotarsale.
A minimum of one individual is represented.

– ANDERNACH

An 2

An upper P3 sin. and P4 sin.; upper M2 and M3 sin.
The material from this site has been identified by Street and a complete material list, including the fragmentary post-cranial finds, is given by Street (in press).
Only the measurements of the more complete upper cheek teeth are given here; the measurements are taken from Street (in press).

– NIEDERBIEBER

A single metatarsus fragment s/d, not further identifiable.
A minimum of one individual is represented.

– MIESENHEIM II

The sparse material from a large bovid has been identified and published by Street (1986) and consists of two first and two second phalanges, more important for their archaeological than palaeontological interest (*ibid*. page 20).
A minimum of one individual is represented.

Genus *SAIGA* (Gray, 1843)

SAIGA TATARICA

(Linnaeus 1766)
Saige antilope

The remains of saiga antilope are known only from the Gönnersdorf locality to date.

Material

– GÖNNERSDORF

Distal fragment of a metatarsus III/IV. The specimen has been identified by F.Poplin (1976, page 53), but the reasons for the identification were not given and the find was not seen during the course of this study.

Stratigraphic range

The first known occurrence of *Saiga tatarica* was towards the end of the Saalian (Delpech, 1983; Delpech & Heintz, in de Lumley, 1976, Kahlke, 1975; Kurtén, 1968), and this species occurred in faunas throughout the Weichselian. The saiga antilope still exists in the central and eastern Eurasian steppe (Stuart, 1982). Its presence at the Late Weichselian locality of Gönnersdorf falls within the known stratigraphic range of this species, and is one of only three localities in western Germany (Gönnersdorf, Bottrop and Blaubeuren) (Kahlke, 1975c), where this species has been recorded.

Palaeoecology

During the Pleistocene, this species occurred in both cold and warm stage faunas. The Gönnersdorf assemblage is dated to the end of the Bölling Interstadial, in association with a predominantly open steppe environment. Its present habitat is salt and loam steppe and sandhill country (v. d. Brink, 1967). It is intolerant of heavy snow-fall (Delpech, 1983).

Genus *CAPRA* (Linnaeus, 1758)

CAPRA IBEX

(Linnaeus, 1758)
Ibex

This species has only been identified at the locality of Niederbieber to date.

Basic identification

Dentition

The lower cheek teeth are of typical caprid form, being small in size, hypsodont and have a selenodont enamel pattern. The lower molars of *Capra ibex* are characterized by the presence of a vertical groove on the lingual side of the crown and the absence of an ectostylid (Prat, in Lavocet, 1966).

Material

- NIEDERBIEBER

Mandible dex. with lower P2 - 3; a lower M1/2 dex.; a lower P2/3 sin.
Measurements:
M1/2: Length: 13.7 Breadth: 8.1

The specimens were identified by van Kolfschoten and a complete material list and description of the finds has already been given by Winter (1986, page 86, fig. 58); only the more complete finds are included here. The measurements on the M1/2 are my own observations.

Description and discussion

The distinction between the two recent forms *Capra ibex* and *Capra pyrenaica* is based on the form of the horn-core and skull and not on the dentition. Usually Pleistocene ibex are referred to the Alpine form *Capra ibex*.

Stratigraphic range

The ibex first appears in faunas dating to the Saalian phase. It was common in faunas dating to the Weichselian, during which time its range covered most of the montane regions of Europe (Kurtén, 1968). The ibex still exists today.

The Niederbieber assemblage dates to the Late Weichselian, and the occurrence of this species is therefore within its known stratigraphic range. The specimens from Niederbieber are the first known appearance of this species during the Pleistocene period in the Middle Rhine region (Winter, 1986).

Palaeoecology

The ibex is known to have occurred in both cold and warm stage Pleistocene faunas in North-West Europe. The ibex inhabits high mountain regions, particularly steep crags, slopes and screes between 7,000 and 10,000 feet today (v.d.Brink, 1967). They are intolerant of very deep snow, and undertake seasonal migrations to avoid this. It is associated in the Neuwied Basin with an assemblage dating to the Alleröd Interstadial, in association with open birch and pine forest.

Genus *PRAEOVIBOS* (Staudinger, 1908)

Basic identification

Dentition

The cheek teeth are hypsodont, with finely wrinkled enamel and have the typical selenodont enamel pattern found in the Bovinae and Caprinae. Although similar in size to the cheek teeth of the larger bovids, the dentition of the genera *Praeovibos* and *Ovibos* both show some morphological characteristics not found in the *Bovinae*.

The posterior lobe of the lower M3 is not as well-defined as in *Bos* or *Bison* and the lingual side of the tooth is flat. The lower molars do not possess an ectostylid. The lower cheek teeth of the large extinct caprid *Soergelia* are characterized by a prominent parastylid and metastylid, which do not occur on the lower molars of *Praeovibos* or *Ovibos*.

cf. *PRAEOVIBOS PRISCUS*
(Staudinger, 1908)
Extinct musk ox

Plate 31B.
Remains possibly belonging to the extinct musk ox, *Praeovibos priscus*, are known only from Kärlich to date.

Material

– KÄRLICH

Kä Bb
A lower M3 dex.; fragment of a lower M2 s/d.

The specimens have been described by F. Poplin as being from a bovid.
A minimum of one individual is represented.

Description

Both specimens are damaged. The lower M3 has an ectostylid between protoconid and hypoconid and an accessory column on the lingual side of the posterior lobe. The lingual side of the crown is flat and the posterior lobe is small and not as developed as in the Bovinae. The lower M2 does not possess an ectostylid. The specimens show the characteristics associated with the genera *Praeovibos* and *Ovibos* and do not belong to the Bovinae (Plate 31B).

Discussion

Two forms of musk oxen were present during the Pleistocene period in Europe. The larger, but more lightly-built, extinct musk ox, *Praeovibos priscus*, and the form still existing today, *Ovibos moschatus*. The lower M3 of *Praeovibos priscus* is characterized by a flaring of the crown towards its base (Cregut & Guerin, 1979). This characteristic is also apparent on the Kärlich M3 (Plate 31B), but does not occur on Pleistocene specimens of *Ovibos moschatus* figured, for example, by Kahlke (1969), page 525, fig. 2). A comparison of the breadth of the Kärlich tooth with a specimen from the Süssenborn locality, described as a subspecies *O. m. süssenbornensis* (Kahlke, 1969, page 526), shows that there is hardly any difference in size. Cregut & Guerin (1979), also noted that there was little difference in the size of the dentition of *Praeovibos priscus* and *Ovibos*.

M3 : Breadth of hypoconid, measured at base of crown.
Kä Bb : 15.5 *O. moschatus süssenbornensis* : 15.7

The lower M3 from Kärlich is, however, morphologically closer to the genera *Praeovibos* and is described here as cf. *Praeovibos priscus*.

Stratigraphic range

The first known occurrence of *Praeovibos priscus* was during the Cromer complex. In England, its remains are known from the Cromer Forest Bed; although its exact stratigraphic position within this formation is unknown (Stuart, 1982). In western Germany, it occurs at the Mosbach locality (=late Cromerian/early Elsterian) (Kahlke, 1975b). This species probably became extinct during the Elsterian, but may also have survived into the Saalian (Cregut & Guerin, 1979). Remains comparable to this species have been recovered from the gravels in Kä Bb, although the fossils themselves could be derived from another deposit. Kä Bb has been correlated with the Glacial A phase of the Dutch division of the Cromer complex (Chapter 3 and Fig. 3).

Palaeoecology

Praeovibos priscus generally occurred in cold stage faunas in North-West Europe. The gravels of Kä Bb were probably deposited during a cold stage, but the fossils themselves may be derived, and can therefore can only be used provisionally as palaeoenvironmental indicators for this deposit.

Genus *RUPICAPRA* (de Blainville, 1816)

RUPICAPRA RUPICAPRA

(Linnaeus 1758)
Chamois

Plate 32; Tables 62 and 63.
The chamois occurs in assemblages at four localities, Hummerich, Wannen, Andernach and Gönnersdorf, in the Neuwied Basin to date.

Basic identification

The following identification is based on Prat (in Lavocet (ed.), 1966).

Horn-cores

The horn-cores are sub-rectilinear in form and rather straight (Plate 32).

Dentition

The teeth are of typical caprid form. They are smaller than those of *Capra ibex* and less hypsodont. The buccal face of the upper premolars is flat, the upper molars have a very prominent mesostyle and the posterior face is convex.
Typical of this species is the presence of an enamel islet on the occlusal surface between the anterior and posterior infundibula of the upper and lower molars (Plate 32,c).

Post-cranial bone

Only the tibia is mentioned here, the remaining material being too fragmentary to describe in detail. Typical of this species is the form of the distal joint of the tibia. The articulation surfaces for the Os malleolare are prominent laterally and, when seen from below, are separated by a deep valley. The articulation surface for the fibula is flat (Plate 32,b i ii iii).

Material

– WANNEN

Wa 2
Two fragmentary horn-cores sin. and dex. from the same individual; maxillary fragment sin. with upper P4 and M1.
A minimum of one individual is represented.

– HUMMERICH

Hu 5
Distal end of a tibia dex.
A minimum of one individual is represented.

– GÖNNERSDORF

Mandible fragments belonging to this species have been described by Poplin (in Brunnacker (ed.), 1978, page 99). A minimum of two individuals have been described.

– ANDERNACH

An 2
An upper P4, M1, M2 and M3 dex. from the same individual; a lower M2 and M3 dex. from a second, younger individual.

The teeth have been identified by F. Poplin (in Bosinski & Hahn, 1972) and M. Street (Bolus & Street, 1985; Street in press). Only the more complete finds are mentioned here; a complete list of the remaining material from *Rupicapra rupicapra* from the 1981 - 1983 excavations can be found in Street (in press).
The measurements given are my own observations.

cf. ***Rupicapra rupicapra:***

– WANNEN

Wa 4/5
Metapodia fragments.
A minimum of one individual is represented.

Description

The right horn-core from Wa 2 has a fragment of the parietal bone at its base and measures 68.2 mm. in length from the base to the tip of the core. The left core has been broken off above the base and is 64.5 mm. Both horn-cores are slightly curved outwards (laterally) at the tips (Plate 32).
The cheek teeth from all the assemblages and the tibia from Hu 5 have all the characteristics already noted in the basic identification. The tibia fragment from Hu 5 is slightly larger than the recent examples given in Table 63. The measurements taken on the cheek teeth are given in Table 62.

Discussion

The identification of the two recent subspecies *R. r. rupicapra* (Alpine form) and *R. r. pyrenaica* (Pyrenean form) is based on the form of the nasal bones (Prat, in Lavocet (ed.), 1966). These parts are missing amongst the material described here, and therefore the specimens are identified as *Rupicapra rupicapra*.

Stratigraphic range

Rupicapra rupicapra was originally thought to have appeared in North-West Europe during the Last Interglacial (Eem) (Kurtén, 1968). This species is now known from faunas in the south-west of France

	Wa 2		An 2			
Upper	P4	M1	P4	M1	M2	M3
Length	7.2	10.8	6.8	12.2	15.0	16.7
Breadth	8.6		9.9			
ant.		12.1		12.1	13.8	13.1
post.		11.8	11.8	13.2	11.3	
Lower			M1		M3	
Length	–		11.3		21.4	
Breadth	–		7.8		8.6	

Table 62 Length and breadth of the upper teeth of *Rupicapra rupicapra* from Wa 2 and An 2.

Hu 5	Recent (Prat, 1966, p. 315)
30.3	26 - 29.5

Table 63 Breadth of the distal end of the tibia from Hu 4 and comparison with recent *Rupicapra rupicapra.* Absolute Measurements of *Cervus elaphus* antler. For measurements taken see Fig. 36.

dating to the Saalian, and its earliest known occurrence is probably at Arago cave (Cregut & Guérin, 1979) dating to the beginning of the Saalian. The species still exists in certain parts of the Alps and Pyrenees.
The oldest occurrences of this species in the Neuwied Basin are in the Wa 2 and Hu 5 assemblages, dating to the Second Cold Stage and the beginning of the Last Cold Stage BP respectively. These have been correlated with a younger phase of the Saalian and the Weichselian. *Rupicapra rupicapra* also occurs in faunas at the Late Weichselian localities of Gönnersdorf and Andernach. The occurrence of this species in the Neuwied Basin falls within its known stratigraphic range in Europe.

Palaeoecology

Rupicapra rupicapra is associated with both cold and warm stage faunas. It occurs in assemblages located in cold stage deposits at the Wannen and Hummerich localities. At Gönnersdorf, this species is associated with an assemblage dating to the end of the Bölling Interstadial. At Andernach, this species occurs in the Alleröd faunal assemblage, probably in association with an open birch and pine forest. The present-day alpine form is confined to montane woodland and rocky slopes above the tree-line between 400 - 4000 metres and higher. It is intolerant of depth of snow and undertakes seasonal migrations to avoid this, moving down to the lower slopes in winter and returning to higher land in summer. During the Last Cold Stage, this species extended its range over Europe from northern Spain and Italy to the Ardennes in the north and to the Elbe in the east (Kurten, 1968) : its most southerly occurrence to date is at the site of Cueva del Nacimiento, Spain (Alferez et al.,1980 - 81).

PART FOUR

CONCLUSIONS

CHAPTER 9

THE MIDDLE AND LATE PLEISTOCENE MACROFAUNAS OF THE NEUWIED BASIN

In Fig. 43a the Neuwied Basin localities and the assemblages described in Part II are correlated with each other. The correlations are based upon the suggested age of the deposits. Those localities marked by a query (?) are the ones where the chronostratigraphy of the deposits and the assemblages is either tentative (lack of marker horizons) or where the proposed chronostratigraphy has been queried (for example by absolute dating, mammalian microfaunas etc.).
Macrofaunal lists are given for each of the assemblages. Numbers in parentheses refer to the minimum number of individuals per species. The symbol »-« indicates that some species of the *Cervidae* family are represented by shed antler only. The symbol »?« before the name of a species refers to those specimens identified by other authors, where the identification has been queried.

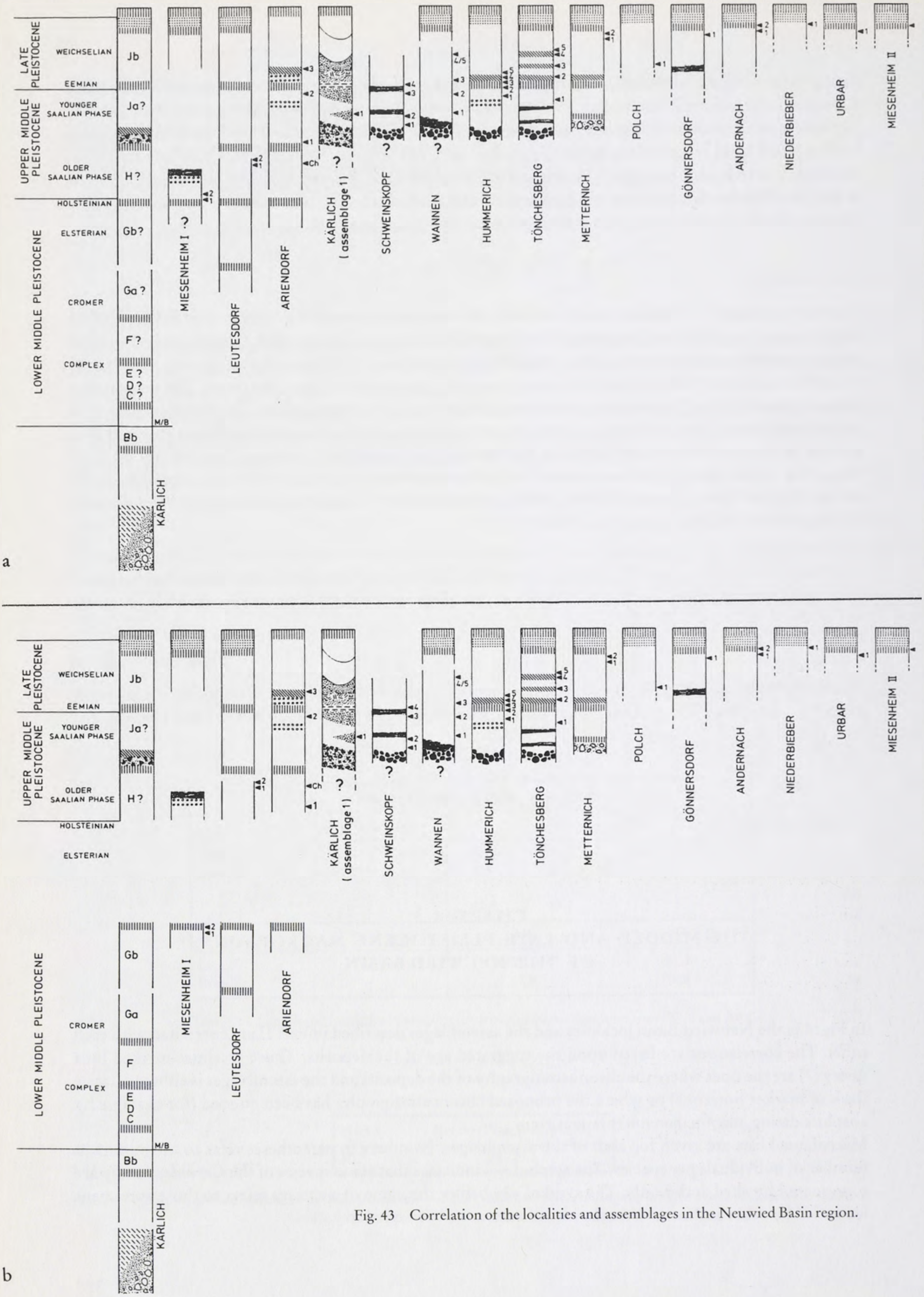


Fig. 43 Correlation of the localities and assemblages in the Neuwied Basin region.

Kärlich

The most complete Middle and late Pleistocene deposits in the Neuwied Basin region are in the Kärlich clay-pit. In this study, the units Bb to Gb have been described as lower Middle Pleistocene deposits. These have been broadly correlated with the Cromer complex (units Bb to Ga), the Elsterian (unit Gb) and the Holsteinian (interglacial palaeosol at the top of unit Ga) by Brunnacker (et al., 1976; in Butzer & Isaacs (eds.), 1975; Windheuser, Meyer & Brunnacker, 1982) (Fig. 3, column 10).

The only reliable marker horizon for the units Kä Bb - Gb is the Matuyama-Brunhes polarity reversal boundary in unit Bb. At Dutch localities, the Matuyama-Brunhes boundary has been located in deposits dating to the first glacial stage (Glacial A) of the Dutch division of the Cromer complex (Zagwijn, 1971). Therefore unit Bb at Kärlich can be correlated with the Glacial A stage of the Dutch division (Brunnacker et al., 1976).

The interglacial soil at the top of Kä Gb has been correlated by Brunnacker (et al., 1976; in Butzer & Isaacs, 1975, Windheuser, Meyer & Brunnacker, 1982), with the locally-named Ariendorf Interglacial, which in turn has been correlated with the Holstein Interglacial (Fig. 3). Following this, the loess of unit Gb probably dates to the Elsterian. Van Kolfschoten (1988) has correlated a mammalian microfauna from Kä Gb with microfaunas from sites in Holland dated to the Interglacial IV stage of the Dutch Cromer complex, which includes the latest of the Cromer interglacials and part of the Elsterian.

An exact correlation between the remaining units at Kärlich and other Cromer complexes in Europe is still unclear. Earlier attempts to date Kä Bb - Gb, based on macrofaunal remains found in these units, were not particularly successful. Both Nobis (1970) and Rothausen (1970) were influenced by Hellers interpretation of microfaunal material from unit F and G as being »post-Cromerian« in age. Because of this, Rothausen suggested an Elsterian age for Kä E-F in which he had identified *Megaloceros* cf. *verticornis* remains; and Nobis suggested a late Cromerian age for the same unit, where he had identified the remains of horse *Equus süssenbornensis*.

The following macrofaunas have been identified:

Kä Bb
cf. *Praeovibos priscus* - extinct musk ox (1)

Kä C
Cervus cf. *elaphus* - red deer (1)

Kä D-E
Mammuthus cf. *trogontherii* - extinct elephant (1)

Kä E-F
Equus sp.
(*?Equus süssenbornensis*) - horse (2)
Megaloceros verticornis - extinct giant deer -

Kä F
Mammuthus sp.
(*M. meridionalis - trogontherii*) - elephant (5)
Equus sp. - horse (1)
Megaloceros verticornis - giant deer -
Cervus elaphus - red deer (2)

Kä Ga
Equus sp. (caballine) - horse (1)
Cervus elaphus - red deer (1)

Kä Ga-Gb
Equus sp. - horse (1)
Alces sp. - elk (1)

Kä Gb
Mammuthus sp. - elephant (1)
Equus sp. (caballine)
(*Equus* cf. *marxi*) - horse (4)
Dicerorhinus sp. - extinct rhinoceros (2)
Cervus elaphus - red deer (1)
Megaloceros verticornis - extinct giant deer (1)
cf. *Dama dama* - fallow deer (1)
Bos sp. or *Bison* sp. - unidentifiable large bovid (2)

The macrofaunas listed above are based on fossils collected since the beginning of this century and the information regarding their provenance (for example, »found in unit Gb«) had to be accepted.

The macrofaunal material from Kä Bb - Gb in the Würges collection described in Part III, was not particularly useful in dating the units Bb to Gb further. The known stratigraphic ranges of most of the fossils that could be identified indicate that units Kä Bb to Gb date to the Middle Pleistocene, which has already been suggested by the stratigraphy at this locality.

For example, *Praeovibos priscus*, *Mammuthus meridionalis*, *Mammuthus trogontherii*, and horses with primitive dental characteristics, such as *Equus marxi*, are all known to have occurred during the lower Middle Pleistocene in North-West Europe.

More informative was the known stratigraphic ranges of the deer occurring in the units C to Gb. Remains of red deer *Cervus elaphus* have been recorded in Kä F - Gb; a fragment of an antler frontlet from Kä C could only be identified as *Cervus* cf. *elaphus*. The first known occurrence of this species is in the Cromerian faunas of West Runton and Voigtstedt (Lister, 1986). Antlers of the extinct giant deer *Megaloceros verticornis* have been recovered from Kä F and possibly Kä E (Rothausen, 1970). Specimens of upper cheek teeth, possibly from this species, were found in Kä Gb. This species also occurs for the first time in the Cromerian faunas, and its absence in faunas dating to the Holstein Interglacial indicates that it became extinct during the Elsterian (Lister, 1986).

The known stratigraphic ranges of these species indicates that the faunas from Kä F - Gb pre-date the Holsteinian and could be as old as those from West Runton and Voigtstedt. If the identification of the cf. *Cervus elaphus* antler frontlet from Kä C is correct, then this species appears to have been present in the Neuwied Basin region in deposits dating almost to the beginning of the Middle Pleistocene.

According to Brunnacker (1976), the younger unit, Kä Gb, could be the equivalent of the Elsterian. Van Kolfschoten correlates Kä Gb with the last interglacial of the Dutch Cromer complex and part of the Elsterian. Kä Gb thus appears to be pre-Holsteinian in age, which is also supported by the occurrence of *Megaloceros verticornis* in this unit.

Miesenheim I

The Mi 1 and Mi 2 assemblages were both deposited during the same interglacial phase. This interglacial is, according to Brunnacker (in Boscheinen et al., 1984), the equivalent of the Ariendorf Interglacial, which in turn has been correlated with the Holsteinian (Brunnacker et al., 1976; in Butzer & Isaacs, 1975) (Fig. 3). However, the Ariendorf Interglacial deposits at the type-site have been recently dated to about 420,000 - 450,000 BP (40Ar39Ar) (v. d. Bogaard & Schmincke, 1988; Lippolt et al., 1986), which indicates that this interglacial is older than previously thought (see relative dates in Fig. 3). The mammalian microfauna from the Miesenheim I assemblages has also been correlated to the Interglacial IV of the Dutch Cromer complex and part of the Elsterian (van Kolfschoten, 1988).

The following macrofaunas have been identified:

Mi 1
Dicerorhinus etruscus cf. *brachycephalus* - extinct rhinoceros (1)
Cervus elaphus - red deer (1)

Mi 2
Ursus cf. *deningeri* - extinct bear (1)
Canis lupus mosbachensis - extinct wolf (1)
Meles sp. - badger (1)
Mammuthus cf.*trogontherii* - extinct elephant (2)
Equus sp. - horse (1)
Dicerorhinus etruscus cf. *brachycephalus* - extinct rhinoceros (2)
Cervus elaphus - red deer (3)
Capreolus capreolus - roe deer (7)
Bos sp. or *Bison* sp. - unidentifiable large bovid (1)

The known stratigraphic ranges of the following species are important for dating the Miesenheim assemblages.

The small wolf, *C. l. mosbachensis*, is known to have occurred in many lower Middle Pleistocene faunas. It occurs in the Cromerian fauna of West Runton (Bishop, 1982), and in the fauna at Mosbach (Soergel, 1924) dated to the end of the Cromer complex and beginning of the Elsterian. Larger wolves, with a more progressive dental morphology, occur in faunas dating to the Holsteinian (Bonifay, 1971) and *C. l. mosbachensis* appears to have been replaced by these sometime during the Elsterian.

The identification of the bear remains from Mi 1 and Mi 2 as being comparable to the species *U. deningeri* is based on a size comparison of only one tooth and is therefore very tentative.

U. deningeri remains are known from the Cromer Forest Bed Formation (Bishop, 1982), but cannot be more closely defined stratigraphically within these deposits. This species also occurs in several lower Middle Pleistocene faunas. The last occurrence of forms resembling *U. deningeri* are of Elsterian age, and this species had been replaced by *Ursus spelaeus* in faunas dating to the Holsteinian (Kurtén, 1969).

The remains of rhinoceros from both assemblages have characteristics resembling those of *D. e. brachycephalus*, a form intermediate between *D. etruscus etruscus* and *D. hemitoechus*. The last occurrence of forms resembling *D. e. brachycephalus* was during the Elsterian (Guérin (1980).

Of the three species discussed above, two identifications are provisional. If the identifications are correct, then the presence of *Ursus* cf.*deningeri*, *Canis lupus mosbachensis* and *Dicerorhinus etruscus* cf. *brachycephalus* indicates a pre-Holsteinian age for the Miesenheim I assemblages. This has also been suggested by the mammalian microfauna.

According to Brunnacker (in Boscheinen et al., 1984), the interglacial deposits at Miesenheim I are the equivalent of the Ariendorf Interglacial. The mammalian macrofaunas from the Miesenheim I assemblages suggest a pre-Holsteinian date, and the mammalian microfaunas from Miesenheim I and from Kä Gb have both been correlated with the Interglacial IV stage of the Dutch division of the Cromer complex (van Kolfschoten, 1988). Recent dating of the Ariendorf Interglacial deposits also suggests that these are the equivalent of an interglacial of the Cromer complex rather than the Holsteinian. Therefore the correlation Miesenheim I assemblages, Kä Gb and Ariendorf Interglacial as shown in Fig. 43a, appears to be correct; the correlation Ariendorf Interglacial = Holstein Interglacial incorrect.

Thus, the Ariendorf Interglacial appears to be the Fourth Warm Stage BP according to the local stratigraphy. Prior to this, the interglacial deposits at Leutesdorf were thought to be the Fourth Warm Stage BP (Brunnacker et al., 1974) (Fig. 3 and 43a). This was based upon the presence of the heavy mineral brown hornblend, which dominated in the Leutesdorf Interglacial deposits, and correlations with the unit Ga at Kärlich, in which this mineral also dominated (Fig. 3).

The heavy mineral pyroxene is dominant in the deposits below the Ariendorf Interglacial at the type-site and in the loesses below the interglacial deposits at Miesenheim I. According to heavy mineral analysis in the Neuwied Basin region, pyroxene only becomes dominant in deposits younger than the Leutesdorf Interglacial (Razi-Rad, 1976; in Brunnacker et al., 1974) and, on the basis of this, the Leutesdorf Interglacial should still be older than the one at Ariendorf. This suggests that the sequence of lower Middle Pleistocene deposits from Kärlich, Miesenheim I, Ariendorf and Leutesdorf and their correlation to one another remains, as far as can be ascertained, the same as shown in Fig. 43 a, but that the whole sequence has become older (Fig. 43b) (see also van Kolfschoten, 1988, for discusssion of this).

However, a tephra (»Wehrer« pumice I) in the stratigraphically younger unit H at Kärlich has been dated to about 683,000 +/- 8,000 BP (v.d.Bogaard & Schmincke, 1988) (Fig. 3), and if this date is correct, shows that there are still problems surrounding the dating of the Kärlich deposits. The suggestions above, regarding the Ariendorf Interglacial, are based on a combination of stratigraphy, heavy mineral analysis, mammalian microfaunas and mammalian macrofaunas, and are considered to be more reliable at the moment than the single date from the tephra.

Thus, the units Kä Bb to Ga at Kärlich and their macrofaunas can still be correlated with the Cromer complex. Unit Gb was previously correlated with the Elsterian, but the microfauna from this unit indicates that Gb is equivalent to part of the Cromer complex and the Elsterian, and it is now difficult to draw an exact boundary between the end of the Cromer complex and the Elsterian at this locality (Fig. 43b). Thus, elements of the rich macrofauna collected from unit Gb may belong to the Elsterian. The assemblages from Miesenheim I are also similar in age to Kä Gb. The lower Middle Pleistocene deposits from Leutesdorf and Ariendorf have produced no fossils so far.

Lower Middle Pleistocene macrofaunas from Kärlich are characterized by the following elements.

Remains identified provisionally as belonging to *Praeovibos priscus* have been found in unit Bb only. Unfortunately, the exact position of the remains within this unit is not known, so that an Early Pleistocene age (the lower part of this unit is stratified below the Matuyama-Brunhes boundary) cannot be excluded. Kä Bb consists of a series of gravel lenses and the finds may also be derived from another deposit.

The extinct elephants of the genus *Mammuthus* from units Bb to Ga are forms comparable with *Mammuthus trogontherii* or forms intermediary between *Mammuthus meridionalis* and *Mammuthus trogontherii.*

Horse remains, described here as *Equus* sp., have been recorded from Kä E - Ga. Horses with caballine dentition are known from Kä Ga. Nobis (1970), has identified deciduous teeth from Kä E-F as *Equus süssenbornensis*, but these specimens do not appear to possess the characteristics typical of this species. An extremely large third metacarpus collected from the same unit is however, comparable in size to those of *Equus süssenbornensis*. The remains of *Equus* from units E - Ga represent individuals large in body-and dental size. An antler frontlet from unit C, described as *Cervus* cf. *elaphus*, may indicate the presence of this species in the earlier part of the Cromer complex.

Interesting is the occurrence in Kä Gb of an equid with some primitive dental characteristics. The upper cheek teeth of this individual are similar in their morphology to those of *Equus marxi*, a species described by Musil (1969), as a relatively progressive lower Middle Pleistocene form. This equid occurs in Kä Gb together with horses with caballine dental characteristics.

The first records of the following species, the giant deer *Megaloceros verticornis*, fallow deer cf. *Dama dama*, elk *Alces* sp., a rhinoceros *Dicerorhinus* sp., and an unidentifiable large bovid *Bos* sp. or *Bison* sp., are in unit Gb.

The Miesenheim I assemblages are similar in age to Kä Gb. They are characterized by the presence of those species thought to have become extinct before the Holsteinian Interglacial, such as the wolf *Canis lupus mosbachensis*, extinct bear *Ursus* cf. *deningeri* and the extinct rhinoceros *Dicerorhinus etruscus* cf. *brachycephalus*. The roe deer *Capreolus capreolus* from the Mi 2 assemblage was a large animal, comparable in size to the living Siberian roe deer *Capreolus capreolus pygargus*. The red deer *Cervus elaphus* from Miesenheim I were larger in body-size than the living animal and had relatively small teeth.

Remains of macrofaunas from the lower Middle Pleistocene deposits at Kärlich are, with the exception of

Kä Gb, sparse. These fossils have been collected over many years, and it was no longer possible to establish whether the fossils from a particular unit were originally from the same phase of deposition or not. Attempts to group the fossils into »assemblages« on the basis of their state of preservation, colouration etc. were not successful.

Thus, the macrofaunal fossils from Kärlich are not particularly useful for interpreting the palaeoenvironment at the time of deposition of these units. The presence of five individuals of the extinct elephant *Mammuthus* sp. in Kä F is probably more indicative of the ease with which the large molars of elephant can be recovered, than a particular environmental phase.

Molluscan faunas recovered in Kä Bb to Gb indicate a cold, damp, steppe environment for all of the loess deposits in these units. Colder conditions are indicated in Kä D by the presence of the mollusc *Columella columella,* in Kä E by the presence of the arctic lemming *Dicrostonyx* sp. and in Kä F and Gb by the presence of ice-wedges (Brunnacker, 1971).

The majority of the species of macrofauna recovered from Kä Bb - Ga are not particularly good indicators of a particular palaeoenvironment, and it was not always possible to reconstruct the original horizon of deposition of the fossils within a unit. For example, the extinct giant deer *Megaloceros verticornis* has been recorded in faunas in association with regional temperate forest in England (Stuart, 1982). It occurs in Kä E in a deposit indicating, by the presence of ice-wedges, extremely cold conditions. This does not exclude the possibility that the remains of this species are actually from warm phase deposits within Kä E.

A rich macrofauna has been recovered from Kä Gb. Temperate elements such as fallow deer cf. *Dama dama* and elk *Alces* sp. are present. Fallow deer are intolerant of cold conditions and appear to have been restricted to interglacial faunas in North-West Europe. Elk *Alces* sp. occurs in interglacial faunas associated with temperate forest and interstadial faunas in association with birch woodland. The occurrence of fallow deer and elk indicates that the macrofauna from Kä Ga and Gb may reflect a mixed fauna including elements from warm stage deposits.

A more detailed picture of the palaeoenvironment during an interglacial of the lower Middle Pleistocene has been obtained from the Miesenheim I locality.

The pollen spectra from Mi 1 and Mi 2 (see pollen diagram, Fig. 5), indicates interglacial conditions for both of these assemblages. The pollen from Mi 1 probably represents a younger phase of this interglacial in which elements of mixed oak forest were still present. The Mi 2 pollen assemblage represents an end of interglacial phase. The environment at this time consisted of a birch and pine dominated woodland, in which spruce, hazel, hornbeam and beech also occurred. The high percentage of non-tree pollen indicates that open areas with herbaceous vegetation were also present in the vicinity of the site.

The mammalian microfauna and molluscan fauna also indicates the same environmental conditions as shown by the pollen. The molluscan fauna shows that very damp, marshy conditions prevailed directly at the site itself. A red deer antler frontlet from the Mi 2 assemblage indicates that this individual died sometime during the months September - March.

The species present in the assemblages from Miesenheim I are known to have occurred in interglacial faunas during the Pleistocene. They are also known to have occurred in association with open woodland, and are therefore consistent with the palaeonvironment as suggested by pollen, microfauna and molluscan fauna. The palaeoecology of *M. trogontherii* is not particularly well known. Tooth fragments possibly belonging to this species have been identified from the Mi 2 assemblage.

The macrofauna from the Mi I assemblage is poor, and only two species, extinct rhinoceros *Dicerorhinus etruscus* cf. *brachycephalus* and red deer *Cervus elaphus* occur. Both of these species also occur in the Mi 2 assemblage. They are associated with some mixed oak forest taxa in Mi 1, and in Mi 2 with open pine and birch woodland.

The macrofauna from Mi 2 is richer in species. This macrofauna is dominated by species usually associated with woodland, such as roe deer *Capreolus capreolus*, red deer *Cervus elaphus* and badger *Meles* sp. The palaeoecology of the extinct rhinoceros *Dicerorhinus etruscus* cf. *brachycephalus*, horse *Equus* sp. and the large bovid *Bos* sp. or *Bison* sp. suggests that these species would have probably inhabited the more open grassland in the vicinity of the site.

Upper Middle Pleistocene Macrofaunas

Assemblages thought to date to the upper Middle Pleistocene (= Saalian) have been recorded at Leutesdorf, Ariendorf, Schweinskopf, Wannen, Hummerich and Tönchesberg. The units H and Ja and the Kä 1 assemblage have also been described as belonging to the upper Middle Pleistocene, although these deposits could be older.

Kärlich H and Ja

According to the stratigraphy of the Kärlich deposits, the loess of unit H was deposited during the Third Cold Stage BP and the loess of unit Ja during the Second Cold Stage BP. The Kärlich Interglacial deposits are located at the top of unit H. Kä H and Ja have been correlated to the Saalian phase (older and younger phases) and the Kärlich Interglacial to an inter-Saalian warm phase by Brunnacker (et al., 1976; in Butzer & Isaacs, 1975) (Fig. 3). Absolute dates obtained from unit H are inconsistent. Tl dates of 232,000 +/- 28,000 BP and 222,000 +/- 25,000 BP (Zöller et al., 1987) obtained on loess below the Kärlich Interglacial palaeosol, support the idea that this is an inter-Saalian warm phase (see relative dates Fig. 3).

However, absolute dates, using the 40Ar39Ar Laser method, indicate that Kä H and the Kärlich Interglacial are much older (v. d. Bogaard & Schmincke, 1988). Tephra horizons stratified towards the base of unit H have been dated to 683,000 +/- 8,000 BP (»Wehrer« pumice I) and 467,000 +/- 8,000 BP (»Wehrer« pumice II). The Brockentuff, deposited during the Kärlich Interglacial, has been dated to 440,000 +/- 18,000 BP by this method (Fig. 3). If these dates are correct, they indicate that the Kärlich Interglacial is as old as the Ariendorf Interglacial, and that at least the sequence Kä H and the Kärlich Interglacial must belong to the lower Middle Pleistocene period (see relative dates Fig. 3).

The following macrofaunas have been identified from the units H and Ja:

Kä H
Elephas antiquus - straight-tusked elephant (2)
Mammuthus sp.
(*Mammuthus* cf. *trogontherii*) - extinct elephant (2)
Equus sp.
(?*Equus* cf. *mosbachensis*) - horse (3)
Bos sp. or *Bison* sp. - unidentifiable large bovid (2)

Kä Ja
Elephas antiquus - straight-tusked elephant (1)
Equus sp. - horse (1)
Bos sp. or *Bison* sp. unidentifiable large bovid (1)

The sparse macrofaunal remains from Kä H and Ja are not particularly useful in dating the deposits. The straight-tusked elephant *E. antiquus*, steppe elephant *M. trogontherii* and caballine horses *Equus* sp. are all known to have occurred in both lower and upper Middle Pleistocene faunas. Two of the molars of *Elephas antiquus* recovered from Kä H have low plate frequencies. This characteristic has often been considered as primitive. However, as this is based on only two specimens and as molars of *E. antiquus* with »primitive« characteristics often occur in faunas from younger deposits, such as the beginning of the Late Pleistocene (pers. comm. A. Lister, 1988), this cannot be used as evidence that Kä H should be of lower Middle Pleistocene age.

Nobis (1970), has identified cheek teeth of *Equus* from Kä H as possibly belonging to *Equus mosbachensis*, a species known to have occurred during the lower Middle Pleistocene. The specimens are from a caballine horse and are similar in size to those from *E. mosbachensis*. However, as has been discussed in Chapter 7, the size of the teeth of the genus *Equus* is not a good biostratigraphic indicator, particularly when only a single specimen is available. A single third metatarsus of *Equus* sp. from this unit is longer than any of the other metatarsals of horse from assemblages in the Neuwied Basin region (see Chapter 7). This individual is comparable in body-size (withers height) with the largest forms of *E. mosbachensis* shown in Fig. 29. It is larger than horses from the Ar 2 assemblage, which are taken as representing a horse population typical of the late Saalian period in this region. However, as there is no comparative material from assemblages in deposits thought to be similar in age to Kä H, it cannot be said that this indicates that Kä H dates to the lower Middle Pleistocene period. The metatarsal fragment from Kä Ja is comparable in size to those from the Ar 2 assemblage.

A elephant molar fragment from Kä H has been described by F. Poplin as being intermediate between *M. trogontherii* and *M. primigenius*. This specimen has characteristics which are more comparable with the molars of *M. trogontherii*, and has been described here as *M.* cf. *trogontherii*. Molars identified as being comparable to *Mammuthus* cf. *trogontherii* occur in the older, lower Middle Pleistocene units at this locality and in assemblages from Ariendorf considered to date to the beginning of the Saalian.

Kärlich 1 assemblage

The Kä 1 assemblage belongs to an interglacial phase. By a series of circular arguments, the Kä 1 deposits have been correlated with those of the Kärlich Interglacial in the main section (Bosinski et al., 1980). Because of this, the Kä 1 assemblage has been brought indirectly into the confusion now surrounding the chronostratigraphy of the Kärlich Interglacial deposits (see above units H and Ja).

Brockentuff deposits are located below the fossiliferous horizon and because of this, the warm phase represented at the Kä 1 site has been correlated with the Kärlich interglacial deposits in the main section, in which a Brockentuff also occurs (Fig. 3). The pollen assemblage identified at the Kä 1 site is considered by Urban (1983; in Brunnacker et al., 1980) to be older than the last (=Eem) interglacial, but otherwise not comparable to any of the known Pleistocene interglacial floras. Bittman (1988), describes the Kä 1 pollen assemblage as being comparable to those found in deposits of Cromerian age at other localities in Germany.

The deposits above the Kä 1 fossiliferous horizon are of no further use in dating the assemblage (see Chapter 4). The uppermost part of the section has been truncated and there is evidence of a system of channels, indicating erosion of the sequence. At least one palaeosol, preserved in one of the channel-infills, indicates that Kä 1 should be older than the last interglacial.

Three correlations can be proposed for the Ka 1 assemblage:

i) the correlation of the Kä 1 assemblage with the Kärlich Interglacial deposits and the Tl dates in the main section indicate that this assemblage is from an inter-Saalian interglacial, called locally the Kärlich Interglacial.

ii) the correlation of the Kä 1 assemblage with the main section deposits combined with the older 40Ar 39Ar dates and the opinion of one of the scientists working on the pollen assemblage from Kä 1, suggests that this assemblage probably belongs to a warm stage in the latter part of the Cromer complex.

iii) the interglacial represented at the Kä 1 site cannot be correlated with the interglacial deposits in the main section, regardless of whether they are of inter-Saalian age or older, as there is no direct contact between the deposits at the site itself and those in the main Kärlich section. Following this, the name Kärlich Interglacial should be restricted to the warm stage deposits in the main section. The pollen assemblage recovered from the Kä 1 site, and also referred to the »Kärlich interglacial« should only be used to indicate the environment at the Kä 1 site itself.

Until the confusion surrounding the chronostratigraphy of these deposits is finally settled, the interglacial deposits at the Kä 1 site have been referred to in this study as an unidentified warm phase as proposed in iii). The presence of at least one palaeosol above the Kä 1 deposits suggests that this interglacial dates at least to the Middle Pleistocene.

The following macrofauna has been identified:

Kä 1
Elephas antiquus - straight-tusked elephant (3)
Equus sp. - wild horse (1)
Cervus elaphus - red deer (1)
Bos cf.*primigenius* - aurochs (1)
Sus scrofa - wild pig (1)

The macrofaunal remains from Kä 1 are not useful in dating the deposits. All of the taxa present in this fauna have long stratigraphic ranges. Most of the species are represented only by fragmentary remains. *Equus* sp. for example, is only represented by two incisor fragments, red deer *Cervus elaphus* by a single shed antler and two lower cheek teeth and wild pig *Sus scrofa* by a tibia fragment.

The only potentially biostratigraphically important species in this macrofauna is the aurochs *Bos* cf. *primigenius*. Unfortunately, only a single metapodium could be identified as possibly belonging to this species (Part III). If the identification is correct, this would indicate that Kä 1 is possibly an inter-Saalian interglacial, as the first known occurrence of this species probably dates to the Saalian (Brugal, 1984).

The straight-tusked elephant is represented by a juvenile and two adult individuals. The cheek teeth from the two adults all have a low plate frequency, which has often been interpreted as a primitive characteristic. However, as has already been stated, such primitive characteristics have also been noted on the cheek teeth of *Elephas antiquus* from Late Pleistocene assemblages (pers. comm. A. Lister, 1988).

It is unfortunate that the Kä 1 assemblage cannot be dated more accurately as this is one of the few assemblages in the Neuwied Basin associated with pollen, and is the only possible candidate for an inter-Saalian warm phase.

According to the pollen-assemblage, the Kä 1 fossiliferous horizon was deposited during a Middle Pleistocene interglacial. The macrofauna recovered from these deposits and their known occurrences in Pleistocene faunas, is consistent with the interglacial character of the pollen assemblage. The horizon in which the fossils are located is associated with the hornbeam-birch (*Carpinus-Betula*) zone (after Urban, 1983; in Brunnacker et al., 1980), or the hornbeam - mixed oak forest - fir zone according to Bittman (1988). Both zones date towards the end of this interglacial phase. Plant macrofossils indicate that very damp conditions were present at the site itself at the time of deposition of the assemblage and there was probably a pond or some kind of water-course nearby.

The Kä 1 macrofauna is not particularly rich in species and is dominated by three individuals of *Elephas antiquus*. The remaining species are all represented by a minimum of one individual. Straight-tusked elephant *Elephas antiquus*, pig *Sus scrofa* and possibly aurochs *Bos* cf. *primigenius* have been recorded from interglacial faunas in North-West Europe, in association with temperate forest, and were still present in Kä 1 in association with more open conditions at the end of an interglacial. Wild horse *Equus* sp., and red deer *Cervus elaphus* have both been recorded from interglacial faunas, whereby horse is indicative of locally open herbaceous vegetation.

Leutesdorf

The macrofaunal remains were recovered from horizons at the top of loess Bed II (Brunnacker et al., 1974). This loess bed has been dated to the Third Cold Stage BP, which in turn has been correlated with an older phase of the Saalian (Brunnacker et al., 1976; in Butzer & Isaacs, 1975). The problems concerning the stratigraphical position of the Leutesdorf Interglacial (see discussion above :lower Middle Pleistocene) may mean that the loess deposits at this locality are older than previously thought.

F. Poplin (in Brunnacker et al., 1974) identified the following macrofauna:

Equus sp. (caballine) - horse (1)
Cervus elaphus - red deer (1)

The red deer *Cervus elaphus* is described as being of large body size. Changes in body size in Pleistocene red deer are known, but are not of biostratigraphic value. The single horse tooth is of caballine form and rather large. However, the size of a single cheek tooth of *Equus* is biostratigraphically insignificant. The remains of red deer and horse from the locality of Leutesdorf are of little use in controlling the suggested date for these deposits.

The fossils from Leutesdorf were located in cold stage loess deposits. Palaeoenvironmental evidence from other sources is not known at this locality. Both red deer and horse occur frequently in assemblages found in loess deposits in the Neuwied Basin region.

Ariendorf

The Ariendorf fossiliferous assemblages are located in loess beds stratified above Middle Terrace Rhine gravels and the Ariendorf Interglacial deposits (Brunnacker et al., 1975). The problems of the stratigraphical position of the Ariendorf Interglacial (see above, lower Middle Pleistocene macrofaunas) does not appear to affect the chronostratigraphy suggested for the overlying loess deposits (Chapter 4). The assemblages Ar Ch, Ar 1 and Ar 2 are located in loess beds considered to date to the upper Middle Pleistocene.

The Ar Ch. assemblage is located in a channel-infill deposit at the base of the loess beds. The channel-infill consists of loess from Bed I (terminology after Brunnacker, ibid), and the fossils in this deposit might be derived from the same loess bed. Bed I has been dated to the Third Cold Stage BP, which in turn has been correlated with an older phase of the Saalian. Ar 1 is located at the base of the same loess bed. Ar 2 is located in the upper part of Bed II, dated to the Second Cold Stage BP, which has been correlated with a younger phase of the Saalian (Brunnacker et al., 1976; Brunnacker in Butzer & Isaacs, 1975). The upper part of Bed II has been dated (TL) to about 199,000 BP (Zöller et al., 1987). Microfaunal remains from the Ar 1 assemblage have been identified as belonging to the *Arvicola terrestris* Partial-range zone, which has been correlated with the Saalian (van Kolfschoten, 1988).

The following macrofaunas have been identified:

Ar Ch.
Mammuthus cf. *trogontherii* - extinct elephant (4)
Equus sp. (caballine) - horse (1)
Coelodonta antiquitatis - woolly rhinoceros (1)
Megaloceros cf. *giganteus* - giant deer -
?*Rangifer tarandus* - reindeer -

Ar 1
Canis lupus - wolf (1)
Canis sp. - unidentifiable canid (1)
Ursus sp. - unidentifiable bear (1)
Felis sp. - unidentifiable large felid (1)
Mammuthus sp. - unidentifiable elephant (1)
Equus sp. (caballine) - horse (2)
Coelodonta antiquitatis - woolly rhinoceros (1)
Cervus elaphus - red deer (1)
Bos sp. or *Bison* sp. - unidentifiable large bovid (3)

Ar 2
Canis lupus - wolf (1)
Mammuthus sp. (*trogontherii-primigenius*) - woolly mammoth (1)
Equus sp. (caballine) - horse (2)

Coelodonta antiquitatis - woolly rhinoceros (2)
Cervus elaphus elaphus - red deer (1)
Bison priscus - extinct bison (2)

Most of the species from the Ariendorf assemblages were not particularly useful in dating the deposits. For example, the known stratigraphic ranges of species such as reindeer *Rangifer tarandus* and the caballine horses are too long, and some of the macrofaunal remains from these assemblages could not be identified to species.

The wolf *Canis lupus* occurs in both the Ar 1 and Ar 2 assemblages. According to Bonifay (19871), *Canis lupus* evolved from the smaller, more primitive *Canis lupus mosbachensis*, present in lower Middle Pleistocene faunas. Larger wolves, with a more progressive dental morphology, occur in the Holsteinian, and wolves similar in size to the living animal occur in Saalian and Weichselian faunas. The remains of *Canis lupus* from Ar 1 and Ar 2 compare in size with those of the living animal.

The woolly rhinoceros *Coelodonta antiquitatis* is generally considered to have appeared in North-West Europe during the Saalian. This species does not occur to date in assemblages in the Neuwied Basin thought to pre-date the Saalian phase. *C. antiquitatis* occurs in both of the oldest assemblages (Ar Ch. and Ar 1) at Ariendorf.

The presence of *C. lupus* in Ar 1 and Ar 2 and *C. antiquitatis* in Ar Ch. and Ar 1 and the known stratigraphic ranges of these species indicates that the loess Beds I and II at Ariendorf are post-Holsteinian in age. The assemblages, and the loess deposits in which they are located, have been correlated with the Saalian. The macrofauna from these assemblages is consistent with this correlation.

Schweinskopf

The sequence of deposits at the Schweinskopf site and the fossiliferous horizons are difficult to correlate because of the lack of marker horizons. Windheuser (1977), has suggested that the oldest deposits found in craters of the Schweinskopf-Karmelenberg group date to the Second Cold Stage BP, and the deposits at the Schweinskopf have also been tentatively dated to this phase (Schäfer, 1987a and b). A Uranium-series date of about 165,000 BP has been obtained on a fossil from the Sk 2 assemblage, and, when compared with the date from the younger Saalian loess deposits Ariendorf, is consistent with the proposed age for the Sk 2 assemblage. The Second Cold Stage has been correlated with a younger phase of the Saalian (Fig. 3).

Although the Sk 1 and Sk 3 assemblages are probably in secondary context, the order (beginning with the oldest first) in which the assemblages from this locality are listed below is probably correct (Chapter 4). The following macrofaunas have been identified:

Sk 1
Equus sp. (caballine) - horse (1)

Sk 2
Alopex lagopus - arctic fox (1)
Equus sp. (caballine) - horse (2)
Coelodonta antiquitatis - woolly rhinoceros (2)

Sk 3
Rangifer tarandus - reindeer

Sk 4
Panthera (Leo) spelaea - extinct lion (1)
Canis lupus - wolf (1)

Alopex lagopus - arctic fox (1)
Mammuthus cf. *primigenius* - woolly mammoth (2)
Equus sp. (caballine) - horse (9)
Equus (Asinus) hydruntinus - extinct wild ass (1)
Coelodonta antiquitatis - woolly rhinoceros (3)
Megaloceros giganteus - extinct giant deer (1)
Cervus elaphus - red deer (2)
Rangifer tarandus - reindeer (3)
Bos sp. or *Bison* sp. - unidentifiable large bovid (2)

The woolly rhinoceros *C. antiquitatis* occurs in both the Sk 2 and the Sk 4 faunas. This species is considered to have first appeared during the Saalian in Europe (Guérin, 1980). In the Neuwied Basin, *C. antiquitatis* is only present in assemblages dating to the Saalian. Its presence in Sk 2 indicates that at least the assemblages Sk 2 - Sk 4 post-date the Holsteinian, and are thus consistent with the proposed Saalian age. The presence of *C. antiquitatis* does not indicate whether the deposits date to an older or a younger phase of the Saalian.

The wolf *Canis lupus* is present in the Sk 4 assemblage. Large wolves, similar in size to the living animal, have been recorded from Saalian and Weichselian faunas in North-West Europe (Bonifay, 1971). The wolf remains from Sk 4 compare in size with those of recent specimens of this species, and support the proposed Saalian age for the assemblages.

The first known occurrences of the arctic fox *Alopex lagopus* and the extinct wild ass *Equus (A) hydruntinus*, present in the Sk 2 and Sk 4 assemblages, were also during the Saalian.

The combination of species such as *Coelodonta antiquitatis*, a large *Canis lupus*, *Alopex lagopus* and *Equus (A) hydruntinus* are consistent with a Saalian age for the Schweinskopf deposits and the assemblages Sk 1 - 4. The known stratigraphic ranges of the species present in the faunas were not detailed enough to control the suggestion that the deposits and assemblages at this locality date to a younger phase of the Saalian. However, the stratigraphy (such as it is) at this locality and the single absolute date from Sk 2 do not contradict the proposed younger Saalian age.

Wannen

The chronostratigraphy of the Wannen fossiliferous asssemblages is difficult to define. Windheuser (1977), has suggested that the oldest deposits in the craters of the east Wannen group probably date to the Second Cold Stage BP. Marker horizons dating to the end of the Pleistocene, such as the Alleröd Interstadial soil overlain by Laacher pumice have been recorded. A hiatus separates this sequence from the older deposits in which the fossiliferous assemblages are located, so that these younger horizons are of no further use in ageing the deposits (Justus,et al., 1987). They only show that the fossiliferous assemblages are older than the latter part of the Last Cold Stage BP (Chapter 4). Fossils from the assemblages Wa 3, and 2 have been dated (Uranium-Series) to about 246,000 +/- 18,000 BP and 210,000 - 15,000 BP. Fossils from Wa 4/5 have been dated by the same method to about 94,000 +/- 22,000 BP. The dates suggest that the older assemblages Wa 1, 2 and 3 were deposited at the beginning of the Second Cold Stage BP (see relative dates Fig. 3), which in turn has been correlated with a younger phase of the Saalian, and the assemblage Wa 4/5 to the Last Cold Stage BP, which has been correlated with the Weichselian.

The assemblages Wa 1, 2 and 3 may belong to the same phase of deposition (Chapter 4). The macrofaunas from these assemblages have, however, been listed separately because the taphonomical study of the fossils at this locality is by no means complete.

The following macrofaunas have been identified:

Wa 1
Ursus spelaeus - cave bear (1)
Panthera leo spelaea - extinct lion (1)

Equus sp. (caballine) - horse (4)
Equus cf. *hydruntinus* - extinct wild ass (1)
Coelodonta antiquitatis - woolly rhinoceros (3)
Cervus elaphus - red deer (6)
Bos sp. or *Bison* sp. - unidentifiable large bovid (2)

Wa 2
Ursus spelaeus - cave bear, same individual as in Wa 1
Panthera leo spelaea - extinct lion, same individual as in Wa 1
Equus sp. (caballine) - horse (6)
Coelodonta antiquitatis - woolly rhinoceros (3)
Cervus elaphus - red deer (2)
Rupicapra rupicapra - chamois (1)

Wa 3
Canis lupus - wolf (1)
Meles meles - badger (1)
Equus sp. (caballine) - horse (5)
Coelodonta antiquitatis - woolly rhinoceros (4)
Cervus elaphus - red deer (2)
Rangifer tarandus - reindeer (1)
Bos sp. or *Bison* sp. - unidentifiable large bovid (1)
cf. *Rupicapra rupicapra* - chamois (1)

Important for the dating of these assemblages is the presence of the woolly rhinoceros *Coelodonta antiquitatis* in Wa 1, which indicates a post-Holsteinian age for the Wannen assemblages. The cave bear *Ursus spelaeus*, extinct lion *Panthera leo spelaea*, the extinct wild ass *Equus (A) hydruntinus* and chamois *Rupicapra rupicapra*, also present in this assemblage, are all known to have occurred in faunas dating to the Saalian. The macrofauna from the oldest assemblage is consistent with the proposed Saalian age for Wa 1, 2 and 3. The location of these assemblages in deposits thought to date to the Second Cold Stage BP and the absolute dates obtained from the fossils in the assemblages are consistent with a younger Saalian phase.
The age of the Wannen Pr III deposits and assemblages is more difficult to define. It is unlikely that they are much older than the main site deposits.

Wa Pr III
Panthera leo spelaea - extinct lion (1)
Equus sp. (caballine) - horse (4)
Coelodonta antiquitatis - woolly rhinoceros (5)
Cervus elaphus - red deer (2)

Species occurring in Wa 1, 2 and 3 are also present in the macrofauna identified from Wa Pr III. The presence of woolly rhinoceros *Coelodonta antiquitatis* also indicates a post-Holsteinian age for this fauna.

Hummerich

Five fossiliferous assemblages have been recorded at the Hummerich locality. According to the stratigraphy at the site, the loess in which the Hu 1 assemblage is located dates to the Second Cold Stage BP, which in turn has been correlated with a younger phase of the Saalian (Kröger, 1987a and b). A date of about 135,000 - 134,000 BP has been obtained from a loess sample at the base of the oldest loess bed (Singvhi et al., 1986), which is broadly consistent with absolute dates obtained from other Saalian deposits and assemblages.

Hu 1
Rhinocerotidae sp. - unidentifiable rhinoceros -

Only the remains of an unidentifiable rhinoceros have been recovered from this assemblage.

Tönchesberg

The Tö 1 assemblage is located in loess deposits dating to the Second Cold Stage BP.A 40Ar/39Ar date from a tephra deposit at the base of this loess has given a lower age limit of 260,000 +/- 50,000 BP for these deposits (Conard, 1988a).
The following macrofauna has been identified:

Tö 1
Equus sp. - horse (1)
Rhinocerotidae sp. - unidentifiable rhinoceros (1)
Rangifer tarandus - reindeer
Cervus elaphus - red deer (1)
Bos sp. or *Bison* sp. - unidentifiable large bovid (1)

Of those macrofaunas described as dating to the upper Middle Pleistocene, the faunas from Kä H and Ja, Kä 1, Leutesdorf, Wa Pr III and the Hu 1 fauna are not discussed further. The faunas from these localities or assemblages were either too sparse or not well-dated.
The macrofaunas from the assemblages at Ariendorf (Ar Ch, Ar 1 and Ar 2), Schweinskopf (Sk 1 - 4), Wannen (Wa 1 - 3) and Tönchesberg (Tö 1) all date to the Saalian. Two assemblages from Ariendorf (Ar Ch. and Ar 1) are thought to date to an older Saalian phase.
These faunas are, with the possible exception of the macrofauna from the Ar Ch. assemblage, all located in cold stage deposits (loess).
Where present, the mammalian microfaunas and molluscan faunas associated with these macrofaunas indicate a cold, sometimes damp, open steppe or steppe-tundra environment. The molluscan faunas from the channel deposit at Ariendorf and Ar 2 also contain species indicative of woodland. This suggests that either some of the species in these faunas are derived from other deposits, or that the molluscan faunas represent a biotope local to the Neuwied Basin region, with wooded areas in the more sheltered valleys of the Rhine River and tributaries and open steppe or tundra on the exposed higher land around the edge of the basin itself (Chapter 2). The latter may have been the case, as similar molluscan faunas have also been recovered in lower Middle Pleistocene loesses at Kärlich. The microfauna associated with Ar 1 indicates a cool, treeless steppe-tundra environment. A sparse microfauna from Sk 4 also indicates a steppe environment.
The macrofaunal species recorded in the assemblages listed above are known to have occurred in cold stage faunas during the Pleistocene. The exception to this is the badger *Meles meles* in Wa 3, which is usually associated with temperate woodland.

Although these faunas were all presumably accumulated by man, the minimum number of individuals show that the macrofaunas are consistently dominated by the large herbivores, such as horse *Equus* sp., woolly rhinoceros *C. antiquitatis* and *B. priscus*, indicative of an open environment with a rich herbaceous vegetation. Thus, the macrofaunas from the upper Middle Pleistocene assemblages listed above, with the possible exception of Ar Ch.(secondary context) and Wa 3 (elements probably derived from other deposits), are consistent with both their depositional context and the palaeoenvironmental evidence from the associated mammalian microfaunas and molluscan faunas. The exception to this is the wild ass *Equus (A) hydruntinus*, which has been recorded from temperate (interglacial/interstadial) faunas in North-West Europe.

Only the macrofauna from Ar 1 can be definitely dated to the older Saalian phase. The macrofaunas consists of the wolf *Canis lupus*, extinct elephant *Mammuthus* sp., a horse *Equus* sp. woolly rhinoceros *Coelodonta antiquitatis*, red deer *Cervus elaphus*, and an unidentifiable large bovid, either *Bos* sp. or *Bison* sp. The macrofauna from the channel infill at this site is probably derived from the older Saalian deposits, and as well as species already mentioned above, giant deer *Megaloceros giganteus* and possibly reindeer *Rangifer tarandus* occur.

Macrofaunas from the younger Saalian phase are better-documented because of the larger number of localities dating to this period. A typical macrofauna from this phase consists of the wolf *Canis lupus*, an elephant *Mammuthus* sp., horse *Equus* sp. woolly rhinoceros *Coelodonta antiquitatis*, red deer *Cervus elaphus* and a large bovid, identified at Ar 2 as the extinct bison *Bison priscus*. In this aspect the macrofaunas of the younger Saalian phase do not differ to those of the older phase. The arctic fox *Alopex lagopus*, the cave bear *Ursus spelaeus*, extinct lion *Panthera (Leo) spelaea*, the wild ass *Equus (A) hydruntinus* and chamois *Rupicapra rupicapra* have been recorded for the first time in the younger Saalian faunas. Whether these species occur for the first time in the Neuwied Basin region during the younger Saalian phase can only be established when more assemblages dated to the older Saalian phase are discovered.

The elephant molars from the Ar Ch. assemblage have been described by Poplin (in Brunnacker et al., 1975) as being intermediate between *Mammuthus trogontherii* and *Mammuthus primigenius*. However, they appear to possess more trogontherioid characteristics than primigenioid ones, and have thus been described here as *Mammuthus* cf. *trogontherii*. These fossils are evidence that mammoths with trogontherioid cheek teeth characteristics were still present in the early Saalian phase in the Neuwied Basin region. The molars of a young individual from Ar 2 compare more with those of *Mammuthus primigenius*.

Horses from the Saalian assemblages are of caballine type and have a wide variation in dental size and morphology (Chapter 7). The horses from Ar 2, Sk 4 and Wa 1 - 3 are all similar to one another in body-size (withers height). When compared to named species of Pleistocene horses, they are comparable in body-size to those already recorded in faunas dating to the end of the Saalian in Europe.

Coronate red deer *Cervus elaphus elaphus*, are known from the Ar 2 assemblage only; the antlers of red deer from the other assemblages were too incomplete to be identified to subspecies. The presence of red deer *Cervus elaphus* in cold stage faunas in the Neuwied Basin is not unusual. This species is ubiquitous and has been recorded from both cold and warm stage faunas during the Pleistocene in association with a variety of environments. Antler frontlets from this species in Ar 2, Sk 4 and Wa 1 indicate that red deer was present between the months September to March. This species appears to be underrepresented in the Ar 2 macrofauna, as the number of shed antler recovered in this assemblage (a total of five specimens) suggests. The presence of this species during the colder months of the year in open, steppe-tundra environment indicates the absence of heavy snowfall which would have prevented access to winter fodder (Stuart, 1982) and suggests that there must have been some form of shelter in the vicinity (Lister, 1984a).

The red deer from the Ar 2 and the Wannen assemblages are larger in both body and dental size than the recent animal. Specimens of antler from these assemblages show that during the younger Saalian phase antler could be extremely large (Chapter 8).

The presence of reindeer and arctic fox in the Sk 4 assemblage introduces a tundra element into the Saalian faunas. A shed antler from a female reindeer in Sk 3 indicates that this species was present in the Neuwied Basin region during the summer months of May - June, as this is the period when the females shed their antler (Schmid, 1972). An antler frontlet from reindeer, found in Wa 3, indicates that this species was also present for the rest of the year, summer being the only time when both male and female reindeer are not carrying antlers.

The extinct wild ass *Equus (Asinus) hydruntinus*, is usually associated with more temperate faunas in North-West Europe. It is however, known to occur in reindeer - dominated faunas in southern France, as is the case at Sk 4. This species is also indicative of an open steppe environment.

The first record of the chamois *Rupicapra rupicapra* is at the Wannen locality. This species occurs in Wa 2 and possibly Wa 3. It is usually associated with montane woodland. It was present in the Wa 2 and 3 assemblages, during the winter months. Badger *Meles meles* occurs in Wa 3. This species is usually associated with temperate woodland, so that its presence in this assemblage along with reindeer and other species indicating an open steppe-tundra environment, probably reflects a mixing of material in the older assemblages at this locality.

Late Pleistocene Macrofaunas

The macrofaunas from assemblages in the Neuwied Basin dating to the Late Pleistocene can be divided into three main phases. Assemblages dating to the early part of the Late Pleistocene, assemblages dating to the Last Cold Stage (=Weichselian), and those dating to the end of the Last Cold Stage (=Late Weichselian).

The Ar 3, Tö 2 and Hu 2 - 4 assemblages date to the beginning of the Late Pleistocene.

Ariendorf

The Ar 3 assemblage is located in a humic soil stratified above the palaeosol of the Last Interglacial and at the base of loess Bed III. Bed III is the youngest loess deposit at the Ariendorf locality and has been dated to the Last Cold Stage BP (Brunnacker et al., 1975), which in turn has been correlated with the Weichselian (Fig. 3).

Ar 3
Ursus spelaeus - cave bear (1)
Mammuthus primigenius - woolly mammoth (2)
Equus sp. - horse (1)
Coelodonta antiquitatis - woolly rhinoceros (1)
Cervus elaphus - red deer (2)
Bison priscus - extinct bison (2)

All of the macrofaunal species occurring in Ar 3 are known to have occurred in Late Pleistocene faunas in North-West Europe.

Hummerich 2-4

The assemblages Hu 2 - 4 are located in deposits stratified between the Last Interglacial soil and the loess of the Last Cold stage BP (Kröger 1987a and b).

Hu 2 is located in a scoria rubble horizon at the top of the Last Interglacial palaeosol and is almost certainly redeposited, appears however to post-date the formation and truncation of the Last Interglacial soil. Hu 3 is located in a loess-like deposit, above the interglacial soil. The fragmentary macrofaunal remains from Hu 3 were not described further. The main assemblage, Hu 4, is located in a humic soil above the interglacial soil.

The following faunas have been identified:

Hu 2
Equus sp. - horse (1)
Bos sp. or *Bison* sp. - unidentifiable large bovid (1)

Hu 4
Crocuta crocuta - spotted hyaena (1)
Panthera leo spelaea - extinct lion (1)
Equus sp. - horse (3)
Equus hydruntinus - extinct wild ass (3)
Coelodonta antiquitatis - woolly rhinoceros (2)
Cervus elaphus - red deer (4)
Dama dama - fallow deer (1)
Capreolus capreolus - roe deer (2)
Bos primigenius - aurochs - (4)

Tönchesberg

The main fossiliferous horizon, Tö 2, is located in the oldest of a series of humic soils above the palaeosol of the Last Interglacial.

Tö 2
Vulpes vulpes - red fox (1)
Felis (Lynx) lynx - lynx (1)
Equus sp. - horse - (1)
Equus cf. *hydruntinus* - extinct wild ass (1)
Dicerorhinus cf. *hemitoechus* - extinct rhinoceros (1)
Cervus elaphus - red deer (1)
cf.*Dama dama* - fallow deer (1)
Bos primigenius - aurochs (3)

All of the identifiable macrofaunal species from the Ar 3, Hu 2, Hu 4 and Tö 2 assemblages have been recorded in Late Pleistocene faunas in North-West Europe. The first known occurrence of the northern lynx *Felis (Lynx) lynx* (Tö 2) was during the Last Interglacial (=Eemian).

The Hu 4, Tö 2 and Ar 3 macrofaunas are all located in humic soils, thought to have formed under temperate environmental conditions. The palaeoenvironmental evidence from the humic soil deposits at these localities is sparse, but does indicate some differences in climate and environment from one site to another. At Ariendorf, a molluscan fauna from the humic soil indicates a cool climate with alternating humid and dry episodes. At the Tönchesberg, the molluscan fauna and microfauna indicate a warm climate and an open environment. Pollen from two conifers, pine and spruce, have been recorded at this locality.

The Hu 4 and Tö 2 macrofaunas are very similar to each other. Temperate elements such as extinct rhinoceros *Dicerorhinus* cf. *hemitoechus*, aurochs *Bos primigenius*, fallow deer *Dama dama* and roe deer *Capreolus capreolus* occur. These species are all known to have occurred in warm stage (interglacial/interstadial) Pleistocene faunas or are usually associated with temperate woodland. Of these species, the fallow deer *Dama dama* and the aurochs *Bos primigenius* appear to have been restricted to interglacial faunas in North-West Europe. However, bones identified as possibly belonging to *Bos primigenius* have been recovered from the Kä 1 assemblage, pollen-dated to the end of an interglacial, and from one of the assemblages dating to the Alleröd Interstadial.

Both the Hu 4 and Tö 2 faunas are dominated by the aurochs *Bos primigenius* and, in the case of the Hu 4 fauna, horse *Equus* sp. and the extinct wild ass *Equus (A) hydruntinus*. The same species also occur in the Tö 2 fauna, and are indicative, as is the aurochs, of open herbaceous vegetation. The carnivores *Crocuta crocuta* and *Panthera (Leo) spelaea* are also associated with an open environment.

Species such as fallow deer *Dama dama* and roe deer *Capreolus capreo*lus are indicative of woodland. Red deer *Cervus elaphus* is represented by a minimum of one individual in the Tö 2 fauna and by a minimum of four individuals in the Hu 4 fauna. However, a total of ten shed antler bases in the Hu 4 fauna and over thirty in the sampled fauna from Tönchesberg indicate that this species was probably more abundant in the fauna living at the time than is represented by the number of individuals which arrived at the site.

The macrofauna from the Tö 2 assemblage is consistent with the palaeoenvironmental evidence from the molluscan and microfaunas, and indicates that the assemblages were deposited during the formation of the humic soil at this site. Because the macrofaunas from Hu 4 and Tö 2 are so similar, it is assumed here that a similar environment prevailed at the Hummerich. The environment at the time of deposition consisted of predominantly open herbaceous vegetation, with some wooded areas; the climate was warm.

Minor differences in macrofaunal composition are apparent amongst the carnivores from these faunas. The spotted hyaena *Crocuta crocuta* and extinct lion *Panthera (Leo) spelaea* are present in the Hu 4 fauna: the red fox *Vulpes vulpes* and the lynx *Felis (Lynx) lynx* in the Tö 2 fauna.

The woolly rhinoceros *Coelodonta antiquitatis* occurs in the Hu 4 assemblage and the extinct rhinoceros *Dicerorhinus* cf. *hemitoechus* in the one from Tönchesberg. *D. hemitoechus* is a temperate species, known to have occurred in interglacial and interstadial faunas in North-West Europe. In England, this species is recorded from faunas dating to the Last Interglacial (Stuart, 1982). *C. antiquitatis* is more commonly associated with cold stage faunas in association with an open steppe environment. It did however, occur in interstadial faunas and in faunas dating to the latter part of interglacials in association with a more open environment.

The macrofauna from Ar 3, although sparse, is characterized by the absence of temperate elements. The fauna is dominated by the extinct bison *Bison priscus*, woolly mammoth *Mammuthus primigenius* and red deer *Cervus elaphus. B. priscus*, woolly mammoth, *M. primigenius, C. antiquitatis* and *Equus* sp. are all indicative of an open steppe environment. *Cervus elaphus* may indicate the presence of some wooded areas, although this species is present in the Ar 1 cold stage fauna associated with an apparently treeless environment. The fauna from Ar 3 is also consistent with the palaeoenvironmental evidence from the molluscan fauna.

With the exception of *Ursus spelaeus* (cave bear), all of the species in the Ar 3 assemblage also occur in the older macrofaunas at this locality. The Ar 3 macrofauna appears to show no apparent differences in composition when compared to the macrofaunas from Ar 1 or Ar 2, which are located in cold stage loess deposits indicating an open steppe or steppe tundra environment.

The interpretation of the Ar 3, Hu 4 and Tö 2 assemblages is unclear. Conard (1988b) has correlated the oldest humic soil at the Tönchesberg, in which the Tö 2 assemblage is located, with the initial cooling after the Last Interglacial. This contradicts the usually-held view that the humic soils developed during one of the interstadials (Amersfoort, Brörup or Odderade) at the beginning of the Last Cold Stage BP (Bosinski, 1983; Kröger, 1987a and b; Turner, 1985).

At Ariendorf, a pumice deposit is stratified between the interglacial and humic soils. This pumice has been previously identified as the Metternich Pumice (Löhr & Brunnacker, 1974) and dated to about 70,000 BP. A date of 223,000 +/- 47,000 BP obtained from the same pumice by v.d.Bogaard and Schmincke (1988) appears to be rather old for a tephra thought to have been deposited during the beginning of the Late Pleistocene.

At the Hummerich, loessic deposits and two further fossiliferous horizons (Hu 2 and Hu 3) are stratified between the interglacial soil and humic soil.

At the Tönchesberg a »bleached horizon« separates the interglacial soil from that of the humic soil sequence. TL dates obtained below and above the oldest humic soil at Tönchesberg date the formation of this soil to between 114,000 - 108,000 BP, and on the basis of this Conard (1988) has correlated the humic soil with the oxygen isotope stage 5d (the Last Interglacial is represented by the oxygen isotope stages 5a - e). Fossils from the Tö 2 assemblage located in the humic soil have, however, been dated by the Uranium-Series method to about 72,000 and 67,000 BP. The TL dates appear to support the Last Interglacial (=Eemian) interpretation; the dates obtained from the fossils themselves indicate a younger warm phase is correct. As it appears that the deposition of the fossils and the formation of the humic soil belong to the same phase, then the dates produced by one of these methods must be false.

The macrofaunas from these assemblages are listed above and compared with each other in Fig. 44. The

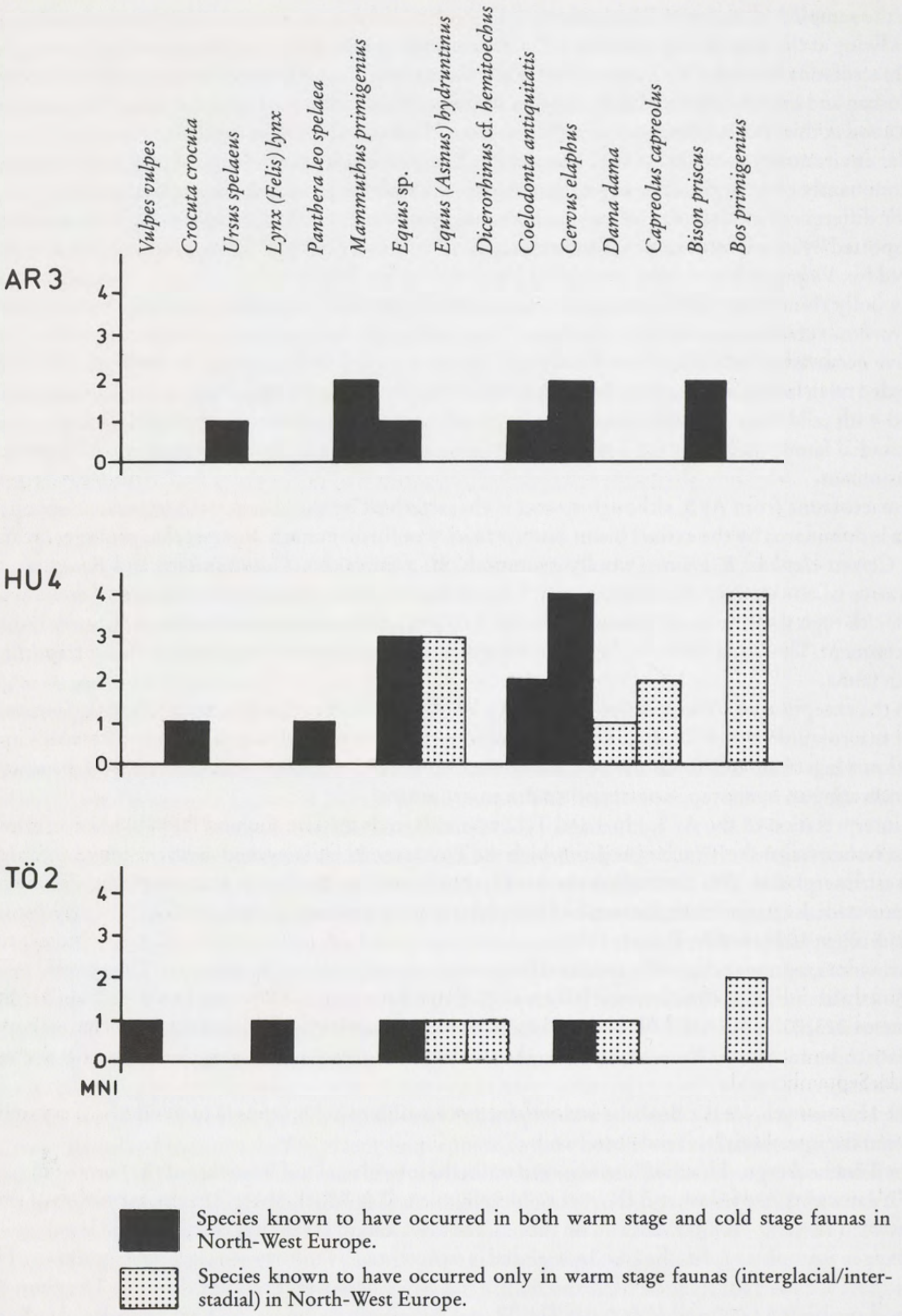


Fig. 44 Comparison of the macrofaunas from the Tö 2, Hu 4 and Ar 3 assemblages. M.N.I. = minimum number of individuals.

numbers in Fig. 44 indicate the minimum number of individuals per species, although it should be noted that the macrofaunal remains from the Ar 3 assemblage represents material that has only been collected from these deposits, and that the material from Tö 2 was only a sample from the 1986 and 1987 excavation campaigns. The material from Hu 4, the result of several excavation campaigns, gives the most reliable information from these three assemblages.

Early Weichselian interstadial faunas, such as the ones from Wallertheim/Rheinhessen (G.F.R., and situated to the south of the study area) (Bosinski et al., 1985), Königsaue (G.D.R.) (Mania & Toepfer, 1973) (G.D.R.) and the Chelford Interstadial in England (Stuart, 1982) are all characterized by the presence of reindeer *Rangifer tarandus* and the absence of species such as fallow deer *Dama dama* and aurochs *Bos primigenius*. In this aspect, the macrofaunas from Hu 4 and Tö 2 resemble those from interglacial episodes more than interstadial ones. The macrofauna recovered so far from Ar 3 is more comparable to those of the known interstadials.

An exact definition of the Ar 3, Hu 4 and Tö 2 macrofaunas in the absence of associated pollen assemblages, sparse palaeoenvironmental information from other sources and contradictory absolute dating is difficult to make.

The Hu 2 fauna, stratified in loessic deposits between the interglacial soil and the humic soil has only a very sparse macrofauna. The only species identified are wild horse *Equus* sp. and an unidentifiable large bovid *Bos* sp. or *Bison* sp. Both are indicative of an open environment.

The macrofaunas from the earlier part of the Late Pleistocene are characterized by the first records in the Neuwied Basin of the red fox *Vulpes vulpes*, extinct rhinoceros *Dicerorhinus* cf. *hemitoechus* and the spotted hyaena *Crocuta crocuta*. The single post-cranial bone from the spotted hyaena in the Hu 4 assemblage is the only record of this species in the macrofaunas from the Neuwied Basin so far.

The remains of *Dama dama* in the Hu 4 assemblage could not be definitely identified as to subspecies. The first known occurrence of the extant *Dama dama dama* is in faunas dating to the Last Interglacial (=Eemian), and it may be that the remains from Hu 4 belong to this subspecies.

The horses found during this stage were similar in size to those occurring in the Saalian assemblages, or tended to be slightly smaller. An individual of *Equus* in the Hu 4 assemblage possesses dental characteristics similar to those of *Equus taubachensis*.

The extinct wild ass *Equus (A) hydruntinus* occurs at the Hummerich, and possibly at the Tönchesberg, is also present in the Saalian faunas at Wannen and Schweinskopf. This species has only been recorded at the volcano localities so far. It occurs in macrofaunas located in both cold stage deposits (Wannen and Schweinskopf) and in deposits formed under temperate conditions (Hummerich and Tönchesberg) at these localities. The assemblages from these localities are all associated with an open steppe or steppe-tundra environment.

The red deer *Cervus elaphus* were all large in dental size when compared to the living animal. The antlers of the red deer from Hu 4 and Tö 2 were as large as those occurring in the Saalian assemblage Ar 2. Antler frontlets found in both the Tö 2 and Hu 4 assemblages indicate that this species was present during the months September - March.

The teeth of the woolly mammoth *Mammuthus primigenius* in Ar 3 have a high plate frequency and thin enamel as is typical for those forms occurring during the Late Pleistocene.

The following assemblages all date to the Last Cold Stage BP, which in turn has been correlated with the Weichselian.

Wannen

The youngest fossiliferous horizon at Wannen is located in a redeposited loess thought to date to the Last Cold Stage BP. Fossils from this horizon have been dated to about 94,000 BP by the Uranium - series method (Tiemei, pers. comm., 1989). The absolute date is consistent with the suggested age of the deposits. The following species have been identified:

Wa 4/5
Panthera leo spelaea - extinct lion (1)
Mammuthus cf. *primigenius* - woolly mammoth (1)
Equus sp. (caballine) - horse (4)
Coelodonta antiquitatis - woolly rhinoceros (3)
Cervus elaphus - red deer (1)
Rangifer tarandus - reindeer (1)

Hummerich 5

Hu 5 is located in a redeposited loess horizon above the humic soil at the base of the loess of the Last Cold Stage. Although in secondary depositional context, this horizon is younger than the humic soil in which the Hu 4 assemblage is located.

Hu 5
Alopex lagopus - arctic fox (1)
Equus sp. - horse (1)
Cervus elaphus - red deer (1)
Rangifer tarandus - reindeer (1)
Rupicapra rupicapra - chamois (1)

Metternich

Fragmentary macrofaunal remains have been recovered from two horizons in loess deposits dating to the Last Cold Stage BP at this locality.

Horizon 1
Cervus elaphus - red deer -

Horizon 2
Equus germanicus - wild horse (1)
Equus przewalski - Przewalski horse (1)

Red deer *Cervus elaphus* antler fragments have been found at the base of the last cold stage loess (horizon 1). Post-cranial bones from horse, identified by Höfer (1937) as *Equus germanicus* and *Equus przewalski* (horizon 2), located in the uppermost part of this loess deposit, may be of late Weichselian age. The specimens from this locality were not examined by the author and therefore a comment upon the identification of one of the horses to the living Przewalski horse could not be made.

Polch

The remains of a single, mature individual of woolly mammoth *Mammuthus primigenius* were recovered from this locality. The bones and teeth were located in a depression at the base of a single loess bed. The upper part of the loess is marked by the horizons Alleröd interstadial soil and Laacher pumice and loess of the Last Cold Stage BP (=Weichselian).

Mammuthus primigenius - woolly mammoth (1)

The Wa 4/5, Hu 5 and the remains of mammoth from Polch are all located in cold stage loess deposits. The remains from Metternich are not described further here.

The woolly mammoth *M. primigenius* is known to have occurred in cold stage faunas in association with an open steppe environment.
The macrofaunas Wa 4/5 and Hu 5 consists of those species, such as arctic fox *Alopex lagopus* and reindeer *Rangifer tarandus*, characteristic of an open steppe or steppe-tundra environment. The presence of red deer indicates that there may have been some form of woodland in the vicinity. The palaeoenvironment of the macrofaunas is consistent with the character of the deposits in which they are located.
These assemblages could not be exactly dated within the Last Cold Stage. The species occurring in these faunas have already been recorded from those assemblages located in cold stage deposits dating to the Saalian in this region. The horse *Equus* from Wa 4/5 was small and stockily-built, and resembles those associated with the assemblage at Gönnersdorf.

The following localities have been dated to the end of the Last Cold Stage BP (=Late Weichselian), and represent assemblages deposited at the end of the Bölling Interstadial and during the Alleröd Interstadial.

Gönnersdorf

The fossiliferous horizon at Gönnersdorf has been correlated, on the basis of stratigraphy, pollen and absolute dating, with the end of the Bölling Interstadial (Bosinski, 1979; Brunnacker (ed.), 1978).

1968 excavation campaign
Canis lupus - wolf (2)
Alopex lagopus - arctic fox (30)
Vulpes vulpes - red fox (2)
Mammuthus primigenius - woolly mammoth (1)
Equus sp. - horse (13)
Cervus elaphus - red deer (5)
Rangifer tarandus - reindeer (4)
Bison sp. - bison (1)
Saiga tatarica - saiga antilope (1)

1970 - 76 excavation campaign
Alopex lagopus - arctic fox
Coelodonta antiquitatis - woolly rhinoceros (1)
Cervus elaphus - red deer (1)
Alces alces - elk (1)
Rangifer tarandus - reindeer
Rupicapra rupicapra - chamois (2)

Andernach

An 1
Canis lupus - wolf
Alopex lagopus - arctic fox
Felis (Lynx) lynx - lynx
Mammuthus primigenius - woolly mammoth
Equus sp. - horse
Rangifer tarandus - reindeer

It is not intended to give a detailed report about the Gönnersdorf and Andernach macrofaunas in this study. The macrofaunal lists from Gönnersdorf quoted above have been taken from Poplin (1976; in

Brunnacker (ed.), 1978). The list for An 1 is based on Poplin (in Bosinski & Hahn, 1972), and from information given by M. Street (pers. comm., 1988). More detailed reports from these two authors will certainly be available when the identification of the material is complete. These assemblages have, however, been included in this study as they form part of the macrofaunal history of the Neuwied Basin region.

The An 1 assemblage has hardly been worked upon to date, so only the macrofauna from the Gönnersdorf locality has been discussed here. There are only minor differences in faunal composition between the Gönnersdorf and An 1 assemblages. At An 1, *Mammuthus primigenius* (woolly mammoth) is represented by tusk fragments only, whereas post-cranial bones of this species have been found in the Gönnersdorf assemblage. The lynx *Felis (Lynx) lynx* occurs at Andernach, but it is not clear whether the remains from this species belongs to the An 1 or An 2 assemblage. All of the remaining species identified so far from An 1 also occur in the Gönnersdorf assemblage. The An 1 assemblage has been dated to 12,980 BP (Radiocarbon pooled value) and is older than the assemblage at Gönnersdorf.

The pollen assemblage from Gönnersdorf indicates that this site was occupied during a period of vegetational change in which the open woodland of the Bölling Interstadial was already giving way to the more open steppe conditions of the Older Dryas Stadial. The microfauna from this assemblage supports this, indicating an open steppe environment with locally damp conditions. The molluscan fauna, sampled directly below the fossiliferous horizon, is dominated by those species preferring a humid biotope and by those indicating a steppe environment. The climate at the time would have been cold with a mean annual temperature of +2° - +4° (Brunnacker (ed.), 1978).

The concentration of material excavated during the 1968 campaign has been interpreted as a winter settlement phase (Poplin, 1976) (Chapter 4). Poplin (1976), suggests that the exaggerated cold character of the macrofauna from the 1968 excavation is due to these animals being present in larger numbers in the Neuwied Basin during the winter.

The macrofauna from this concentration is dominated by reindeer *Rangifer tarandus* (minimum of four individuals) and arctic fox *Alopex lagopus*. A minimum of thirty individuals of arctic fox has been recorded. This is probably the direct result of selective hunting by man in order to obtain the furs of these animals in winter pelage.

Arctic fox is restricted today to arctic regions, and reindeer was a common element of faunas in association with an open steppe-tundra environment. Horse *Equus* sp. is represented by a minimum of thirteen individuals and also indicates, along with woolly mammoth *M. primigenius*, bison *Bison priscus* and saiga antilope, an open steppe environment.

Red deer *Cervus elaphus* is represented in this fauna only by canine teeth, which have been worked to be worn as part of a pendant. This does not neccessarily mean that red deer was a part of the fauna living at the time of deposition of the assemblage. These teeth could have been procured at some other time.

Only a provisional list of the species found in the concentrations from the 1970 - 76 campaigns is given. According to Poplin (in Brunnacker (ed.), 1978) species such as reindeer and arctic fox still occur, but no longer dominate. Woolly rhinoceros *Coelodonta antiquitatis* and chamois *Rupicapra rupicapra* are present; red deer *Cervus elaphus* is represented here by post-cranial bones and appears to have been part of the living fauna at the time of deposition. Elk *Alces alces* is the only really temperate species found in the macrofauna from Gönnersdorf; this species has been recorded in interglacial and interstadial faunas during the Pleistocene. Poplin (in Brunnacker (ed.), 1978), has interpreted this macrofauna as belonging to a summer settlement phase at the Gönnersdorf site.

The first record of the saiga antilope *Saiga tatarica* in the Neuwied Basin region is in the Gönnersdorf fauna. Its presence at Gönnersdorf, is one of only three occurrences known to date in Pleistocene faunas from western Germany (Kahlke, 1975c). The red fox *Vulpes vulpes* is also present in the Gönnersdorf fauna; the only other occurrence of this species in the Neuwied Basin assemblages is in the Hu 4 fauna.

The woolly mammoth *Mammuthus primigenius* is also present in the Gönnersdorf fauna. It has previously been thought that this species became extinct early in North- West Europe, and only survived later in Siberia and North America. Extremely realistic sketches of mammoths on slate slabs (Bosinski, 1971,

1980) and a few remains of this species were recovered from the Gönnersdorf assemblage. Recent discoveries in England, France and Switzerland (Coope & Lister, 1987) show that this species survived during the period of climatic amelioration called here the Bölling Interstadial. Collagen from mammoth bone found at Condover in England has been dated to about 12,700 and 12,920 BP (*ibid.*). The Gönnersdorf assemblage has been dated to about 12,520 +/- 300 BP. Several other species of larger mammals were also portrayed in this way, including the woolly rhinoceros *Coelodonta antiquitatis* and extinct lion *Panthera (Leo) spelaea*. Upper cheek teeth of the woolly rhinoceros were also recovered from this assemblage.

Alleröd Interstadial

Macrofaunal remains from four assemblages, An 2, Niederbieber, Urbar and Miesenheim II, all dating to the Alleröd Interstadial, have been described in this study. The pollen assemblage from the site of Thür, which has produced no macrofaunal remains to date, has been used here as an example of a typical Alleröd flora. As with the assemblages at Gönnersdorf and Andernach (An 1), the chronostratigraphy of the An 2, Niederbieber, Urbar and Miesenheim II assemblages is reliable. These assemblages are all located in weakly-developed soil horizons, formed during the first half of the Alleröd Interstadial, and stratified directly beneath the Laacher pumice.

Absolute dates (Radiocarbon) for the Laacher eruption give a terminus ante quem of 10,950 - 11,050 BP for all of these assemblages. Radiocarbon dates from the individual assemblages allow a tentative finer chronostratigraphy within the Alleröd phase. The oldest assemblage is An 2 dated to about 12 010 +/- 110 BP (pooled value). According to the classical series of dates given for the Alleröd (see page 189), the An 2 assemblage should be placed at the very beginning of this interstadial. The assemblage from Urbar, dated to about 11 350 +/- 120 BP (single date), is younger. The assemblage from Miesenheim II is, with a date of 11 265 +/- 124 BP (pooled value), the youngest of the Alleröd assemblages in the Neuwied Basin.

The following faunas have been identified:

Andernach (An 2)
Cervus elaphus - red deer (6)
Alces alces - elk (1)
Bos sp. or *Bison* sp. - unidentifiable large bovid (?)
Rupicapra rupicapra - chamois (2)

Niederbieber
Meles meles - badger (1)
Equus sp. - horse (1)
Cervus elaphus - red deer (4)
Alces alces - elk (2)
Bos sp. or *Bison* sp. - unidentifiable large bovid (1)
Capra ibex - ibex (1)

Urbar
Cervus elaphus - red deer (7)
?*Bos primigenius* - aurochs - (1)

Miesenheim II
Equus sp. - horse (1)
Cervus elaphus - red deer (1)
Bos sp. or *Bison* sp. - unidentifiable large bovid (1)

The vegetation during the Alleröd Interstadial consisted of open forest or woodland dominated by pine (*Pinus*) and some birch (*Betula*) trees. *Artemisia* and *Rumex* are present amongst the non-tree pollen, and indicate a locally open herbaceous vegetation (Urban in Brunnacker et al., 1982). A sparse microfauna from Miesenheim II consists of species indicating an open herbaceous environment and those indicating a damp, woodland environment (Street, 1986). This mixing of species indicating different environments may reflect the damp conditions at the site itself and a more open environment in the vicinity.

The macrofauna from the Alleröd assemblages in the Neuwied basin are all similar to one another in their faunal composition. A typical Alleröd macrofauna from this region consists of red deer, elk and a large bovid, possibly aurochs. Horse, chamois, ibex and badger are present. One large rodent, beaver *Castor fiber*, also appears in these faunas.

Red deer consistently dominates in the Alleröd assemblages in the Neuwied Basin region, and suggests that this species was also well-represented in the fauna living during the Alleröd phase, rather than this being the result of selective hunting by man. The red deer living during the Alleröd were larger in body-size than the living animals. Large dental size was characteristic of this species during the Alleröd Interstadial.

At least one concentration at Niederbieber may represent a winter settlement. A red deer antler frontlet was recovered from this site and shows that this individual died during the autumn and winter months of September to March.

The only record of the ibex *Capra ibex* in the Neuwied Basin occurs during this phase. Its presence at the Niederbieber locality is the first occurrence of this species in a Pleistocene fauna in the Middle Rhineland (Winter, 1986).

The metapodial fragment from the Urbar assemblage has been identified as being comparable to those of the aurochs *Bos primigenius*. If this identification is correct, then this would be the first occurrence of this species in an interstadial in the Neuwied Basin region.

A detailed picture of faunal change at the end of the Last Cold Stage BP in the Neuwied Basin region is hampered by the lack of information from assemblages dating to the Bölling Interstadial. The locality of Andernach, with its two superimposed assemblages, dating to the Bölling Interstadial(?) and to the Alleröd Interstadial respectively, will certainly provide details of macrofaunal change during this period when the identification of the macrofaunal material is complete (Street, in prep.). In the meantime, Fig. 45 compares the Late Weichselian macrofaunas recorded so far from the Neuwied Basin region.

The Gönnersdorf fauna is used as an example of a macrofauna from the end of the Bölling Interstadial. The macrofaunas from An 2, Niederbieber, Urbar and Miesenheim II are given as examples of those occurring during the Alleröd. Absolute (Radiocarbon) dates for all these assemblages are also given.

The pollen assemblage from Gönnersdorf indicates an open environment with pine trees, the climate was cold; pollen recorded during the temperate Alleröd Interstadial indicates a more open pine and birch woodland with some herbaceous areas.

i) The fauna from Gönnersdorf is richer in species than those dating to the Alleröd Interstadial.

ii) Species such as reindeer *Rangifer tarandus* and arctic fox *Alopex lagopus*, which have a northern or arctic distribution today, dominate in the fauna from the Gönnersdorf winter settlement (the number of individuals of arctic fox are probably biased by selective hunting by man) are present, but no longer dominant in the Gönnersdorf summer settlement and absent in the Alleröd faunas.

iii) Woolly mammoth *Mammuthus primigenius* and woolly rhinoceros *Coelodonta antiquitatis* are present in the macrofauna at Gönnersdorf, but absent in the Alleröd faunas.

iv) Horse *Equus* sp. is present at Gönnersdorf and is represented by a minimum of thirteen individuals in the winter settlement. It is still present, but represented only by a minimum of one individual in the Alleröd faunas at Niederbieber and Miesenheim II. Horse is indicative of an open environment with herbaceous vegetation. The reduction in numbers of this species between the two phases reflecting the change from a predominantly open herbaceous environment prevailing at Gönnersdorf, to the open

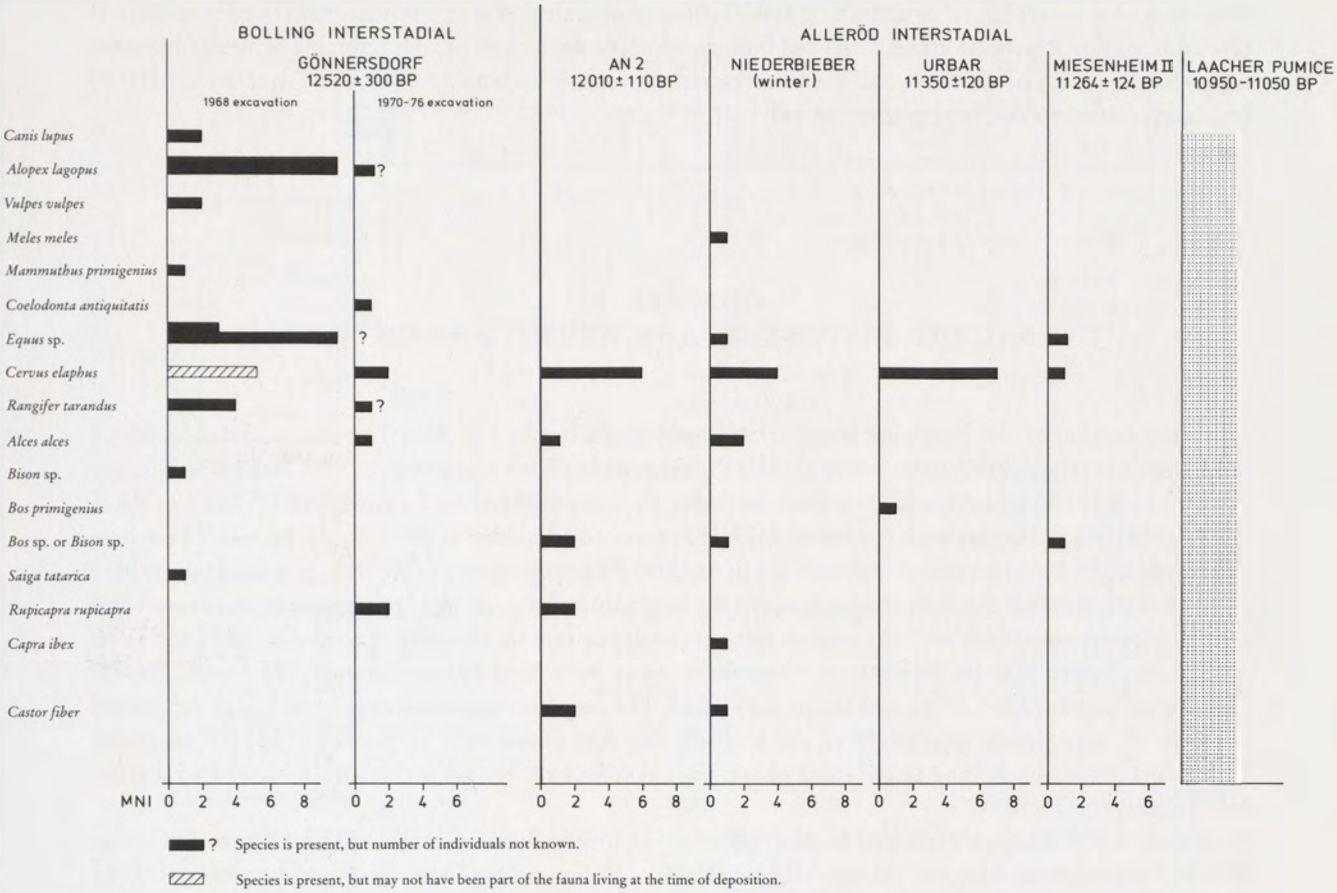


Fig. 45 The macrofaunas from Gönnersdorf and from assemblages dating to the Alleröd Interstadial. (Dates given are pooled values).

woodland of the Alleröd Interstadial, where open areas for grazing, essential for the survival of this species, were probably reduced to clearings.

v) Red deer *Cervus elaphus* is present in all of the late Weichselian assemblages in the Neuwied Basin. It is only represented by canine teeth, intended to be worn as a pendant, in the Gönnersdorf winter settlement phase and therefore may not have been part of the living fauna at this time. It is, however, represented by post-cranial bones from a minimum of two individuals in the summer settlement phase at this site. This species dominates, with up to seven individuals at Urbar, in the Alleröd macrofaunas.

vi) Montane elements such as chamois *Rupicapra rupicapra* are present in the fauna from the Gönnersdorf summer settlement phase and in the Alleröd fauna from An 2. The ibex *Capra ibex* also occurs in the fauna from Niederbieber.
Both species are intolerant of deep snow and undertake seasonal migrations to avoid this, moving down to lower altitudes in winter. The ibex is present at Niederbieber in an assemblage possibly deposited during the months September to March (presence of red deer antler frontlet). This may indicate that the ibex moved into the sheltered Neuwied Basin during the colder months of the year.
The chamois is present in the summer settlement phase at Gönnersdorf and this species may have inhabited the rocky slate outcrops on the slopes of the basin itself.

vii) Elk *Alces alces* is only present in the summer settlement phase at Gönnersdorf. This species occurs in the Alleröd faunas at Andernach and Niederbieber and is one of the typical elements of these faunas.

The changes in macrofaunal composition reflect those of climate and environment from the dominance of typical steppe or steppe-tundra elements at Gönnersdorf, to the lack of or reduction in numbers of species dependant upon the open steppe and the corresponding increase in elements such as red deer in the Alleröd Interstadial where woodland predominated.

CHAPTER 10

THE FAUNAL HISTORY OF THE NEUWIED BASIN REGION

A revised version of the Neuwied Basin stratigraphy is shown in Fig. 43b. The chronostratigraphy of those deposits referred to here as lower Middle Pleistocene has been discussed above (Chapter 9). The age of the units Kä H and possibly Kä Ja are still not clear. Two possibilities can be considered. The units Kä H and possibly Kä Ja may, as with the lower Middle Pleistocene deposits at this locality, be older than previously thought. If this is correct, a date of about 683,000 BP for the tephra (»Wehrer« pumice I) at the base of Kä H, indicates that this unit almost dates to the beginning of the Middle Pleistocene in this region and this is no longer consistent with the stratigraphy of the deposits at this locality. If the units Kä H and Ja do date to the upper Middle Pleistocene, then there must be a long hiatus between the lower Middle Pleistocene sequence at Kärlich and the base of Kä H. The recently-exposed lower loess bed at Ariendorf (Chapter 4) may be the equivalent of the missing deposits at Kärlich. Loess beds exposed earlier at Leutesdorf could also belong to the same phase, but the fossils recovered at this locality are of no further use in dating the deposits.

If the units Kä H and Ja are ignored for the moment, the units Kä Bb - Gb can still be described as lower Middle Pleistocene and are still the equivalent of the Cromer complex/Elsterian. Macrofaunas equivalent to the Elsterian only and the Holsteinian do not exist in this region. The next group of macrofaunas are those deposited during the Third and Second Cold stages BP, the equivalent of the Saalian. Macrofaunas dating to the Late Pleistocene are still present.

The occurrence of the large mammals described in Part III, and their stratigraphic ranges through the Middle and Late Pleistocene deposits in the Neuwied Basin to the present day are plotted in Fig. 46.

The species *Elephas antiquus* and *Sus scrofa* have been plotted separately as they are only present in those assemblages (Kä 1 and the units Kä H and Ja) where the age of the deposits is not clear.

Lower Middle Pleistocene (Cromerian/Elsterian)

The extinct mammoths *Mammuthus meridionalis-trogontherii* and *Mammuthus* cf. *trogontherii*, horse, possibly *Equus süssenbornensis* and *Equus* cf. *marxi*, and the extinct musk ox *Praeovibos priscus* only occur in the units Kä Bb - Ga, which are the equivalent of the Cromer complex. Some species such as the caballine horses *Equus* sp., and red deer *Cervus elaphus*, which have long stratigraphic ranges in the Neuwied Basin region, are recorded here for the first time.

The macrofaunas from Miesenheim I and Kä Gb are similar in age and probably date to the end of the Cromer complex and the Elsterian (van Kolfschoten, 1988). Species such as extinct wolf *Canis lupus mosbachensis*, extinct rhinoceros *Dicerorhinus etruscus* cf. *brachycephalus* and extinct bear *Ursus* cf. *deningeri*, characteristic of pre-Holsteinian macrofaunas, occur in the assemblages at Miesenheim I.

Roe deer *Capreolus capreolus*, elk *Alces* sp. and fallow deer *Dama dama* are also recorded for the first time in the Neuwied Basin region in these faunas.

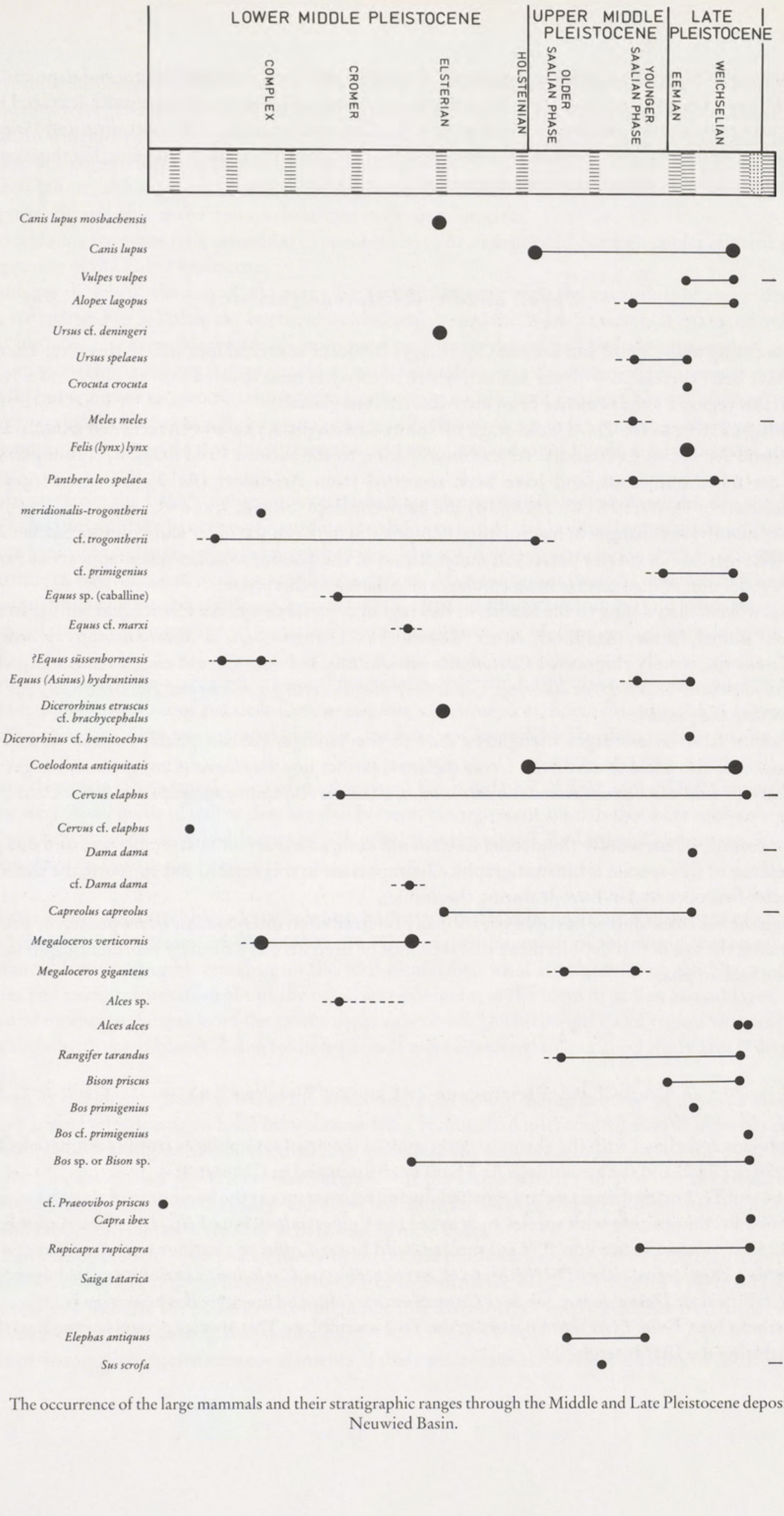


Fig. 46 The occurrence of the large mammals and their stratigraphic ranges through the Middle and Late Pleistocene deposits in the Neuwied Basin.

The only really biostratigraphically important species in the lower Middle Pleistocene deposits of the Neuwied Basin is the extinct giant deer *Megaloceros verticornis*. This species occurs in Kä E - Gb. The first known occurrence of *Megaloceros verticornis* is in the Cromerian faunas of West Runton and Voigtstedt, and it probably became extinct during the Elsterian. Its occurrence in Kärlich suggests that there could be a correlation between these Cromerian faunas and the units Kä E - Gb.

Upper Middle Pleistocene (Saalian)

Deposits dating to the Third and Second Cold Stages BP occur at several localities in this area. These cold stages have been correlated with the Saalian, which in turn has been divided into an older and a younger phase in this region by the presence of an inter-Saalian interglacial.

Assemblages dating to the Third Cold Stage BP (older Saalian phase) have been recorded from Ariendorf (Ar Ch. and Ar 1) and Leutesdorf. Assemblages dating to the Second Cold Stage BP (younger Saalian phase) are more numerous, and have been recorded from Ariendorf (Ar 2), Tönchesberg (Tö 1), Hummerich (Hu 1), Wannen (Wa 1, 2 and 3) and Schweinskopf (Sk 1, 2, 3, and 4).

There are no obvious changes in macrofaunal compositon between the older and younger Saalian assemblages. The increase in species present in macrofaunas of the younger Saalian phase appears so far to be simply a reflection of the increase in assemblages also dating to this phase.

A typical macrofauna dating to the Saalian in this region consists of wolves *Canis lupus* similar in size to the recent animal, extinct mammoth, either *Mammuthus* cf. *trogontherii* or *Mammuthus* cf. *primigenius*, horse *Equus* sp., woolly rhinoceros *Coelodonta antiquitatis*, red deer *Cervus elaphus* and a large bovid, either *Bison priscus* or *Bos* sp. or *Bison* sp. Giant deer *Megaloceros giganteus* and reindeer *Rangifer tarandus* complete the picture.

Macrofaunas from assemblages thought to date to the younger Saalian phase, such as Wannen and Schweinskopf, also include cave bear *Ursus spelaeus*, extinct lion *Panthera (Leo) spelaea*, badger *Meles meles*, extinct wild ass *Equus* (Asinus) *hydruntinus*, chamois *Rupicapra rupicapra* and arctic fox *Alopex lagopus*.

The first records of the woolly rhinoceros *Coelodonta antiquitatis* are all in assemblages from this phase. The presence of this species is biostratigraphically important in this region, and supports the theory that this species first occurred in Europe during the Saalian.

Although the Kä 1 assemblage has been occasionally referred to an inter-Saalian warm phase, the problems surrounding the age of this deposit mean that it cannot be used here as definitely representing an interglacial in the Saalian phase.

Late Pleistocene (=Eemian/Weichselian)

The problems associated with the chronostratigraphy of the main assemblages from Hummerich (Hu 4), Tönchesberg (Tö 2) and the assemblage Ar 3 have been discussed in Chapter 9.

The Hu 4 and Tö 2 macrofaunas were deposited during warm stages at the beginning of this phase, and are very similar in composition with species such as red fox *Vulpes vulpes*, lynx *Felis (Lynx) lynx*, spotted hyaena *Crocuta crocuta*, extinct lion *P. (Leo) spelaea*, wild horse *Equus* sp., extinct wild ass *Equus (Asinus) hydruntinus*, rhinoceros, either *Dicerorhinus* cf. *hemitoechus* or *Coelodonta antiquitatis*, red deer *Cervus elaphus*, fallow deer *Dama dama*, roe deer *Capreolus capreolus* and aurochs *Bos primigenius*.

The northern lynx *Felis (Lynx) lynx* occurs in the Tö 2 assemblage.This species occurs for the first time in Europe during the Last Interglacial.

Interesting is the presence of the extinct wild ass *Equus (Asinus) hydruntinus* in macrofaunas from the volcano localities. At Hummerich and Tönchesberg, this species occurs in a warm stage faunal assemblage, in association with an open environment. At Schweinskopf and Wannen it occurs in cold stage faunas in association with an open steppe or steppe-tundra environment. The extinct wild ass is usually associated with temperate faunas, although it is known to have occurred in reindeer-dominated faunas in southern France. This species occurs only at the volcano localities in this region so far.

The macrofauna from the Ar 3 assemblage appears to have been deposited during a cooler climatic stage at the beginning of the Late Pleistocene.

Assemblages dating to the Last Cold Stage BP (=Weichselian), with the exception of those described above, are sparse. Hu 5, Polch, the horizons at Metternich, and the Wa 4/5 assemblages are the only ones known to date. The assemblages are all from cold stage loess deposits. The following species occur in these faunas, arctic fox *Alopex lagopus*, extinct lion *P. leo spelaea*, woolly mammoth *Mammuthus primigenius*, wild horse *Equus* sp., woolly rhinoceros *Coelodonta antiquitatis*, red deer *Cervus elaphus*, reindeer *Rangifer tarandus* and chamois *Rupicapra rupicapra*. The macrofauna indicates an open steppe or steppe-tundra environment, and do not differ from the cold stage macrofaunas found during the Saalian in this region.

Macrofaunas from the Late Weichselian interstadials are also recorded in the Neuwied Basin region. The Gönnersdorf assemblage has been pollen-dated to the very end of the Bölling Interstadial and consists of elements typical of older assemblages deposited in cold stage loesses in association with an open steppe or steppe-tundra environment, such as woolly mammoth *M. primigenius*, woolly rhinoceros *Coelodonta antiquitatis*, horse *Equus* sp., red deer *Cervus elaphus*, reindeer *Rangifer tarandus* and bison *Bison priscus*. The macrofauna from Gönnersdorf is marked by the last appearance of some species in the Neuwied Basin region.

In contrast to this rich macrofauna, a typical macrofauna present during the temperate younger Alleröd Interstadial phase consists of red deer *Cervus elaphus*, elk *Alces alces*, horse *Equus* sp., and a large bovid *Bos* sp. or *Bison* sp. One microfaunal element, the beaver *Castor fiber*, is often present in the Alleröd assemblages.

Roe deer dominates the natural fauna of the Neuwied Basin today. Red deer and wild pig are only occasionally seen. Small herds of fallow deer are also present, but represent animals that have probably escaped from one of the numerous Wild-life parks (Wildgehege) in the region. Red fox and badger are also part of the natural fauna, but are rarely seen.

This thesis attempts to establish a local biostratigraphy for the Middle and Late Pleistocene macrofaunas of the Neuwied Basin region of West Germany. The original intention of this study was to produce a macrofaunal biostratigraphy based upon the well-established local stratigraphy of the Neuwied Basin localities and using information about the palaeoenvironment, in the form of pollen assemblages, microfaunas and molluscan faunas from the assemblages described. The Neuwied Basin region with its numerous localities with assemblages dating to these periods was considered to be a good study area (Chapters 1, 2 and 3).

However, as has already been stated in the introduction, absolute dating at some of the Neuwied Basin localities and new biostratigraphical information from mammalian microfaunal assemblages has resulted in the established stratigraphy being called into question. The assemblages at some of the more recently discovered localities also posed chronostratigraphical problems which had still not been successfully interpreted before the end of this study. The expected results from sampling for pollen, mammalian microfauna and molluscan faunas were very provisional in most cases.

Thus, more emphasis had to be placed firstly upon the use of the various species of macrofauna present in the Neuwied Basin assemblages to attempt to date or to control the suggested date for a particular deposit, and secondly to indicate the palaeoenvironment of those assemblages where evidence from other sources was not available, than was originally intended.

The use of mammalian macrofaunas or elements of these macrofaunas for relative dating or controlling the suggested date of the deposits was found to be rather limited. This was not only due to the macrofaunas themselves, but also to the geographical area approach used here.

For example, sampling begins automatically when a particular geographical area is chosen. The state of preservation of the fossils available in the area chosen has to be accepted. The state of preservation of some of the Neuwied Basin macrofaunal remains was often so poor that some specimens, of potential biostratigraphical importance, could only be identified to genus, when the species was important or to species when the subspecies was important. Sampling from the assemblages meant that some biostratigraphically important fossils may simply not have been seen so far.

Some of the species identified occurred only once in the Neuwied Basin assemblages or were only present for a short period of time. As the known stratigraphic ranges of many species of macrofauna are very long, it was often only possible to state that the presence of a certain species in the Neuwied Basin assemblages falls within its known stratigraphic range in North-West Europe. Occasionally, a combination of species could be used as, for example, at Miesenheim I to indicate that these fossiliferous horizons were older than had been previously stated.

Attempts to use the evolutionary stages of certain species to date the deposits was also limited. Evolution can only be used where the sample-size is adequate and where the history of the species concerned is well-known (Lister, 1986). Only three species occurring in the Neuwied Basin assemblages produced large amounts of material. Of these, the evolution of the extinct mammoths *Mammuthus* spp., (Chapter 6) underwent a gradual evolution during the Middle and Late Pleistocene which can only be broadly stratigraphically correlated. Red deer *Cervus elaphus* shows changes in body-size which are not biostratigraphically important. The antlers of this species were unfortunately not preserved well to be of biostratigraphical use (Chapter 7). The study of the remains of horse *Equus* spp.(Chapter 7) had to be based upon changes in body-size which is not a particularly good biostratigraphical indicator.

The use of macrofaunas alone for interpreting the palaeoenvironment of a deposit was also limited. The discussion about the character of the Hu 4, Tö 2 and Ar 3 faunas illustrates this point (Chapter 9). Usually it was attempted to find evidence for the palaeoenvironmental from other sources. In the absence of pollen assemblages at some localities, the mammalian microfaunas, molluscan faunas and sedimentologic context were also referred to.

Despite these problems a local biostratigraphy of the macrofaunas from the Neuwied Basin region has been established, using a combination of stratigraphy, palaeoenvironmental evidence from several sources and the macrofaunal remains themselves.

The results of this study can only be described as provisional. The continuing excavations at the localities already known in this area, the likelihood that new localities will be discovered in the near future and more intensive multi-disciplinary research will obviously increase our knowledge of the macrofaunas discussed here considerably. It is hoped that the problems surrounding the dating of some of the deposits and assemblages in this region will be solved at the same time.

APPENDIX I
DESCRIPTION AND SIZE OF RED DEER *CERVUS ELAPHUS* ANTLER

Hummerich
Assemblage 4

Shed antler dex. (Hu 63/77,2)
Shed antler beam with bases of brow and bez tines present. Beam broken behind bez tine. Damaged on lateral side of burr.
The surface of the rose is flat; the brow tine rises behind the burr and the bez tine rises behind and lateral to the brow tine. The beam fragment is circular in cross-section and has a weakly-defined anterior edge running lateral from the base of the bez tine.

Shed antler dex. (Hu 58/72,1)
Shed base with base of brow tine only. The beam is broken behind the brow tine.
The surface of the rose is convex, the pearling of the burr is damaged. The brow tine rises directly behind the burr, and is placed at 90°to the beam. The beam has a sharply defined anterior edge running from the base of the brow tine.

Shed antler dex. (Hu 35/84,4)
Shed base with base of brow and bez tines only. The find is very weathered. The surface of the rose is slightly convex.

Shed antler sin. (Hu 69/79,2)
Shed beam with bases of brow and bez tines present; the beam is broken in the region of the trez tine. The pearling of the burr is eroded; the surface of the rose is slightly concave. The brow tine rises close to the burr, the bez tine rises behind and lateral to the brow tine. The beam is circular in cross-section and has an anterior edge running from the base of the bez tine.

Shed antler sin. (Hu 59/71,6)
Shed beam with bases of both brow and bez tines present. The beam is broken at the base of the trez tine. The surface of the rose is slightly convex; the burr is totally eroded. The brow tine rises at a distance behind the burr, the bez tine rises behind and lateral to the brow tine. The beam does have a circular cross-section, but does not possess an anterior edge.

Shed antler dex. (Hu 4/32,4)
Shed beam with bases of both brow and bez tines. The beam is broken after bez tine, no trez tine remains. The surface of the rose is concave in the centre. The pearling of the burr is well-developed where preserved. The brow tine rises well behind the burr, the bez tine rises well behind and in the same axis as the brow tine. The beam has a circular cross-section and does not possess an anterior edge.

Shed antler dex. (Hu 2/34,5)
Shed base with fragment of brow tine and complete bez tine. Beam broken in region of trez tine. The surface of the rose is flat, with well-developed pearling of the burr. The brow tine rises close behind the burr, the bez tine rises close behind and lateral to the brow tine. The beam between the bez and the base of the trez tine is curved anteriorly. The bez tine is long and curved and has a circular cross-section.

Shed antler sin. (Hu 40/84,7)
Shed base and fragment of base of brow tine only. The base is very weathered; the rose has a flat surface. The pearling of the burr is well-developed, but eroded. The brow tine rises close behind the burr.

Shed antler dex. (Hu Str. 3001)
Shed base with bases of both brow and bez tines. The surface of the rose is slightly convex. The brow tine rises close behind the burr; the bez tine rises close behind and lateral to the brow tine.

Shed antler dex. (Hu 5/31,1)
Shed base with bases of both brow and bez tines present. The surface of the rose is convex. The pearling of the burr is, where preserved, well-developed. The brow tine rises at a distance behind the burr; the bez tine rises behind and lateral to the brow tine. The beam is circular in cross-section has a weakly-developed anterior edge running from the base of the bez tine.

Antler frontlet sin. and dex. (Hu 72/80, 1021;1011)
Only the pedicles were preserved. Not measurable.

Antler frontlet dex. (Hu 56/83,11)
Pedicle only. Not measurable.

Ariendorf
Assemblage 1
Shed antler sin. (Ar 85/-11,3)

Shed beam with brow tine fragment. The pearling of the burr, brow tine and beam are all very weakly-developed. The brow tine rises directly behind the burr; the beam is very straight.

Shed antler sin. (Ar Str. 40)
Shed beam with bases of both brow and bez tines. The burr is partly eroded. The surface of the rose is slightly convex; the pearling of the burr, where preserved, is weakly developed. The brow tine rises at a distance of 36mm. behind the burr and the bez tine rises directly behind and lateral to the brow tine. The beam is circular in cross-section, slender and straight.

Shed antler sin. (Ar Str. 5)
Shed base with base of brow tine. The beam is distorted. The surface of the rose is slightly convex. The pearling of the burr is fairly well-developed.

Ariendorf
Assemblage 2

Shed antler sin. (Ar 2 80/09,21)
Shed beam with bases of both brow and bez tines. The burr is eroded; the base of the brow tine is damaged. The surface of the rose is concave. The pearling of the burr is weakly-developed. The bez tine rises behind and lateral to the brow tine. The beam has a pronounced anterior edge.

Shed antler s/d. (Ar 79/10,4)
Shed base only. The surface of the rose is slightly convex. The pearling of the burr, where preserved, is well-developed.

Shed antler sin. (Ar 80/10,23)
Shed base only. The pearling of the burr is eroded. The surface of the rose is concave.

Shed antler sin. (Ar 79/09,72)
Shed base with base of brow tine and part of bez tine base only.

Shed antler sin. (Ar 81/08,3)
Shed beam with fragments of brow and bez tines. The surface of the rose is flat; the pearling of the burr is well-developed. The brow tine rises slightly behind the burr, the bez tine rises behind and lateral to the brow tine. The beam has a pronounced anterior edge running from the base of the bez tine and gradually flattening out along the length of the beam.

Shed antler dex. (Ar 82/10,5) (Plate 27A, b)
A difficult piece to identify an account of its similarities to giant deer (*Megaloceros*) antler.
Shed base with fragments of brow and bez tines and part of beam, broken in region of trez tine (?). The surface of the rose is very convex and protrudes beyond the burr itself. The depression in the middle of the rose surface may be due to the development of a loess concretion which has been subsequently removed. The pearling of the burr is not particularly well-developed. The brow tine rises behind the burr and the bez tine rises directly behind and lateral to the brow. Both tines are very robust, the brow tine has a posterior ridge at its base. The bez tine has a small boss at its base on the posterior side. Another similar boss is placed at the base of the bez tine on the medial side. The beam is very robust, and slightly curved. At the point where the beam is broken, it begins to flatten as if a trez tine had originally been present. The pearling of the beam is visible, but it is less pronounced as on all the other *Cervus elaphus* antler. The beam has a very pronounced anterior edge running from bez to trez tine. The form of the rose is similar to that of *Megaloceros* but the rest of the antler shows characteristics found on all the *Cervus elaphus* antler. The size of the rose is also comparable to the very large find with crown development (Ar 80/80,24).

Shed antler sin. (Ar 80/08,24) (Plate 27A, b)
An almost complete shed beam with brow tine, base of bez tine and trez tine and a crown. The surface of the rose is convex; the pearling of the burr well-developed. The brow tine rises directly behind the burr and the bez tine directly behind and lateral to this. The brow tine is very robust, particularly at the base, otherwise it has the typical circular cross-section found on all the other specimens and the recent material. The bez tine also appears to rise from the burr, as is usual for very robust antler. The beam is circular in section and has a weakly-defined anterior ridge rising from the base of the brow tine. The upper part of the beam is flattened laterally towards the crown, which is placed antero-posterior to the axis of the beam. The crown is not complete, but has the remains of at least three tines on the anterior side and two on the posterior side. All of the tines are robust.

Antler frontlets
Antler sin and dex. (Ar 85/07,3 and 84/10,1)
Both finds have a pedicle with a small fragment of skull attached. The pearling of the burr is present but very eroded. A fragment of the beam is also preserved with the bases of both brow and bez tines present. Both finds are very eroded and measurements were taken only on the left piece. The pedicle is very short and robust, which indicates a mature animal. The pearling of the burr is, where preserved, rather weakly developed. The brow tine rises at a distance of about 25mm. behind the burr. The bez tine rises directly behind the brow and slightly lateral to this.

Ariendorf
Assemblage 3

Shed antler dex. (Ar Str. 4)
Shed antler beam with bases of both brow and bez tines. The surface of the rose is convex. The pearling of the burr, where preserved, is well-developed. The brow tine rises about 25mm. behind the burr; the bez tine rises directly behind and lateral to the brow. The beam has a pronounced ridge running from the medial side of the bez tine.

Shed antler dex. (Ar Str. 5)
Shed beam with fragments of brow and bez tines. The burr is eroded and the beam has been flattened post-depositionally. The surface of the rose is slightly concave. The brow tine rises behind the burr, the bez tine rises behind and lateral to the brow.

Shed antler (Ar 72.32)
Shed beam with part of rose, base of brow tine(?). The find has been crushed post-depositionally. Not measurable.

Antler frontlets
Only fragmentary pieces were found, indicating one individual.

Kärlich
Assemblage 1

Shed antler dex. (Kä 23,7)
Shed beam with fragments of both brow and bez tines. The find, particularly the beam, has been crushed post-depositionally. The surface of the rose is flat. The pearling of the burr is well-developed. The brow tine rises directly behind the burr and the bez tine rises at a distance behind and lateral to the brow tine. The beam is straight, as are the tines.

Schweinskopf
Assemblage 4

Shed antler dex. (Sk 31/25,806)
Shed base with fragment of brow tine only. The surface of the rose is slightly convex. The pearling is well-developed.

Shed antler dex. (Sk 8/84,11)
Fragment of a shed beam with base of brow and fragment of bez tine. The find is very damaged. The rose is flat, the pearling of the burr is well-developed. The find was not measurable.

Antler frontlet (Sk 9/54,6)
Fragment of pedicle only, not measurable.

Wannen
Assemblage 4

Shed antler dex. (Wa 98/50,28)
Shed antler beam with base of brow tine, complete bez tine and base of trez tine. The burr is eroded. The surface of the rose is slightly convex. The brow tine rises directly behind the burr and the bez tine rises behind and lateral to the brow. The bez tine has a circular cross-section and is curved. The beam between bez and trez tine is curved posteriorly. The beam also possesses an anterior edge, running from a small boss behind the base of the bez tine.

Shed antler sin. (Wa 96/50,23b)
Shed beam with fragment of brow and base of bez tine. the surface of the rose is convex. The brow tine rises directly behind the burr and the bez tine directly behind and lateral to the brow. The beam has a weakly-developed anterior edge rising from a small antler boss behind the bez. tine. The beam is rather straight.

Wannen
Assemblage 5

Shed antler dex. (Wa 97/56,9)
The shed base is damaged in the region of the rose. The brow tine rises directly behind the burr and is, in comparison to the beam, very long, thin and curved. A small point is placed about half-way along the remains of the beam, suggesting a second tine development. The beam is circular in cross-section, has a weakly-developed anterior edge running from the base of the brow tine and is rather slender. The surface of the rose is slightly convex.

Shed antler sin. (Wa 95/54,14)
Shed antler beam with bases of brow and bez tines. The find is poorly preserved. The beam is rather weakly-built and is curved.

Shed antler dex. (Wa 96/50,34)
Shed antler beam with complete brow and bez tines and part of beam. The rose is damaged; its surface is flat. The pearling of the burr is missing (damaged). The brow tine rises behind the burr; the bez tine rises behind and lateral to the brow tine. A weakly-developed anterior edge is present on the beam. Both brow and bez tines are very twisted (corkscrewing). As with all robust antler, the bez tine base can also be »traced« to the burr by a ridge-like swelling, resulting in a slight indentation in the edge of the rose, which becomes kidney-shaped.

Wannen

Assemblage 6

Shed antler dex. (Wa 96/57,20)
Shed beam with bases of both brow and bez tines. The pearling of the burr is weathered. The surface of the rose is slightly convex. The brow tine rises about 20 mm. behind the burr, and the bez tine rises directly behind and lateral to this. The rather weakly-developed beam has been crushed.

Shed antler sin. (Wa 99/51,16)
Shed antler beam with bases of brow and bez tines.
The surface of the rose is convex. Where preserved, the pearling of the burr is well-developed. The brow tine rises directly behind the burr and the bez tine behind and lateral to the brow tine.

Shed antler sin. (Wa 96/50,36)
Shed antler beam with almost complete brow, bez and trez tines.
The surface of the rose is slightly convex. The pearling of the burr is very well-developed. The brow tine rises directly behind the burr, and the bez tine rises directly behind and lateral to this. The beam is rather straight and possesses a prominent anterior edge rising from a boss at the base of the bez tine on the medial side and continuing along a greater part of the beam. The tines all have a circular cross-section. The brow tine also has a pronounced posterior ridge towards its base.

Antler frontlets sin. and dex. (Wa 95/50,34)
The pedicles are slender, indicating a young individual. The pearling of the burr is not particularly well-developed. The base of the brow tine appears to rise directly behind the burr. The bez tine is almost completely preserved on the left side and is very thin. The tine is placed directly behind and in the same axis as the brow tine. The beam has been crushed.

Antler frontlet sin.(Wa 97/56,16)
The pedicle is short and stout, indicating an older individual. The fragment of the beam has the bases of both brow and bez tines present.

Frontlets sin. and dex. (Wa 99/50,36)
Only the two pedicles are preserved. The pedicles are both robust and short. The antler had just been shed shortly before the death of the animal.

Tönchesberg

Shed antler dex. (Tö 15/79,12)
Shed beam with base of brow tine. The surface of the rose has a prominent central swelling. The pearling of the burr, where preserved, is weakly developed. The brow tine rises about 5mm. behind the burr.

Shed antler sin. (Tö 12/72,23)
Shed base with remains of brow and bez tines. Beam broken in region of trez(?) tine. The surface of the rose is slightly convex. The pearling of the burr, where present, is weakly-developed. The brow tine rises behind the burr, the beam is very straight and does not possess an anterior ridge.

Shed antler sin. (Tö 15/78,27)
Shed beam with brow and bez tine bases. The surface of the rose is slightly convex, the pearling of the burr is well-developed.The brow tine rises behind the burr; the bez tine is placed directly behind and lateral to the brow tine. At the base of the bez tine and medial to this, is a small, pointed boss, from which the weakly defined anterior ridge rises.

Shed antler sin. (Tö 15/83,33)
Shed base with base of brow tine (damaged) and bez tine. The find is poorly preserved. The surface of the rose is slightly concave.
The bez tine rises close to the brow tine. The beam is slender and slightly curved posteriorly.

Shed antler dex. (Tö 16/78,2)
Shed base with an almost complete brow tine. No evidence of a bez tine. The rose is slightly convex. The pearling of the burr is weakly developed. The brow tine rises directly behind the burr. The tine is slender. The beam is straight and slender.

Shed antler dex. (Tö 17/86,4)
Shed beam with almost complete brow tine. No evidence of bez tine. The surface of the rose is flat; the burr is weakly pearled. The brow tine rises behind the burr. The tine is slender and only slightly curved. The beam is circular in cross-section, straight and possesses a pronounced anterior edge running from the lateral side of the brow tine. A small boss has developed on the anterior edge.

Shed antler dex. (Tö 14/78,15)
Shed beam with bases of brow and bez tines. The surface of the rose has a prominent boss in the centre. The burr is weakly developed. The brow tine rises directly behind the burr; the bez tine rises directly behind and lateral to the brow tine. The beam has a prominent anterior edge running from the medial side of the base of the bez tine.

Shed antler sin. (Tö 11/72,23)
Shed beam with complete brow tine and fragment of bez tine. The surface of the well-preserved rose is

slightly convex with a small boss in the centre. The pearling of the burr is fairly well-developed. The brow tine rises behind the burr; the tine is very long, thin and curved. The bez tine rises at a distance behind and lateral to the brow tine. The beam is very slender and straight and possesses a weakly-defined anterior edge.

Shed antler sin. (Tö 14/74,1)
Shed beam with complete brow and bez tines, base of trez tine and terminal points.
The surface of the rose is slightly convex; the pearling of the burr is weakly-developed. The brow tine rises directly behind the burr and the bez tine behind and slightly lateral to the brow tine. Both tines are relatively short, thin and slightly curved. The beam is weakly built, with a prominent anterior edge running from the base of the brow tine and gradually merging into the body of the beam towards the trez tine. The beam curves posteriorly between bez and trez tine and again between trez and terminal tines. The terminal tines consist of two tines, one complete example placed laterally to the axis of the beam and one fragment to the medial side.

Shed antler dex. (Tö 14/78,23)
Shed beam with bases of brow and bez tines. The beam is broken behind the bez tine. The surface of the rose is convex. The brow tine rises directly behind the burr and the bez tine rises behind and lateral to the brow tine. The beam fragment is damaged.

Shed antler dex. (Tö 17/86,5)
Shed beam with bases of both brow and bez tines. The beam is broken at the base of the trez tine. The surface of the rose is slightly convex. The burr is eroded. The brow tine rises about 10 mm. behind the burr. The bez tine rises at a distance behind and lateral to the brow tine. The beam is curved posteriorly between bez and trez tine and has a weakly-developed anterior edge.

Shed antler dex. (Tö 11/75,1)
Shed beam with complete brow tine and base of bez tine. The beam is broken directly behind the bez tine. The find is well-preserved. The surface of the rose has a convex boss in the centre. The pearling of the burr is well-developed. The brow tine rises behind the burr; the bez tine rises at a distance behind and lateral to the brow tine. The brow tine is well-developed and curved.

Shed antler sin. (Tö 15/75,1)
Shed beam with base of brow tine and fragment of bez tine. The beam has been broken directly behind the bez tine. The burr is eroded. The surface of the rose is convex. The brow tine rises directly behind the burr, the bez tine rises behind and lateral to this.

Shed antler sin. (Tö 14/74,6)
Shed beam with fragment of brow and complete bez tine. The beam is broken at the base of the trez tine. The burr is eroded; the surface of the rose has a convex boss in the centre. The brow tine rises directly behind the burr; the bez tine rises at a distance behind and lateral to the brow. The brow tine is well-developed; the bez tine is a very short point. The beam has an anterior edge rising at the base of the brow tine and merging into the beam between bez and trez tine.

Shed antler sin. (Tö 12/80, 4)
Shed base with base of brow and bez tines. The beam is broken behind the bez tine. The rose is damaged and the burr eroded. The brow tine rises behind the burr and the bez tine rises directly behind and lateral to the brow tine.

Shed antler s/d (Tö 14/47,1)
Only the surface of the rose is preserved; the burr is eroded.

Shed antler dex. (Tö 12/73,16)
Shed base with fragments of brow and bez tines. The beam is broken directly behind the bez tine. The burr is eroded; the surface of the rose is flat. The brow tine rises directly behind the burr and the bez tine directly behind and lateral to the brow tine.

Shed antler dex. (Tö 13/77,9)
Shed base with base of brow and fragment of bez tine. The beam fragment is damaged and the burr is eroded. The surface of the rose is convex. The brow tine rises directly behind the burr; the bez tine rises slightly behind and lateral to the brow tine.

Shed antler dex. (Tö 15/83,5)
Shed base with fragment of brow and bez tines. Very fragmentary find.

Shed antler dex. (Tö 14/85,2)
Fragmentary shed base with bases of brow and bez tines.

Shed antler dex. (Tö 12/76,35)
Shed beam with fragment of brow and complete bez tines. The beam is very fragmentary. The burr is weakly developed; the surface of the rose is convex. The brow tine rises about 10 mm. behind the burr and the bez tine rises directly behind and lateral to the brow tine. The bez tine is slender and short. The beam has a weak anterior edge running from the base of the bez tine.

Shed antler sin. (Tö 14/76,5)
Shed beam with brow tine. The surface of the rose is

ARIENDORF	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Ar 1																	
85/-11,3	85.0+	–	45.2	31.2	–	–	–	–	–	80.0	–	–	–	–	–	–	–
Str. 40	220.0+	–	(60.0)	(54.0)	(182.0)	–	–	–	–	135.0	–	–	–	–	–	–	–
Str. 5	70.0+	–	72.5	59.4	(210.0)	–	–	–	–	(145.0)	–	–	–	–	–	–	–
Ar 2																	
80/9, 21	140.0+	–	43.1	40.8	–	–	–	–	–	120.0	–	–	–	–	–	–	–
79/10, 4	–	–	67.3	65.2	–	–	–	–	–	–	–	–	–	–	–	–	–
80/10, 23	–	–	(68.0)	(59.1)	(224.0)	–	–	–	–	–	–	–	–	–	–	–	–
79/09, 72	–	–	(72.2)	(69.0)	–	–	–	–	–	–	–	–	–	–	–	–	–
81/08, 3	235.0+	–	83.5	64.5	233.0	130.0	105.0	180.0	100.0	160.0	–	–	–	–	–	–	–
82/10, 5	340.0+	–	82.2	85.2	265.0	130.0	128.0-	–	–	196.0	–	–	–	–	–	–	–
80/80, 24	920.0+	–	91.5	(81.0)	270.0	80.0+	123.0-	–	–	175.0	245.0	–	–	196.0	(380)	–	–
84/10, 1	–	–	–	–	(222.2)	–	–	–	–	–	–	–	–	–	–	–	–
Ar 3																	
Str. 3	200.0+	–	61.5	57.2	(185.0)	160.0	–	–	–	132.0	–	–	–	–	–	–	–
Str. 5	100.0+	–	(61.2)	(53.3)	–	–	–	–	–	–	–	–	–	–	–	–	–
KÄRLICH																	
Kä 1																	
Kä 23/7	180.0+	–	67.4	55.2	110.0+	89.0	65.0+	72.0	–	–	–	–	–	–	–	–	–
SCHWEINSKOPF																	
Sk 4																	
31/25, 806	–	–	(68.3)	(52.2)	–	–	–	–	–	–	–	–	–	–	–	–	–
WANNEN																	
Wa 1																	
96/57, 20	190.0+	–	(53.3)	(46.5)	–	–	–	–	–	–	–	–	–	–	–	–	–
99/51, 16	140.0+	–	(84.2)	–	–	–	–	–	–		–	–	–	–	–	–	–
99/50, 36	420.0	–	(84.5)	(79.2)	–	–	–	–	–	285.0	–	–	–	–	–	–	–
Wa 2																	
97/56, 9	210.0+	–	–	–	–	–	91.0	–	–	138.0	–	–	–	–	–	–	–
95/54, 14	350.0+	–	–	–	–	–	–	–	–	(130.0)	–	–	–	–	–	–	–
96/50, 34	220.0+	–	(75.5)	(67.5)	–	–	–	–	–	157.0	–	–	–	–	–	–	–
Wa 3																	
98/50, 28	430.0+	–	–	–	–	–	–	–	–	133.0	–	–	–	–	–	–	–
96/50, 23b	300.0+	–	–	–	–	–	–	–	77.0	155.0	–	–	–	–	–	–	–

HUMMERICH																	
Hu 4																	
63/77,2	105.0+	–	43.7	34.0	–	–	–	–	–	90.0	–	–	–	–	–	–	–
58/72,1	80.0+	–	–	–	–	–	69.0	–	–	100.0	–	–	–	–	–	–	–
35/84,8	95.0+	–	(61.9)	(61.5)	–	–	–	–	–	–	–	–	–	–	–	–	–
69/79,2	230.0+	–	72.6	56.7	(240.0)	–	–	–	–	148.0	–	–	–	–	–	–	–
59/71,6	380.0+	–	69.8	61.3	(220.0)	–	–	–	–	160.0	–	–	–	–	–	–	–
4/32,4	400.5+	–	(72.0)	(73.0)	224.0	–	–	–	–	168.0	–	–	–	–	–	–	–
2/34,5	460.0+	–	71.3	61.4	214.0	–	–	280.0	98.0	136.0	280.0	–	–	–	–	–	–
40/84,7	–	–	(86.8)	(67.0)	–	–	–	–	–	–	–	–	–	–	–	–	–
Str. 3001	130.0+	–	76.4	74.6	235.0	–	–	–	–	–	–	–	–	–	–	–	–
5/31,1	280.0+	–	(83.1)	(71.5)	(246.0)	–	–	–	–	171.0	–	–	–	–	–	–	–
TÖNCHESBERG																	
Tö 2																	
15/79,12	50.0+	–	(46.3)	(37.6)	(128.0)	–	–	–	–	–	–	–	–	–	–	–	–
12/72,23	150.0+	–	(62.9)	(45.5)	(169.0)	–	–	–	–	(129.0)	–	–	–	–	–	–	–
15/78,27	125.0+	–	57.8	(49.5)	(170.0)	–	–	–	–	122.0	–	–	–	–	–	–	–
15/83,33	260.0+	–	–	–	–	–	–	–	–	120.0	–	–	–	–	–	–	–
16/78,2	140.0+	–	(48.0)	(38.0)	(141.0)	95.0+	61.0	–	–	–	–	–	–	–	–	–	–
17/86,4	100.0+	–	(50.3)	(46.2)	(153.0)	120.0+	75.0	–	–	119.0	–	–	–	–	–	–	–
14/78,15	110.0+	–	(53.0)	(45.2)	(157.0)	–	–	–	–	103.0	–	–	–	–	–	–	–
11/72,23	180.0+	–	60.7	52.6	175.0	300.0	187.0	75.0+	68.0	(106)	–	–	–	–	–	–	–
14/74,1	540.0+	–	(60.5)	–	–	160.0	63.0	168.0	162.0	115.0	–	–	–	101.0	230.0	75.0	130.0+
14/78,23	140.0+	–	(63.0)	(54.3)	(182.0)	–	–	–	–	–	–	–	–	–	–	–	–
17/86,4	280.0+	–	(61.8)	(56.5)	(185.0)	–	–	–	–	133.0	–	–	–	–	–	–	–
11/75,1	105.0+	–	63.8	53.0	190.0	210.0	87.0	–	–	–	–	–	–	–	–	–	–
15/75,1	50.0+	–	(62.4)	(50.4)	180.0	–	–	–	–	–	–	–	–	–	–	–	–
14/74,6	265.0+	–	(64.0)	(59.0)	(94.0)	40.0+	–	50.0	43.0	130.0	–	–	–	–	–	–	–
12/80,4	80.0+	–	(64.1)	(59.7)	(195.0)	–	–	–	–	–	–	–	–	–	–	–	–
14/47,1	–	–	(65.2)	(57.6)	(194.0)	–	–	–	–	–	–	–	–	–	–	–	–
12/73,16	40.0+	–	(64.2)	(50.7)	(179.0)	–	–	–	–	–	–	–	–	–	–	–	–
13/77,9	180.0+	–	(73.5)	(57.0)	(203.0)	–	–	–	–	–	–	–	–	–	–	–	–
15/83,5	–	–	(68.6)	(64.0)	–	–	–	–	–	–	–	–	–	–	–	–	–
14/85,2	–	–	(65.7)	(55.1)	(193.0)	–	–	–	–	–	–	–	–	–	–	–	–
12/76,5	130.0+	–	(67.0)	(52.6)	(185.0)	–	84.0	105.0	–	114.0	66.0	–	–	–	–	–	–
14/76.5	145.0+	–	78.1	71.0	235.0	160.0+	120.0	–	–	165.0	–	–	–	–	–	–	–
17/85,4	130.0+	–	(67.7)	(60.5)	(204.0)	–	–	170.0	73.0	–	–	–	–	–	–	–	–
13,73,18	225.0+	–	(71.7)	(50.5)	(202.0)	–	–	–	104.0	153.0	–	–	–	–	–	–	–
13/83,3	190.0+	–	(75.3)	(60.5)	(220.0)	–	–	–	–	145.0	–	–	–	–	–	–	–
12/76,34	280.0+	–	(72.3)	(62.7)	(215.0)	–	–	–	–	–	–	–	–	–	–	–	–
13/73,7	200.0+	–	(75.0)	(63.8)	(215.0)	–	–	–	–	139.0	–	–	–	–	–	–	–
13/76,30	–	–	(74.5)	(62.0)	–	–	–	–	–	–	–	–	–	–	–	–	–
16/86,2	170.0+	–	(72.3)	(62.0)	–	–	–	–	–	–	–	–	–	–	–	–	–
15/70,5	–	–	(76.0)	(68.8)	–	–	–	–	–	–	–	–	–	–	–	–	–

Absolute Measurements of *Cervus elaphus* antler. For measurements taken see Fig. 36.

convex. The pearling of the burr is well-developed. The brow tine rises about 10 mm. behind the burr. The tine is robust and has a pronounced posterior edge. The beam fragment is also robust and has a pronounced anterior edge running from the base of the brow tine.

Shed antler dex. (Tö 17/85,4)
Shed base with base of brow tine and almost complete bez tine. The burr is eroded; the surface of the rose convex. The brow tine rises directly behind the burr; the bez tine rises slightly behind and lateral to the brow tine. The bez tine is slender, and slightly curved. The beam has a prominent anterior edge.

Shed antler sin. (Tö 13/73,18)
Shed beam with fragments of brow and bez tines and base of trez tine. The beam is broken at the base of the trez tine. The surface of the rose has a central swelling. The brow tine rises about 10 mm. behind pathe burr; the bez tine rises directly behind and lateral to the brow tine. The beam is slightly curved and has a prominent anterior edge running between the bases of bez and trez tines.

Shed antler dex. (Tö 13/83,3)
Shed beam with bases of brow and bez tines. The burr is eroded. The beam is very fragmentary and may have had a trez tine. The surface of the rose is flat; the pearling of the burr is well-developed. The brow tine rises about 5mm. behind the burr; the bez tine rises behind the brow and slightly lateral to this. The beam has a pronounced anterior edge running from the base of the bez tine.

Shed antler sin. (Tö 12/76,34)
Shed beam with bases of brow, bez and trez tines. The damaged beam is broken in the region of the trez tine. The surface of the rose is convex; the pearling of the burr is well-developed. The brow tine rises directly behind the burr; the bez tine rises at a distance behind and lateral to the brow tine. The beam, as far as can be ascertained, is relatively straight and possesses an anterior edge between the bases of the bez and trez tines.

Shed antler sin. (Tö 13/73,11)
Shed base with bases of brow and bez tines. The burr is damaged; the surface of the rose is convex. The pearling of the burr is well-developed. The brow tine rises behind the burr; the bez tine rises slightly behind and lateral to the brow tine. The beam has a weak anterior edge.

Shed antler dex. (Tö 13/76,30 - 31)
Shed base and fragment of brow tine only. The find is poorly preserved; the pearling of the burr is, where preserved, well-developed.

Shed antler sin. (Tö 16/86,2)
Shed base with bases of brow and bez tines and part of beam. The surface of the rose is convex. The brow tine rises behind the burr; the bez tine rises slightly behind and lateral to the brow tine.

Shed antler s/d (Tö 15/70,5)
Shed base with beam fragment. The burr is eroded. The surface of the rose has a prominent swelling in the centre. The pearling of the burr is well-developed.

Shed antler dex. (Tö 15/71,2)
Shed beam with base of brow tine and trez tine. No bez tine development. The burr is eroded and the beam is broken in the region of the trez tine. The surface of the rose is convex; the pearling of the burr is well-developed. The beam is straight and robust with a weak anterior edge.

Shed antler dex. (Tö 15/77,3)
Shed beam with an almost complete brow tine, bases of bez and trez tine. The beam is broken in the region of the trez tine. The surface of the rose is convex. The pearling of the burr is well-developed. The brow tine rises directly behind the burr; the bez tine rises directly behind and lateral to the brow tine. The brow tine is robust and curved; the bez tine is smaller in size. The beam is robust.

Shed antler dex. (Tö 13/68,15)
Well-preserved shed base with complete brow and bez tines and part of beam. The surface of the rose is convex, the pearling of the burr, where preserved, well-developed. The brow tine rises about 10 mm. behind the burr; the bez tine rises directly behind and lateral to the brow tine. The beam has an anterior edge running from the base of the bez tine.

Shed antler dex. (Tö 14/76,15)
Shed beam with base of brow and fragment of bez tines. The beam is very fragmentary. The surface of the rose is convex. The brow tine rises directly behind the burr; the bez tine at a distance behind and lateral to the brow tine. The beam is robust.

Shed antler sin. (Tö 14/78,9)
Shed beam with complete brow and bez tines. A trez tine development was not observed. The surface of the rose is flat. The pearling of the burr is well-developed, where preserved. The brow tine rises behind the burr; the bez tine rises directly behind the brow and slightly lateral to this. A small boss is present on the medial side at the base of the bez tine. The brow tine is robust, the

bez tine in comparison is very short and stunted. The beam is not as robust as other examples in this group.

Shed antler dex. (Tö 14/76,17)
Shed beam with fragments of brow and bez tines, base of trez tine and part of distal antler. The brow tine rises directly behind the burr; the bez tine rises directly behind and lateral to brow tine. The surface of the rose is flat, the pearling of the burr is well-developed. The beam curves posteriorly between bez nad trez tines and above trez tine.

Shed antler dex. (Tö 15/85,1)
Shed beam with brow and bez tine fragments. The burr is eroded. The surface of the rose is flat. The brow tine rises close to the burr and the bez tine rises directly behind and lateral to the brow tine. Both brow and bez tine are robust.

Antler frontlets sin. (Tö 13/71,10)
Only the pedicle, part of the rose and a fragment of the skull was preserved. Not measurable.

Str. found between H2 and H1 in loess.
Shed antler dex.
Shed antler beam with bases of both brow and bez tines. The surface of the rose is convex, the pearling of the burr is well-developed. The brow tine rises behind the burr; the bez tine rises behind and lateral to the brow tine.

Urbar

Only part of the beam was preserved, with base of bez(?) tine and a fragment of the trez tine.

Niederbieber

Antler frontlet s/d.
The fragment consisted of the pedicle only, and is from a young animal. The find is very worn and measurements could not be taken.

APPENDIX II
DESCRIPTION OF THE DECIDUOUS CHEEK TEETH OF *COELODONTA ANTIQUITATIS*, THE WOOLLY RHINOCEROS

Deciduous upper cheek teeth

dp1

Wa 95/55,34
The medifossette appears to be closed; the post-fossette is partly closed by a low wall. The prefossette is also closed. An internal cingulum is not present.

Wa 98/52,29
The medifossette is closed, the post-fossette is open and has a small cusp on the posterior side. Both crista and crochet are present; the antricrochet appears as an enamel fold deep down in the median valley. A row of small tubercules on the lingual side of the tooth at the base of the crown indicates a weakly-developed cingulum.

Wa Pr III Str. 60
The post-fossette is partly open; the pre-fossette likewise. The medifossette is totally closed. A crista, crochet and anticrochet are present. The median valley has been reduced to a closed fossette. A row of small tubercules indicate a low lingual cingulum.

dp2

Wa 98/52,29
The medifossette is closed. A crista and a crochet are present. The anti-crochet is not present. The post-fossette has a low outer cingulum-like wall with a cusp on its upper edge, as on the dp1. The median valley is closed lingually by a low cingulum. A low anterior cingulum (protocone fold) is also present.

Wa 96/50,30
The post-fossette is partly open and has a low cingulum-like wall with cusp. The medifossette is possibly (damaged) closed. Both crochet and crista are doubled.

Wa 98/52,29
The post-fossette is closed by a low cingulum. A cro-

chet is present; the crista is doubled. The median valley appears closed lingually. A low anterior cingulum is also present.

Wa Str. 3014
The tooth has a closed medifossette ; an anticrochet is indicated by a fold of enamel. The post-fossette is closed by a low cingulum-like wall. The median valley is closed lingually by a cingulum.

Wa Pr III Str. 60
The post-fossette is partly closed. A crista and a crochet are present and the medifossette is closed. The anticrochet is marked by small enamel folds on the inner side of the protocone. The median valley has a small lingual cingulum at its base. A low anterior cingulum is also present.

Wa 92/55,1
The post-fossette is closed. The crista and crochet are present and the medifossette is closed. The anticrochet is marked by two enamel folds on the inner side of the protocone. The median valley is closed lingually by a low cingulum.

Wa 96/53,28
The tooth has a partly closed post-fossette. The crista and crochet are present and the medifossette is closed. The median valley is closed lingually by a low cingulum. There is a marked folding of the enamel on the inner side of the protocone and hypocone. This feature also occurs on the dp3 and dp4 of this individual.

Hu 4 Str. 1014
The tooth has a closed medifossette. The post-fossette is closed by a low cingulum-like wall. The median valley is also closed by a low cingulum on the lingual side. An anterior cingulum is also present.

dp3

Wa 96/50,30
The medifossette is closed. The crochet is doubled, the remainder of the tooth is damaged.

Wa 98/52,31
The post-fossette is closed by a low cingulum with a cusp. The medifossette is closed. A crista and crochet are present. A low anterior cingulum is also present.

Wa 95/55,34
The tooth has a low anterior cingulum, the post-fossette is closed by a low cingulum-like wall. The medifossette is still slightly open. The crista is present, but the anticrochet is not quite fused to this.

Wa Pr III Str. 60
The tooth has a partly closed post-fossette, and a closed medifossette with fused crista and crochet. The anticrochet is marked by enamel folds only. A small lingual cingulum is placed at the base of the median valley. The tooth has a weakly-developed anterior cingulum.

Wa 92/55,1
As above.

Wa 96/53,28
The tooth has a partly-closed post-fossette. The medifossette is closed. A small lingual cingulum is present.

Wa 96/53,28
As above.

Wa 99/51,17
The tooth has a partly-closed post-fossette. The crista and crochet are present; the anticrochet is missing. The medifossette is closed.

Deciduous lower cheek teeth

dp1

Wa 94/56,22
The tooth is small and button-like.

dp2

Wa 94/56, 22
The anterior valley appears »v«-like and the posterior valley is »u«-shaped.

dp3

As above.

Most of the deciduous lower cheek teeth have weakly-developed anterior and posterior cingulums.

APPENDIX III
ABSOLUTE MEASUREMENTS

Canis lupus

Dentition

Upper canine

	Sk 4
Greatest length	(49.0)
Antero-posterior breadth of crown	13.5

Mandible dex.

		Ar 1
Length of cheek tooth row	P1 - M3*	98.0
Length of cheek tootk row	P2 - M3*	92.0
Length of molar row*		47.5
Length of premolar row	P1 - P4*	49.0
Length of premolar row	P2 - P4*	42.4
Height of mandible behind	M1	34.0
Height of mandible between	P2 and P3	29.5

*measured on alveolar edge.

Post-cranial bone

Vertebra

Axis: Greatest length in region of corpus 63.1

Cervical	Sk 4	Wa 3
Greatest length	34.5	41.5
Greatest breadth of cranial end	34.5	-
Greatest breadth of caudal end	-	41.5

Humerus

	Sk 4
Greatest length	187.0
Greatest breadth of distal end	38.7

Equus sp.

Dentition

The teeth are sorted after excavation and assemblage. u=upper cheek teeth. l=lower cheek teeth. L= length. B=breadth. LP=length protocone. no no. = number not given.

		L	B	LP
Kärlich				
Kä Ga				
462	M3 u	35.0	27.0	17.0
70	P3 u	0.0	32.5	15.0
Kä Gb				
277	P2 u	42.0	26.0	10.0
277	P3 u	33.2	31.0	14.2
277	P4 u	35.5	31.6	14.4
277	M1 u	27.7	29.0	13.0
35	M1 u	32.0	31.5	0.0
52	M1 u	34.0	32.0	0.0
157	M2 l	30.5	0.0	0.0
277	M2 u	30.5	28.5	14.0
35	M2 u	31.2	31.0	0.0
277	M3 u	29.3	25.3	16.0
277	M3 u	33.5	0.0	0.0
35	M3 u	0.0	25.5	15.8
Kä H				
116	P2 l	39.5	16.5	0.0
237	P2 l	38.5	15.0	0.0
116	P3 l	35.0	17.0	0.0
237	P4 l	30.0	20.0	0.0
115	M1 l	33.0	17.8	0.0
237	M1 l	27.0	20.0	0.0
232	M1 u	30.0	28.5	0.0

237	M2 l	27.0	18.0	0.0
237	M3 l	34.0	16.0	0.0
Kä Ja				
147	P2 l	34.0	15.0	0.0
146	P3 l	31.5	18.5	0.0

Ariendorf

Ar Ch				
70. 8	P2 l	37.6	15.9	0.0
Ar 1				
Str. 4	P3/4 l	29.9	19.2	0.0
81/-15,4	P3/4 u	30.4	30.0	0.0
86/-17,1	M1 u	27.9	28.4	0.0
90/-12,1	M12 u	29.3	29.2	0.0
Str. 11	M12 l	27.0	17.0	0.0
82/-15,4	M3 l	36.8	15.9	0.0
Ar 2				
78/08,8	P2 l	35.0	15.3	0.0
79/07,1	M3 l	34.7	16.4	0.0
79/04,2	M3 u	30.3	0.0	0.0
Ar 3				
72. 38	M1 u	27.9	28.3	0.0

Leutesdorf

72. 3	M3 u	35.0	0.0	16.5

Schweinskopf

Sk 1				
31/24,3	P2 u	37.4	0.0	0.0
31/24,3	P3 u	30.9	27.9	0.0
31/24,3	P4 u	30.1	28.1	14.8
31/24,3	P4 u	29.9	27.9	0.0
31/24,3	M1 u	25.2	27.6	13.8
31/24,3	M1 u	26.5	27.3	14.8
31/32,2	M1 u	27.5	29.0	0.0
31/24,3	M2 u	26.4	25.4	13.0
31/24,3	M2 u	27.9	25.4	0.0
31/24,3	M3 u	29.9	3.4	14.5
Sk 4				
6/48,2	dp2 l	39.3	14.1	0.0
9/48,5	dp2 u	39.8	27.0	0.0
Str. 713	dp2 u	33.2	25.7	0.0
7/45,5	dp3 l	34.1	14.2	0.0
10/47,11	dp3 u	30.7	30.4	0.0
12/48,26	dp3 u	33.3	24.0	0.0
Str. 712	dp3 u	37.2	25.7	0.0
7/48,4	dp4 l	37.2	13.7	0.0
7/48,8	P2 l	36.3	17.0	0.0
Str. 752	P2 l	36.3	17.0	0.0
8/60,8	P2 u	34.5	16.8	0.0
Str. no no.	P2/3 l	26.8	17.6	0.0
11/59,7	P2/3 u	33.2	29.0	15.4
7/48,8	P3 l	34.6	17.0	0.0
Str. 714	P3/4 u	30.2	18.5	0.0
Str. 715	P3/4 u	30.7	19.0	0.0
7/48,8	M1	33.0	19.1	0.0
12/58,nos	M1 u	30.2	28.2	0.0
12/58,24	M1 u	30.3	22.9	15.1
138/20	M1 u	32.9	26.3	14.5
Str. no no.	M1/2 l	21.8	17.9	0.0
6/61,6	M1/2 u	27.1	27.9	12.8
Str. B749	M1/2 u	29.0	19.7	0.0
7/48,8	M2 l	35.2	17.2	0.0
12/58,nos	M2 u	31.0	25.5	15.3
12/58,nos	M2 u	30.5	25.8	0.0
138/20	M2 u	32.0	25.0	0.0
Kar B	M2 u	27.0	28.0	0.0
Kar B	M3 l	37.7	16.4	0.0
Kar B	M3 u	32.0	25.1	17.3
Kar B	M3 u	33.9	24.7	0.0
Kar B	M3 u	32.0	24.9	16.5
Kar B	M3 u	33.2	0.0	0.0
Kar B	M3 u	32.5	25.7	16.0

Wannen

Wa 1				
97/53,28	dp2 l	41.3	0.0	0.0
96/51,66	dp2 u	45.5	24.5	0.0
97/60,57	dp3 l	30.3	8.5	0.0
96/51,65	dp3 u	33.6	26.6	0.0
95/53,5	dp4 l	34.8	13.2	0.0
97/60,57	dp4 l	40.0	13.4	0.0
Str. no no.	dp4 l	36.0	14.0	0.0
96/51,64	dp4 u	36.2	24.5	0.0
95/55,57	P2	38.4	16.6	0.0
97/53,50	P2 u	38.3	0.0	0.0
95/55,57	P3 l	33.0	17.8	0.0
97/53,51	P3 u	34.0	28.1	15.8
97/53,69	P4 u	33.6	25.3	0.0
97/55,29	P4 u	27.3	30.2	0.0
95/55,57	M1 l	32.7	18.3	0.0
97/53,52	M1 u	31.0	26.2	13.7
95/55,57	M2 l	35.2	17.4	0.0
97/53,54	M2 u	30.4	24.8	0.0
96/57,19	M3 u	31.3	28.0	0.0
97/52,28	M3 u	32.6	27.5	0.0
Wa 2				
94/55,18	dp2 l	42.0	14.2	0.0
95/51,41	dp2 l	35.1	14.4	0.0
Str. 200	dp2 l	37.2	15.1	0.0
97/49,56	dp2 u	45.5	22.0	0.0
94/55,18	dp3 l	34.9	15.3	0.0
95751,41	dp3 l	33.5	14.0	0.0
Str. 200	dp3 l	32.3	15.5	0.0
97/49,57	dp3 u	35.0	0.0	0.0
94/55,18	dp4 l	41.3	14.8	0.0
95/51,41	dp4 l	39.7	13.1	0.0
Str. 200	dp4 l	36.8	16.3	0.0
97/49,55	dp4 u	36.5	0.0	0.0
95/55,25	P2 l	36.7	17.3	0.0
95/55,25	P3 l	33.5	20.7	0.0
95/55,25	P4 l	32.0	21.3	0.0
95/55,25	M1 l	27.4	20.0	0.0

Str. 200	M1 l	34.7	15.0	0.0
95/55,21	M1 u	28.5	30.0	15.2
95/55,25	M2 l	28.4	19.6	0.0
Str. 200	M2 l	34.9	13.9	0.0
95/55,25	M3 l	34.2	17.5	0.0
Wa 3				
95/51,38	dp3/4 u	36.9	25.0	0.0
96/57,32	dp2 u	42.2	23.1	0.0
95/51,37	dp4 l	38.3	16.3	0.0
97/53,13	P2/3 u	32.8	30.4	16.4
Wa 4/5				
95/51,21	dp2 l	34.2	13.1	0.0
95/51,27	dp3 l	30.6	13.6	0.0
97/49,9	P2/3 l	29.4	18.3	0.0
97/49,37	M1 u	25.5	26.9	13.4
97/48,8	M3 l	33.7	14.5	0.0
98748,21	P2 u	29.0	27.4	12.3
Wa Pr III				
Str. 14	P2 l	36.3	18.2	0.0
Str. 37	P2 l	35.4	17.9	0.0
Str. 5	P2 u	41.1	28.2	0.0
Str. 14	P3 l	29.6	19.1	0.0
str. 37	P3 l	30.0	20.7	0.0
Str. 14	P4 l	28.3	20.4	0.0
Str. 37	P4 l	28.1	20.0	0.0
Str. 72	P4 l	31.5	24.0	0.0
Str. 77	P4 l	34.7	16.8	0.0
Str. 14	M1 l	22.0	19.1	0.0
Str. 37	M1 l	27.3	18.5	0.0
Str. 72	M1 l	26.7	21.2	0.0
Str. 77	M1 l	30.3	16.4	0.0
Str. 37	M2 l	27.5	17.7	0.0
Str. 54	M2 l	25.0	16.6	0.0
Str. 77	M2 l	30.1	16.4	0.0
Str. 72	M2 l	28.6	19.6	0.0
Str. 37	M3 l	36.0	15.5	0.0
Str. 72	M3 l	40.7	17.4	0.0
Str. 77	M3 l	34.2	0.0	0.0
Str.Urm3	dp2 u	0.0	27.5	0.0
Str Urm3	dp3 u	30.3	0.0	0.0

Hummerich

Hu 2				
64/73,3	P2 l	34.8	15.4	0.0
64/73,3	P3 l	29.0	18.4	0.0
64/73,3	P4 l	27.3	16.7	0.0
59/74,9	P3 u	30.1	26.5	0.0
67/75,6	P4 u	28.9	27.0	0.0
67/75,6	M1 u	23.8	25.6	0.0
62/73,13	M1/2 u	26.3	26.8	0.0
67/75,6	M2 u	26.6	25.8	0.0
67/75,6	M3 u	28.8	0.0	0.0
Hu 4				
39/82,16	dp3/4 l	36.3	25.0	0.0
45/84,10	dp3/4 l	37.0	12.2	0.0
62/76,7	P2 l	27.7	20.5	0.0
62/76,7	P3 l	28.9	19.7	0.0
66/80,2	P3 l	30.4	17.4	0.0
59/67,8	P3 u	29.9	27.2	0.0
65/78,7	P4 l	30.1	17.3	0.0
39/84,6	P4 u	28.2	30.0	0.0
62/73,12	P4 u	30.3	29.2	0.0
64/73,3	M1 l	24.4	14.3	0.0
40/84,11	M1 u	27.5	30.9	0.0
66/81,8	M1/2 l	30.2	15.8	0.0
66/80,sf	M1/2 l	29.5	16.8	0.0
69/81,17	M1/2 l	28.8	17.5	0.0
62/73,13	M3 u	31.8	24.9	0.0
Hu 5				
Str. 1015	M1 u	26.9	30.0	0.0

Niederbieber

71/79,12	dp1 u	43.0	22.0	0.0
71/79,8	dp1 u	0.0	22.5	0.0
70/79,5	dp2 u	29.0	23.0	0.0

Post-cranial bone

Atlas

	Wa 2 95/53,19
Greatest breadth caudalis	92.0

Cervical Vertebra

1 Greatest breadth processus articularis cranialis
2 Greatest breadth processus articularis caudales
3 Greatest length

	Ar 1	Ar 2	Sk 3		Sk 4		Wa 2	
	Str. 6	82/10,6	30/29,1	6/61,2	14/51,8	Sk B	95/56,15	96/56,15
1	(79.0)	(93.0)	87.6	79.4	81.5	83.1	75.2	72.4
2	-	-	-	73.0	75.3	76.2	-	76.7
3	-	-	-	114.3	122.7	(121.6)	-	-

Sacrum

	Sk 4 7/45,6
Greatest length	(240. 0)
Greatest breadth	182. 0
Physical length	(214. 0)

Scapula

	Sk 4	Wa Pr III	
	B 726	Str. 83	Str. 22
Length of glenoid cavity	67. 9	57. 2	-
Breadth of glenoid cavity	59. 9	45. 7	65. 5

Pelvis

1 Length acetabulum including lip
2 Length acetabulum on rim

	Ar 2	Sk 4		Wa 2	Wa 4/5	
	Str. 10	49/50,100		96/49,29	99/47,27	
1	86. 0	(72. 3)	73. 5	75. 1	72. 5	73. 7
2	81. 5	-	67. 2	66. 9	67. 7	64. 9

Humerus

1 Breadth distal end
2 Breadth trochlea

	Kä H	Ar 2	Sk 4			Wa 2	Wa 4		Wa 2/3		
	200	85/11,9	Str. no no.	12/58,6	9/44,3	99/51,14	95/57,12	96/55,39	98/50,30	95/50,19	98/48,nos.
1	98. 5	81. 8	94. 5	96. 2	95. 0	85. 8	86. 5	84. 4	82. 1	85. 0	(82. 5)
2	-	-	89. 9	85. 4	87. 5	-	-	-	-	-	-

Radius

1 Length
2 Breadth proximal
3 Greatest breadth prox. artic.
4 Smallest breadth diaphysis
5 Greatest breadth distal end
6 Greatest breadth distal artic.

	Kä Gb	Ar 2	Sk 2	Sk 4	Wa 1	Wa 2	Wa 3			
		81/06,1	30/21,2	7/45,11	95/57,20	96/55,40	95/56,25	no no.	94/52,23	95/51,39
1	326. 0	-	-	(344. 0)	-	-	-	-	340. 0	-
2	-	-	94. 2		90. 6	90. 7	-	93. 0	-	89. 5
3	-	-	-	-	81. 6	85. 7	-	85. 4	(86. 8)	82. 5
4	47. 2	-	-	-	-	43. 7	-	-	4. 3	39. 9
5	-	82. 3	-	85. 3	-	83. 1	72.	-	84. 5	79. 0
6	–	70. 1	73. 9	(86. 3)	-	73. 9	69. 3	73. 5		67. 4
							juv		juv.	juv.

	Hu 4	Tö 2	
	Str.no no.	Str. 211	15/78,11
1	-	-	390. 0
2	-	-	98. 2
3	-	-	88. 1
	-	-	-
5	88. 3	79. 6	88. 8
6	74. 5	69. 5	73. 0

Ulna

	Wa 1	Wa 2	Wa 3		
	96/55,40	98/52,27	94/53,2	95/53,16	95/51,39
Breadth of proximal end	43.1 juv.	47.2	43.7 juv.	46.1	45.7 juv.

Metacarpus III

1 Length
2 Lateral length
3 Breadth of diaphysis
4 Breadth proximal end
5 Breadth distal end

	Kä F	Kä Gb	Kä H	Ar 2	Sk 4					
	95	72	237	86/08,5	12/44,5	8/59,1	13/55,41	13/45,?	Str. 738	Str. 729
1	302.0	-	-	229.0	247.0	-	-	-	-	-
2	-	-	-	224.0	239.0	-	-	-	-	-
3	40.8	-	37.7	42.0	40.7	-	-	-	-	-
4	66.0	-	59.5	58.7	58.9	-		57.8	56.5	-
5	61.5	(75.0)	-	53.4	53.1	51.6	-	-	-	-

	Sk 4	Hu 2	Hu 4					
	14/44,4	52/82,8	Str. no no.	62/79,6	34/82,4	45/82,15	40/82,5	Str. 101
1	-	225.0	-	-	-	-	-	-
2	-	220.0	-	-	-	-	-	-
3	-	41.5	-	41.4	-	-	-	-
4	-	58.5	59.5	51.8	58.7	52.8	55.8	-
5	-	53.1	59.6	-	-	-	-	51.5

	Wa 2	Wa 3	Wa 4/5				Wa Pr III			
	96/52,15	94/53,6	96/53,7	99/47,16	98/47,7	Str no no.	Str. 28	Str. 11	Str. 65	Str. 45
1	240.0	233.0	239.0	218.0	213.0	231.0	-	-	-	-
2	232.0	227.0	233.0	213.5	210.0	226.0	-	-	-	-
3	41.4	41.5	41.5	39.2	36.3	35.3	41.3	43.6	40.7	-
4	56.9	53.8	57.6	51.5	50.0	51.6	55.4	-	-	-
5	54.6	52.7	53.8	49.2	46.6	48.7	-	58.7	55.0	53.2

Femur

	Sk 4	Wa 1	Wa 2	Wa 3
	8/52,2	95/55,47	95/55,9	98/50,27
Greatest length	(372.0)	-	-	-
Smallest depth diaphysis		45.0	46.1	49.6

Tibia

1 Greatest length
2 Smallest depth diaphysis
3 Greatest breadth distal end
4 Greatest depth distal end

	Mi 2	Kä Gb		Kä H	Kä Ja	Ar 1		Ar 2	
	68/42	49		281	15	Str. 44	83/-11,6	79/11,15	81/15,1
1	-	-	-	-	-	(375. 0)	-	-	(390. 0)
2	-	-	-	-	-	50. 5	-	-	-
3	(88. 2)	92. 5	88. 0	86. 0	74. 0	-	83. 8	-	-
4	-	-	-	-	-	-	51. 2	87. 0	-

	Sk 4						Wa 1		Wa 2	Wa 3		
	9/52,7	Str. 700	B 742	Str. 723	B731	Str. 730	96/54,9	95/55,46	95/55,51	94/55,9	97/56,6	96/51,1
1	-	-	-	-	-	-	-	-	-	-	(389. 0)	-
2	-	-	-	-	-	-	-	45. 3	45. 5	-	-	42. 6
3	87. 6	89. 9	91. 1	83. 4	85. 1	87. 4	89. 3	83. 1	82. 6	82. 1	87. 1	73. 0
4	54. 5	53. 3	50. 2	50. 5	54. 7	(54. 3)	-	51. 7	51. 0	49. 9	52. 2	46. 2

	Hu 4		Hu 2		
	62/76,6	59/74,15	42/84,5	60/77,2	59/70,4
3	79. 4	84. 0	82. 2	83. 6	85. 5

Calcaneum

1 Greatest length
2 Greatest breadth

	Mi 2	Ar 2	Sk 4		Wa 1	Hu 4		
	69/42,7	86/02,1	Str. 721	13/55,25	94/56,27	64/70,9	63/78,4	Str. 110
1	130. 1	-	124. 0	126. 0	121. 0	118. 0	-	-
2	63. 0	61. 0	59. 0	61. 0	-	59. 2	63. 5	60. 2

Astragalus

1 Greatest height
2 Greatest breadth
3 Breadth of distal artic.
4 Medial length
5 Lateral height

	Mi 2	Sk 4					Wa 1			Wa 3	Wa 4/5
	Str.	30/16,1	11/60,13	Str. 744	Str. 720	52/83,2	94/56,24	98/49,50	96/55,26	96/49,28	99/48,5
1	72. 0	64. 0	63. 0	51. 0	-	71. 0	65. 0	61. 0	61. 0	64. 0	58. 0
2	76. 0	71. 0	68. 0	-	68. 0	69. 0	70. 0	-	61. 0	66. 0	73. 0
3	63. 8	-	-	-	55. 2	62. 1	(57. 3)	-	52. 9	56. 0	55. 6
4	75. 5	-	-	-	-	-	67. 7	-	-	66. 5	57. 2
5	-	65. 5	67. 0	-	-	67. 0	67. 7	-	-	66. 5	57. 2

	Hu 4	Hu 2	Tö 2	
	58/66,10	45/83,8	16/96,1	
1	66. 0	70. 0	66. 0	67. 0
2	69. 0	69. 0	69. 0	75. 0
3	56. 7	58. 0	53. 9	60. 0
4	64. 6	70. 0	-	65. 5
5	-	66. 0	-	-

Tarsals

– Os tarsale III

	Mi 2	Ar 1	Sk 3		Sk 4	Hu 4
	68/42,6	77/-17,10	35/52,1102	Str. 736	13/55,23	63/78,4
Greatest breadth	61.3	54.5	59.0	55.5	54.3	55.3

– Os tarsi centrale

	Mi 2	Ar 1	Sk 4	Hu 4	Wa 1
	68/42,2	83/-17,2	13/55,35	62/78,9	96/48,4
Greatest breadth	66.2	59.3	55.4	56.1	57.7

Metatarsus III

1 Length	4 Breadth of proximal end
2 Lateral length	5 Breadth of distal end
3 Breadth of diaphysis	6 Breadth of distal epiphysis

	Mi 2	Kä F	Kä Gb		Kä H			Ar 2		
	69/2,2	187	83	277	237	80/08,23	86/02,1	Str. 71	Str. 70	78/06,1
1	-	-	-	-	323.0	299.0	275.0	-	-	-
2	-	-	-	-	-	296.0	271.0	-	-	-
3	-	60.5	-	-	-	38.2	39.2	-	-	-
4	(58.0)	-	59.0	(62.0)	-	59.8	61.4	60.2	55.2	-
5	-	-	-	-	-	56.2	55.9	-	-	53.5
6	-	-	-	-	-	55.6	55.0	-	-	54.1

		Sk 4		
	48,805	9/53,12	Str. 701	13/52,5
1	273.0	-	-	-
2	270.0	-	-	-
3	39.4 -	-	-	-
4	57.8	61.5	-	62.3
5	55.7	-	54.4	-
6	57.0	-	57.7	-

	Wa 1	Wa 2		Wa 3		Wa 4/5			Wa Pr III	
	94/56,25	Str. no no.	Str. Urm. no no.	93/53,4	96/54,10	98/50,11	98/47,6	Str. 56	Str. 63	Str. 53
1	274.0	-	261.0	275.0	-	254.0	-	273.0	276.0	-
2	271.0	-	257.0	271.0	-	251.0	-	260.0	-	-
3	38.3	39.0	33.2	39.5	38.4	35.3	-	36.5	41.1	37.9
4	59.9	60.5	54.0	61.2	-	52.6	-	51.2	60.6	-
5	(57.3)	-	50.9	55.8	-	50.3	43.5	53.0	57.1	52.7
6	56.3	-	53.0	58.2	-	51.7	47.4	52.8	57.5	53.8

			Hu 4			Mi II
	56/84,6	58/56, no no	2/36,14	55/81,6	69/81,13	
1	-	-	287.0	285.0	-	269.0
2	-	-	(283.0)	282.0	-	33.7
3	39.2	-	37.0	39.6	-	(52.1)
4	60.0	58.8	54.0	54.2	-	51.4
5	-	-	52.6	52.8	-	-
6	-	-	51.3	(48.0)	52.3	-

Phalanx I

1 Greatest length
2 Breadth of proximal end
3 Breadth proximal articulation
4 Smallest breadth diaphysis
5 Breadth distal end
6 Breadth distal articulation

	Mi 2	Ar 1	Ar 2	Sk 2		Sk 4			Hu 4		
	51/38,1	94/-12,1	85/10,6	30/21,6	30/20,2	27/53,1	8/44,2	12/49,4	59/59,12	65/70,3	57/80,3
1	97.0	91.5	93.0	(82.0)	82.0	-	95.4	87.0	95.0	90.0	(98.0)
2	67.0	59.3	64.1	(60.2)	58.2	-	67.9	-	62.2	59.7	69.2
3	62.0	56.5	58.5	-	53.5	-	61.1	-	54.0	-	62.5
4	44.5	39.7	40.3	42.5	41.1	35.2	41.5	41.8	37.8	-	(47.0)
5	53.9	49.8	51.5	51.5	50.6	48.3	54.2	51.9	51.7	52.0	57.3
6	50.0	47.9	49.4	-	49.5	48.3	50.6	49.1	47.1	47.4	-

	Hu 2	Hu 4	Hu 5			Tö 2	Wa 1			
	Str. 117	Str. 2	Str. no no.	59/64,6	Str. no no.	15/79,11	96/57,18	97/53,42	95/56,27	94/56,18
1	93.0	97.0	92.0	90.0	76.0	96.0	90.0	94.0	89.0	87.0
2	(57.0)	59.2	65.0	62.3	54.5	62.3	56.0	58.0	(62.5)	62.3
3	-	54.8	60.3	55.3	51.5	54.6	-	-	-	-
4	40.0	38.6	40.5	40.0	35.1	41.3	-	-	-	-
5	52.4	50.1	50.0	51.8	44.5	55.2	50.0	51.0	57.5	50.9
6	49.9	50.1	48.6	50.4	43.6	50.7	-	-	-	-

	Wa 2		Wa 3	Wa 4/5		Wa Pr III	Wa 3	Wa 4/5
	93/52,4	97/50,62	96/53,12	98/50,5	97/50,sev.	Str. 33	Str. no no.	Str. no no.
1	92.0	89.0	91.0	81.0	83.0	-	89.6	90.0
2	63.5	65.0	67.9	52.1	65.9	-	62.0	50.2
3	-	-	-	-	-	-	53.9	51.5
4	41.8	42.0	41.0	38.5	42.3	-	40.2	38.6
5	53.1	54.4	51.6	45.5	53.7	54.5	53.2	49.3
6	-	-	-	-	-	54.5	50.8	46.8

Phalanx II

1 - 6 as Phalanx I

	Kä H	Ar 1	Ar 2	Sk 4						Wa 1	Wa 2		Wa 3
	208	Str. 1	86/10,1	35/49,803	12/47,2	12/44,2	8/55,10	12/44,4	Str. 734	94/52,28	94/55,8	95/55,20	94/56,1
1	(57.0)	51.0	(51.0)	52.0	49.0	50.3	50.1	52.0	53.0	50.0	55.0	(58.0)	54.0
2	(64.5)	60.5	62.9	59.5	62.7	63.5	59.5	62.2	62.3	56.1	60.5	65.0	62.5
3	-	53.8	56.8	51.5	54.9	56.7	51.4	54.2	54.3	-	-	-	-
4	-	35.2	(54.3)	49.8	54.5	-	49.8	49.5	50.5	48.4	55.3	-	52.2
5	-	48.4	56.9	56.3	-	58.5	53.8	52.3	52.4	53.0	58.2	50.6	53.5
6	(64.0)	52.1	-	-	-	-	-	-	-	-	-	-	-

	Wa 4/5			Wa Pr III	Hu 4	Hu 5	Tö 2			
	97/49,30	98/49,22	99/47,46	Str. 9	1/37,32	8/31,32	59/64,8	13/76,37	Str. 5	15/78,8
1	55.0	42.0	43.0	46.3	49.0	56.0	56.0	55.0	51.0	54.0
2	62.0	54.0	52.3	54.0	58.5	60.0	59.0	60.7	(56.0)	60.5
3	-	-	-	-	51.1	54.0	53.3	55.5	49.3	52.5
4	50.5	45.6	45.0	-	-	39.6	47.8	40.2	38.5	51.5
5	55.3	50.4	-	49.3	-	48.2	52.6	56.3	(49.9)	57.9
6	-	-	-	-	-	53.1	-	(57.6)	49.9	-

Phalanx III

1 Greatest length
2 Greatest breadth
3 Breadth of articulation
4 Depth of articulation
5 Dorsal length
6 Height

	Mi 2	Sk 4	Hu 4		Tö 2		Wa 3	Wa 4/5	
	49/55,1	6/56,1	14/55,1	56/84,5	15/78,14	16/84,2	93/52,3	95/52,35	95/54,21
1	86. 0	-	-	-	-	79. 0	70. 6	-	
2	99. 2	-	-	(81. 0)	-	87. 0	-	-	-
3	63. 7	53. 3	52. 5	53. 6	29. 8	27. 8	57. 6	59. 1	59. 1
4	-	(30. 9)	30. 0	29. 0	56. 7	54. 2	-	-	-
5	(68. 3)	-	-	-	-	-	-	-	-
6	55. 0	-	-	-	48. 0	50. 0	(56. 3)	-	-

Equus Hydruntinus

Dentition

Lower deciduous cheek teeth

dp3

	Hu 4 53/84,1
Length	29. 7
Breadth	11. 3

Post-cranial bone

Pelvis

	Tö 2 16/78,1
Length acetabulum including lip	59. 6
Length acetabulum including on lip	54. 5

Femur

	Hu 48/83,3
Greatest breadth distal end	76. 4

Metacarpus III

		Hu 4	
	Str. 103	58/83,7	60/73,7
Width of proximal articulation	-	-	43. 4
Depth of proximal articulation	-	-	39. 9
Greatest breadth distal end	37. 0	37. 7	-

Metatarsus III

	Hu 4 9/1,35
Greatest breadth distal end	38.5

Phalanx I

	Hu 4				
	2/36,21	46/82,2	49/84,11	71/78,1	58/71,1
1 Greatest length	84.0	86.0	81.0	75.2	82.0
2 Breadth proximal end	41.1	-	41.8	-	44.0
3 Depth proximal end	29.6	-	30.4	-	25.6
4 Smallest breadth diaphysis	23.5	22.9	25.2	23.5	-
5 Breadth of distal end	34.1	-	35.0	32.0	-

Phalanx II

1 - 5 as above Phalanx I

	Hu 4		
	43/83,13	48/83,1007	63/73,8
1	41.0	39.0	39.0
2	40.8	37.0	35.7
3	27.8	26.5	-
4	35.5	32.3	30.5
5	37.2	34.4	31.7

Phalanx III

	Hu 4	
	49/82,2	Str. 3005
Length	(40.4	(52.0)
Breadth artic. surface	36.6	35.7
Length dorsal surface	-	47.8
Height	-	35.5

Coelodonta antiquitatis

Dentition

	Assemblage	Length	Breadth
Upper dp 1	Wa 2 95/55,24	26.0	18.1
	Wa 2 96/53,28	27.5	21.5
	Wa 2 98/52,31	24.2	21.0
	Wa Pr. III Str. 60	24.3	21.7
Upper dp 2	Wa 4/5 92/55,1	31.6	33.4
	Wa 2 96/53,28	33.5	32.2
	Wa 2 98/52,31	33.2	33.0
	Wa 2 95/55,24	32.9	30.0
	Wa Pr. III Str. 60	33.2	31.8
Upper dp 3	Wa 4/5 92/55,1	44.5	39.0
	Wa 2 95/55,24	44.8	-
	Wa 2 96/53,28	45.5	40.8
	Wa 2 98/52,31	46.5	-

	Wa 2 96/53,28	47.2	-
	Wa 1 99/51,17	44.0	-
	Wa Pr. III Str. 60	43.0	38.0
Lower dp 2	Wa 3 99/54,2	31.0	17.7
	Wa 2 98/52,30	32.0	18.5
	Wa 2 99/53,29	34.2	17.3
	Wa 1 94/56,22	31.3	16.4
Lower dp 3	Wa 2 98/48,65	41.8	21.2
	Wa 2 98/52,30	43.0	21.4
	Wa 1 94/56,22	40.3	-
	Wa 3 99/54,2	41.2	20.2
Lower dp 4	Wa 2 99/51,13	-	42.0
Upper P 2	Wa 3 98/52,24	28.8	29.5
	Wa 2 96/53,26	32.2	32.8
Upper P3	Wa 3 98/52,24	36.5	38.4
	Wa 2 96/53,26	39.2	40.0
Upper P4	Wa 3 98/52,24	40.7	-
	Ar Str. 81	43.0	44.5
Lower P2	Wa 4/5 97/50,3	28.1	17.2
Lower P3	Wa 4/5 95/54,4	31.2	24.2
	Wa 3 97/51,21	29.7	21.3
	Wa 2 95/54,4	28.6	18.8
	Ar 2 78/10,4	32.3	27.8
	Ar 2 79/09,21	29.5	23.1
Lower P4	Wa Pr. III Str.	36.9	30.0
Upper M1	Ar Str. 81	48.9	55.7
Upper M2	Ar Str. 81	57.3	53.8
	Ar 1 Str. 31	-	58.9
	Ar 2 78/09,44	52.5	52.0
	Ar 2 Str. 74	-	55.2
	Wa 2 98/54,23	56.7	63.0
	Wa Pr. III Str. 3	50.2	-
	Wa Pr. III Str. 49	55.8	63.4
Upper M3	Wa 3 97/48,30	57.4	57.0
	Wa 3 99/52,9	57.0	51.4
	Wa Pr. III Str. 1	66.0	51.5
Lower M1	Ar Ch. 70.12	47.0	35.5
	Wa Pr. III Str.?	39.6	34.0
Lower M2	Ar 1 Str. 32	52.0	32.7
	Ar Ch. 70.12	54.2	32.3
	Sk 4 Str. 761	57.2	30.0
	Wa Pr. III Str.	50.8	37.0
Lower M3	Wa 4/5 95/54,3	54.0	34.6
	Wa 4/5 95/53,4	-	33.2
	Wa Pr. III Str.	57.5	33.0
	Wa Pr. III Str. 8	57.4	35.9

Post-cranial bone

Scapula

	Sk 2
Breadth of articulation	87.5
Depth of articulation	111.8

Radius

1 Greatest length
2 Greatest breadth proximal
3 Depth proximal
4 Breadth diaphysis
5 Depth diaphysis
6 Breadth distal

	Sk 4	Wa 2			Wa Pr III					
	8/50,6	96/56,8	95/54,16	95/54,17	Str. 93	Str. 92	Str. 84	Str. 25	Str. 82	Str. 80
1	-	-	386.0	(436.0)	425.0	431.5	-	-	-	-
2	115.5	119.1	112.0	115.6	125.2	121.1	116.3	112.3	-	-
3	(76.0)	-	-		88.5	82.0	(78.5)	-	-	-
4	-	64.0	64.0	63.8	69.0	71.1	63.0	-	-	-
5	-	38.7	40.5	40.5	50.0	47.4	43.5	-	-	-
6	-	-	-	127.0	-	129.0	-	-	119.0	134.0
				juv.					juv.	juv.

Ulna

1 Greatest length
2 Breadth olecranon
3 Depth olecranon
4 Breadth proximal joint
5 Depth proximal joint
6 Breadth proximal articulation
7 Breadth diaphysis
8 Depth diaphysis
9 Breadth distal end
10 Depth distal end

	Sk 4		Wa 1		Wa 2	Wa 3			Wa 4/5		
	Str. 753	11/44,19	97/53,24	97/52,25	96/56,9	97/51,20	93/55,8	95/53,18	99/57,10	94/52,20	98/48,46
1	-	-	-	-	-	483.0	-	-	-	485.5	-
2	-	-	-	-	-	-	-	-	-	81.5	-
3	-	-	-	-	-	(111.0)	-	-	-	114.0	-
4	-	-	-	-	-	-	-	-	-	-	-
5	-	-	-	-	-	-	-	-	-	154.5	-
6	-	102.8	-	-	-	-	-	-	-	91.8	-
7	63.7	62.0	47.5	(57.5)	(59.5)	59.8	(49.5)	-	(55.1)	59.0	49.5
8	64.7	59.5	48.7	58.0	59.0	46.7	(49.0)	-	(45.2)	48.0	38.3
9	-	-	-	-	-	60.0	-	56.3	-	62.0	-
10	-	-	-	-	-	-	(69.5)	70.4	-	75.0	-
								juv.			juv.

	Wa Pr III			
	Str. 94	Str. 68	Str. 67	Str. 71
1	-	-	-	-
2	-	-	-	-
3	124.0	-	-	-
4	-	-	-	-
5	166.0	-	-	-
6	109.5	107.2	-	98.5
7	49.0	-	-	-
8	-	-	44.0	-
9	-	-	-	52.0
10	-	-	-	77.0

Carpals
– Naviculare

	Wa 2 95/55,24	Wa 4/5 99/48,21	Wa Pr III Str. 41
Length	71.5	71.5	75.5
Breadth	60.0	57.0	55.5

– Scaphoid

1 Length
2 Breadth
3 Height
4 Length proximal articulation
5 Breadth proximal articulation
6 Length distal articulation
7 Breadth distal articulation

	Wa 4/5		Wa Pr III		
	95/52,38	96/43,23	Str. 23	Str. 66	Str. 61
1	94.5	89.0	94.5	92.0	-
2	72.0	66.5	75.6	68.0	-
3	76.0	72.0	76.0	81.0	-
4	(60.0)	-	(61.0)	63.7	(61.2)
5	67.9	65.8	73.0	68.0	64.0
6	72.3	69.0	70.0	83.5	-
7	41.5	38.5	43.0	39.1	-

– Lunate

	Wa 3 96/52,11	Wa 4/5 98/47,17	 95/52,25	Wa Pr III Str. 17
Length	74.0	67.5	76.1	73.0
Breadth	59.2	50.8	59.1	-
Height	56.0	49.5	57.5	52.0
Height anterior	59.8	50.3	58.9	52.8

– Unciform

	Ar 2 79/09,36	Wa 2 95/54,22	Wa 3 96/50,29	Wa 4/5 96/53,30	 96/51,20	Wa Pr III Str. 19
1 Absolute length	-	103.5	-	99.9	86.7	96.5
2 Anatomical length	-	88.0	-	76.0	73.5	70.0
3 Breadth	83.0	84.2	(84.3)	82.1	68.1	77.8
4 Height	59.5	61.5	61.0	61.5	50.5	54.0

– Magnum

	Wa 2 96/54,2
Height	69.4

– Pisiforme

	Wa 4/5 98/48,19	Wa Pr III Str. 42
Length	65.0	77.5
Breadth	45.3	58.4
Height	-	-

– Cuneiform

	Wa 2 95/55,62	Wa 3 96/53,6	Wa 4/5 97/50,46	 96/49,15	Wa Pr III Str. 47	Sk 4 Str. 705
Length	-	48.0	56.0	(44.5)	46.6	-
Breadth	51.5	56.0	51.8	50.0	53.0	-
Height	55.3	54.0	60.0	49.0	52.0	(55.0)

– Cuneiform large

	Wa 2
Length	50.7
Breadth	49.0

Metacarpus

1 Length	5 Depth of diaphysis
2 Breadth of proximal end	6 Breadth of distal end
3 Depth of proximal end	7 Breadth of distal articulation
4 Breadth of diaphysis	8 Depth of distal articulation

– Metacarpus II

	Wa 1 96/57,6	Wa 2 93/55,9	Wa 3 93/56,7	Wa 4/5 99/48,33	Sk 4 Str. 747
1	176. 0	161. 0	171. 0	162. 5	166. 0
2	(60. 0)	58. 0	-	54. 5	53. 3
3	-	-	-	51. 5	45. 5
4	45. 5	(51. 3)	-	39. 2	41. 3
5	27. 7	-	-	25. 0	25. 5
6	56. 6	49. 4	-	45. 6	49. 3
7	(44. 7)	40. 9	-	40. 0	39. 1
8	(47. 1)	48. 6	-	40. 1	-

– Metacarpus III

	Wa 1	Wa 2			Wa 3	Wa 4/5	Wa Pr. III	Sk 2	Sk 4		
	97/50,65	95/54,9	93/56,6	94/57,8	97/56,12	99/47,25	Str. 48	32/44,3	Str. 746	Str. 741	10/51,13
1	-	-	202. 0	202. 0	200. 0	-	-	194. 0	-	-	-
2	-	-	-	71. 6	-	61. 5	-	74. 9	-	68. 5	60. 6
3	-	52. 9	-	(56. 0)	-	50. 5	-	56. 1	-	50. 3	-
4	49. 7	49. 4	-	54. 6	60. 5	49. 0	-	57. 2	51. 0	-	-
5	25. 1	26. 5	-	24. 8	29. 2	-	28. 2	26. 1	-	-	
6	-	-	-	-	70. 0	-	76. 2	70. 5	-	-	-
7	-	-	-	-	-	-	57. 7	(54. 5)	-	-	-
8	-	-	-	-	(50. 2)	-	52. 1	-	-	-	-

– Metarcapus IV

	Wa 1	Wa 3	Wa 4/5	Wa Pr III		
	96/51,5	93/57,21	98/49,29	Str. 21	Str. 24	Str. 18
1	151. 0	157. 0	151. 0	-	167. 0	47. 5
2	-	-	54. 8	-	60. 5	49. 2
3	-	-	46. 7	-	46. 5	37. 0
4	35. 2	-	37. 2	-	44. 5	23. 8
5	22. 2	-	22. 2	-	27. 5	-
6	49. 3	-	-	53. 4	59. 0	-
7	42. 6	-	-	40. 0	47. 0	-
8	46. 1	-	-	46. 5	47. 0	-

Pelvis

	Wa 2 98/50,32
Breadth acetabulum	120. 8

Tibia

	Wa 3	Wa 4/5	Wa Pr III			
	99/50,27	99/49,24,25	Str. 51	Str. 78	Str. 85	Str. 91
Greatest length	-	-	(418.0)	-	-	420.0
Breadth proximal	-	-	-	-	-	151.5
Depth proximal	-	-	-	-	-	155.0
Breadth diaphysis	-	-	76.0	-	-	78.0
Depth diaphysis	-	-	68.0	-	-	74.5
Breadth distal	96.5	96.0	121.9	122.4	114.2	117.2
Depth distal	-	-	90.0	90.5	86.7	95.3
Breadth distal articulation	-	-	-	91.5	90.5	89.2
					juv.	

Tarsal
– Cuboid

	Sk 4	Wa 3	Wa Pr III	Ar 3
	10/52,7	no no.	Str. 39	72.37
Length antero-posterior	(70.0)	75.5	79.0	(74.7)
Breadth	-	(50.1)	52.5	53.0
Height	-	(67.0)	66.0	-
Height of anterior face	-	50.6	47.8	44.1
Length of articulation	-	52.0	(53.7)	-
Breadth of articulation	-	-	-	43.8

Calcaneum

	Wa 3	Wa Pr. III
	96/55,16	Str. 64
Greatest length	-	132.0
Breadth summit	-	89.0
Breadth at base of bec	-	71.0
Breadth transv summit	-	65.0
Bd. transv. sustentaculum tali	87.0	89.0
Depth diaphysis	52.9	-

Astragalus

	Wa 4/5		Wa Pr III	
	96/49,16	99/47,40	Str. 82	Str. 31
Height	88.0	(85.0)	96.0	87.0
Greatest breadth	92.5	92.5	102.0	103.0
Breadth of the distal articulation	86.1	86.1	93.0	89.0
Length antero-posterior on distal face	57.4	57.4	58.5	(55.2)

Metatarsus II

1 - 8 as Mc II

	Wa 2	Wa 4/5	Hu 4
	99/55,59 sf	99/49,31	46/84,10
1	155. 0	-	157. 0
2	-	-	30. 5
3	-	-	(44. 5)
4	26. 0	-	29. 5
5	33. 0	-	29. 0
6	34. 6	36. 1	39. 5
7	34. 3	35. 2	-
8	40. 9	37. 9	-

Metatarsus III

1 - 8 as for Mt II

	Wa 1	Wa 4/5	Wa Pr III	Sk 2
	95/55,59	98/49,19	Str. 4	32/24,1
1	-	157. 0	186. 0	169. 0
2	61. 3	55. 7	61. 5	55. 0
3	44. 7	40. 9	49. 9	45. 4
4	44. 3	42. 2	-	46. 0
5	-	24. 5	-	26. 0
6	53. 0	50. 1	62. 2	51. 7
7	(44. 2)	45. 2	51. 3	(46. 5)
8	47. 4	40. 6	46. 8	-

Metatarsus IV

1 - 8 as for Mt II

	Wa 2	Urm
	96/55,19	Str. 4
1	157. 0	148. 0
2	48. 4	-
3	47. 6	48. 8
4	24. 9	29. 1
5	31. 5	29. 6
6	(35. 8)	37. 6
7	34. 7	34. 2
8	44. 1	41. 2

Phalanx I

	Wa 4/5	Wa Pr III		
	(96/51,13)	98/49,36	Str. 36	Str. 6
Length	44. 0	-	54. 0	52. 5
Breadth	54. 0	-	54. 0	45. 0
Breadth proximal end	49. 5	32. 2	43. 4	37. 0
Breadth distal end	47. 8	-	44. 7	38. 5
	ant.	post.	post.	post.

Phalanx II

	Wa 3	Wa 4/5	
	96/50,31	98/52,14	99/50,17
Length	31. 0	28. 0	35. 0
Breadth	38. 0	32. 5	66. 0
Breadth proximal end	35. 2	32. 3	53. 3
Breadth distal end	32. 0	29. 0	-
	post.	post.	ant.

Phalanx II
(medial / lateral)

	Wa 4/5
	99/51,8
Length	33. 5
Breadth	51. 0
Breadth proximal end	45. 8

Phalanx III
(medial/lateral)

	Wa 3
	95/51,36
Length	-
Breadth	-
Breadth proximal end	47. 9
Breadth distal end	-

Cervus elaphus

Dentition

Andernach

		L	B
An 2			
25/88,34	dp4	u 21.5	21.0
18/85,42	M12 u	27.0	0.0
18/85,41	M3 l	35.0	14.9
19/86,101	M3 l	34.0	15.0
Schaaf	M3 l	38.5	16.0
19/88,62	M3 u	28.0	0.0
19/85,72	P2 u	19.5	15.5
24/88,19	P3 u	18.5	21.0
18/85,44	P4 u	17.5	21.5
21/87,86	M12 u	26.5	0.0

Hummerich

Hu 4			
46/82,9	M2 l	22.8	15.0
46/82,9	M3 l	32.0	14.1
46/82,9	P2 l	13.0	9.5
46/82,9	P3 l	14.5	11.0
Str. 113	P3 l	16.3	12.2
46/82,9	P4 l	17.1	12.2
55/84,10	P4 u	15.2	17.9

Kärlich

Kä 1			
32c	M1 l	23.5	14.5

Miesenheim I

Mi 2			
76/42,5	M1 u	18.8	0.0
48/43,1	M3 u	22.5	0.0
76/42,2	M3 u	21.0	0.0
76/42,3	P3 u	16.2	16.8
76/42,4	P4 u	13.6	17.3
75/41,6	dp2 u	18.1	10.7

Miesenheim II

15/25,2	dp 4 l	24.3	12.4

Niederbieber

54/14,11	M1 l	23.3	13.1
55/15,9	M1 l	26.8	14.2
55/18,42	M1 l	24.1	14.0
51/15,47	M2 l	28.6	15.0
54/14,11	M2 l	28.6	15.0
55/15,9	M2 l	30.0	15.2
55/18,14	M2 l	27.4	17.7
55/18,42	M2 l	29.3	14.5
56/17,3	M2 u	24.9	0.0
51/15,47	M3 l	34.2	15.2
55/15,9	M3 l	28.0	0.0
51/15,47	P3 l	19.2	10.0
51/15,47	P4 l	20.1	12.0
51/15,47	M1 l	23.1	14.4

Schweinskopf

Sk 3			
33/49,sf	P3 l	17.8	10.5
33/49,sf	P4 l	12.7	12.7
Sk 4			
12/59,35	M1 l	23.0	14.6
12/59,34	M2 l	26.1	27.7
12/47,9	M3 l	35.0	16.3

Tönchesberg

Tö 4			
13/65,5	M2 u	24.0	0.0

Urbar

8/436	P2 l	12.5	8.6
8/57	P2 l	13.0	9.6
8/238b	P2 u	18.8	16.4
7/213	P3 l	17.0	10.5
8/436	P3 l	17.4	10.5
8/57	M3 l	38.0	14.6
1	M3 u	29.5	0.0
1	P3 u	15.9	19.5
8/238b	P3 u	0.0	20.3
109	P4 l	20.7	12.5
8/179,1000	P4 l	19.2	13.0
8/436	P4 l	19.0	12.2
8/436	P4 l	20.2	12.7
7/213	P2 l	12.0	7.8
8/238a	M2 u	23.0	0.0
1	M2 u	25.1	0.0
8/238b	P4 u	16.2	19.3
1	M2 u	25.0	0.0
8/234,1000	dp2 u	15.7	9.8
8/57	M2 l	0.0	15.2
8/234,1000	dp3 u	17.7	0.0
8/179	P2 l	13.8	8.1
2/101,1000	dp2 l	11.2	5.5
8/213,1000	dp3 l	15.1	8.6
8/238c	M3 l	35.2	15.6

8/57	M2 l	25.4	15.3
8/436	M2 l	27.5	16.2
2/242	M1 u	22.5	0.0
1	M1 u	23.5	0.0
8/436	M1 l	23.0	14.5
108	P2 l	14.0	8.7
8/57	M3 l	36.7	14.4
8/57	P4 l	19.0	12.3
1	P4 u	13.8	19.5
8/57	P3 l	14.6	11.1
8/238a	M1 u	27.5	0.0
8/436	P3 l	16.7	10.5

Wannen

Wa 4			
94/55,3	M1 l	21.4	12.6
95/55,32	dp3 u	17.3	0.0
Wa 5			
95/56,16	dp2 l	11.5	6.3
95/56,16	dp3 l	17.2	8.5
95/56,16	dp4 l	28.5	11.0
Wa 6			
97/53,70	M3 l	34.3	16.3
No no.	M3 l	33.2	0.0
No no.	M3 l	29.5	14.2
No no.	M3 l	31.0	13.8
97/53,46	M3 u	25.2	0.0
99/52,38	P2 l	16.3	9.8
99/53,25	P2 l	13.0	0.0
97/50,71	P2 u	17.7	17.6
97/52,34	P2 u	17.7	0.0
96/56,22	P3 u	14.2	19.5
97/52,32	P3 u	0.0	20.5
98/53,33	P3 u	16.5	21.3
96/55,80	M3 l	31.7	14.3
99/52,38	M12 l	24.3	13.3
96/55,71	M12 l	23.5	14.0
99/52,14	dp3 l	16.3	8.2
96/55,59	M12 l	23.2	14.5
97/53,73	M2 l	24.0	14.7
96/55,80	M2 l	24.5	15.3
96/55,80	M3 l	33.1	14.8
97/53,74	M2 l	23.5	15.3
97/53,67	M2 l	21.4	17.9
94/54,33	M12 l	21.2	12.7
97/53,60	M1 u	22.7	0.0
96/51,77	M1 u	23.0	0.0
97/53,73	M1 l	21.2	18.7
97/53,68	M1 l	21.4	15.4
95/54,34	M3 l	31.7	14.3
97/53,45	M2 u	25.3	0.0
95/54,30	M2 u	23.8	0.0
96/55,43	P4 l	19.1	11.7
97/52,33	P4 u	16.1	21.4

Post-cranial bone

Scapula

1 Greatest length of the processus articularis
2 Greatest length of the glenoid cavity
3 Greatest breadth of the glenoid cavity

	Sk 4	Tö 2	Hu 4
1	60.1	72.7	61.4
2	47.2	55.0	48.2
3	-	53.3	44.9

Humerus

1 Greatest breadth distal end
2 Breadth of distal trochlea

	Ar 3	Hu 4					Hu 5	Wa 2
	106/22,1	34/82,6	Str. 104	44/83,18	58/67,4	73/72,3	66/75,3	96/52,40
1	52.5	54.4	56.3	59.8	(61.8)	61.1	-	64.9
2	49.4	53.5	53.3	56.2	-	-	(60.7)	-

Radius

1 Greatest breadth proximal end
2 Greatest breadth proximal articulation
3 Greatest breadth distal end

	Ar 3	Hu 4				Hu 5	Wa 4/5	Niederbieber
	106/22,2	43/84,16	9/27,4	58/76,10	73/72,3	58/57,10	96/49,9 juv.	40/45,1
1	55.1	-	-	66.0	(63.5)	-	-	62.0
2	53.0	-	-	61.0	-	-	-	-
3	-	59.0	62.3	-	-	61.2	58.2	-

	Wa 1 97/53,37
Greatest length	294.0
Greatest breadth proximal	60.8
Greatest breadth distal	56.3

Ulna

	Ur 8/451
Smallest depth of olecranon	34.0

Pelvis

	Wa 2 96/49,30	An 2 21/87,95
Length of acetabulum	63.9	58.0

Femur

	Hu 4 43/82, 11 and 12
Greatest breadth of distal end	(83.0)

Tibia

1 Greatest breadth proximal
2 Greatest breadth distal

	Mi 2	Hu 4				Wa 3	Wa 1	Niederbieber			
	49/45,4	58/83,1013	55/84,9	14/78,20	59/82,9	94/55,4	94/55,2	96/51,59	67/80,2	70/75,4	41/44,3
1	-	-	-	-	-	-	(80.3)	-	-	-	-
2	57.4	51.4	(50.7)	56.3	(52.8)	54.0	-	54.5	58.9	55.9	64.0

Os malleolare

	Wa 1 96/51 sf	Niederbieber 52/16,122
Greatest breadth	26.9	26.0

Metacarpus III/IV

1 Greatest length
2 Greatest breadth proximal
3 Smallest breadth diaphysis
4 Greatest breadth distal

	Mi 1	Ar 1	Hu 4					Wa 1	Wa Pr III	
	52/54. 2	Str. 20	48/83,23	- 6/33.12	37/84,3	39/83,9	73/72,3	97/52,27	Str. 57	Str. 10
1	-	-	292. 5	-	-	-	-	-	-	-
2	-	-	49. 8	(47 . 0)	50. 2	-	-	47. 5	-	-
3	-	-	27. 7	-	-	-	-	-	-	-
4	4. 45. 3	(42. 1)	51. 3	-	-	44. 1	(45. 3)	-	43. 5	44. 8

Metacarpus III/IV

	Niederbieber 66/71,1	An 2 17/86,52
4	(44. 0)	49. 0

Tarsal
– Os centrotarsale

	Mi 2	Hu 4		Wa 1
	Str. 1007	55/57,1	58/79,6	96/51,50
Greatest breadth	47. 8	47. 1	51. 4	47. 0
Greatest depth	-	-	-	-

Calcaneum

	Kä Ga	Hu 4	Wa 3	Niederbieber	
	Kw 463	49/82,9	93/55,7	93/54,4	40/40,2
Greatest length	123. 0	128. 0	125. 0	123. 0	122. 0
Greatest breadth	41. 0	41. 0	43. 0	(45. 0)	-

Astragalus

1 Greatest length on the lateral side
2 Greatest length on the medial side
3 Depth laterally
4 Depth medially
5 Breadth of the distal end.

	Kä F	Mi 1	Ar 3		Hu 4			Tö	Wa 4/5	Wa 3	Wa 1
		51/51,4	Str. 2	Str. 3	48/84,7	Str. 111	67/81,10	12/76,25	96/54,6	93/55,4	92/57,8
1	61. 2	-	58. 4	-	62. 0	58. 0	(61. 0)	61. 0	57. 0	61. 0	60. 0
2	-	-	-	51. 0	59. 0	55. 5	(58. 0)	57. 0	53. 5	58. 0	55. 0
3	32. 5	-	31. 9	-	35. 5	-	-	-	37. 0	38. 7	35. 7
4	-	-	-	22. 2	36. 5	33. 4	-	-	32. 6	32. 8	-
5	-	39. 0	-	33. 5	42. 1	37. 2	-	-	32. 5	-	-

	Niederbieber	Urbar		
	35/35,144	103	7/61	7/74
1	61. 5	60. 8	60. 1	57. 2
2	57. 0	55. 8	55. 0	55. 5
3	32. 5	32. 3	32. 3	31. 5
4	33. 0	31. 7	30. 5	31. 0
5	37. 5	37. 0	37. 0	31. 0

Metatarsus III/IV

	Mi 1	Mi 2	Wa 3	Wa 1	An 2	Urbar		
	51/53,3	Str. 1030	93/55,2	96/51,50	20/86,102	101	2210	102
Greatest length	(318. 0)	317. 0	(295. 0)	-	-	-	-	-
Breadth proximal end	-	-	-	42. 2	-	-	-	-
Breadth distal end	40. 5	45. 3	44. 1	-	46. 0	52. 0	(45. 0)	46. 3

Phalanx I

1 Greatest length
2 Greatest breadth proximal end
3 Greatest breadth diaphysis
4 Greatest breadth distal end

	Mi 2				Ar 1		Wa 1		An 2
	83/43,1	51/51,7	53/50,1	Str. 1009 (Juv.)	80/-19,1	75/-18,1	95/51,47		21/88,58
1	64. 0	65. 0	66. 0	-	59. 8	-	62. 0	61. 5	70. 0
2	22. 4	23. 8	21. 7	-	22. 9	-	23. 4	23. 4	25. 0
3	-	-	-	18. 5	-	-	-	-	-
4	20. 3	22. 8	19. 8	18. 7	22. 5	22. 0	22. 7	2	-

Phalanx II

1 Greatest length
2 Greatest breadth of the proximal end
3 Greatest breadth of the distal end

	Mi 2				Wa 3		An 2	
	54/53,3	Str. 1003	Str. 1002	50/43,3	95/50,28	95/50,29	21/87,63	19/86,141
1	40. 9	46. 8	47. 0	44. 7	45. 0	45. 0	49. 7	-
2	20. 2	23. 0	22. 4	21. 7	22. 6	23. 0	26. 3	24. 0
3	17. 2	19. 9	19. 0	17. 5	19. 2	19. 3	21. 9	-

Phalanx III

	Miesenheim II 48/42,3	An 2 21/88,20
Greatest length	42. 2	54. 0
Breadth proximal	-	17. 7

Capreolus capreolus

All roe deer remains here are from Miesenheim I.

Antler

	48/41,4 Adult	83/42,3 1st.year	Str. 102 1st.year	49/51,4 1st.year
1 Length of beam	227.0	101.6	-	-
2 Circumference of rose	-	-	-	-
3 Antero-posterior diameter of rose	33.2	26.2	21.8	25.6
4 Transverse diameter of rose	27.2	23.3	18.5	21.3
5 Circumference of beam above rose	75.0	-	-	-

Dentiton

Upper cheek teeth

	P2	P3		P4			
	81/42,5	Str. 1042	51/40,2	48/49,6	68/41,10	67/42,3	54/54,2
Length	12.5	10.3	10.4	9.0	9.4	9.5	8.0
Breadth	-	11.6	10.7	-	11.3	11.5	10.5

	M1				M2					M3	
	50/46,1	67/41,23	81/42,2	Str. 1046 juv.	67/41,21	68/42,2	81/42,3	76/42,6	54/53,4	67/41,22	81/42,4
Length	13.0	13.6	14.6	10.7	14.4	-	13.9	12.4	13.4	13.8	13.5
Breadth											
ant.	13.1	12.6	13.6	9.5	13.8	-	13.7	12.0	12.5	13.3	13.3
post.	12.9	12.5	12.4	9.8	13.1	13.5	12.0	11.1	11.5	11.5	13.7

Lower cheek teeth

	P3 67/42,1	P4 51/48,6	M3 67/42,2
Length	10.7	10.7	17.3
Breadth	6.0	7.6	8.1

Post-cranial bone

Humerus

	65/41,4	49/49,37
Greatest breadth of distal end	32.3	33.6

Radius

	75/41,1	49/49,37
Greatest breadth of proximal end	27.5	31.8
Greatest breadth of distal end	–	31.1

Metacarpus III/IV

	48/49,2 and 5
Greatest breadth of distal end	24.7

Os centrotarsale

	51/49,4	48/42,5
Greatest breadth	28.4	25.7

Phalanx I

	52/49, 5	74/48, 100	49/50, 12	49/49, 38	84/42, 3	56/56, Fi	49/48, 5	49/49, 21
Length	48.0	-	44.0	43.0	42.0	41.0	32.0	-
Breadth prox. end	14.6	13.5	13.5	14.3	12.1	12.6	13.3	-
Breadth dist. end 12.1	-	11.1	11.2	10.3	-	11.0	10.8	

Phalanx II

	73/41,5	Str. 106	49/48,3
Length	27.0	33.1	28.7
Breadth prox. end	11.2	13.3	11.5
Breadth dist. end	8.3	9.2	8.8

Phalanx III

	52/49,4	49/50,15
Length	29.8	31.3

Bos primigenius

Dentition

Absolute measurements of deciduous upper cheek teeth

	Hu 4 56/84,4			Hu 4 39/82,5		
	dp2	dp	dp4	dp2	dp3	dp4
Length	18.2	24.4	28.0	-	24.0	25.4
Breadth	11.2	17.3	-	-	15.5	(18.2)

Permanent upper cheek teeth

	Tö 2			
	P2	P3	P4	
	13/73,22	15/72,7	13/73,19	12/76,24
Length	20.9	20.7	20.7	19.5
Breadth	16.5	19.0	22.4	(21.7)

	M1		M2		M3	
	Tö 2	Hu 4	Tö 2		Tö 2	Hu 4
	13/73,26	58/69,9	13/73,27	Str. 8	13/73,23	9/25,5
Length	26.1	28.7	30.9	32.9	37.0	32.9
Breadth						
ant.	25.0	(27.7)	27.5	28.0	28.7	26.4
post.	-	-	-	27.0	28.1	25.5

Permanent lower cheek teeth

	M2	M3
	Hu 4	Hu 4
	58/80,23	59/71,10
Length	36.7	47.2
Breadth	22.3	-

Post-cranial bone

Tarsal

– Os centrotarsale

	Hu 4	Tö 2		
	65/72,16	Str. 212	Str. 102	14/74,4
Greatest breadth	89.3	(70.8)	(68.9)	88.4

Astragalus

	Hu 4	Tö 2
	67/75,2	15/76,4
Greatest length medial	87.0	88.0
Greatest depth lateral	54.0	54.0
Greatest depth medial	52.0	56.0
Greatest breadth	62.0	64.5

Calcaneum

	Hu 4
	65/72,13
Greatest length	204.0
Greatest breadth	75.0

Phalanx I

	Hu 4	
	65/72,12	68/73,3
Length	84. 8	(75. 5)
Proximal breadth	43. 0	39. 5
Distal breadth	41. 3	32. 8

Phalanx II

	Hu 4
	52/83,15
Length	62. 5
Distal breadth	(33. 0)

Phalanx III

	Hu 4	Tö 2
	45/83,5	15/78,21
Greatest length sole	80. 0	87. 8
Breadth middle sole	-	34. 8
Length dorsal surface	-	71. 6

Bos or *Bison* sp

Dentition

Permanent upper cheek teeth

	An 2		
	P3	P4	M2
Length	19. 0	21. 0	28. 0
Breadth	16. 0	18. 0	26. 0

M3	Kä H			Ar 1	Tö 2	An 2
	190	190	190	Str. 3	Str. 6	no no.
Length	34. 5	32. 0	31. 5	32. 1	36. 5	32. 0
Breadth	27. 5	28. 0	27. 0	27. 2	25. 1	28. 0

Permanent lower cheek teeth

M1	Kä Gb
	76
Length	42. 3 (1)
Breadth	15. 7

M1/2	Sk 4
Length	(30. 6)
-	-

M2	Kä Gb		Ar 1
	295	76	Str. 41
Length	32. 0	42. 3 (1)	32. 1*
Breadth	19. 5	15. 7	20. 5*

M3	Kä Gb			Ar 1
	202	82	295	Str. 41
Length	43. 0	45. 0	47. 0	45. 9*
Breadth	16. 0	13. 5	18. 5	20. 5*

* measured at occlusal surface.

Post-cranial bone

Radius

	Kä Gb 460	Wa 6
Breadth proximal end	-	106.0
Breadth distal end	115.0	-

Tibia

	Kä Ja 124	Ar 1 92/-13,1
Breadth distal end	91.0	80.0

Os centrotarsale

	Tö 1 Str. Urm. 1
Greatest breadth	81.9

Astragalus

	Wa 1 95/54,32
Greatest length of lateral side	85.0
Greatest length medial side	79.0
Greatest breadth	55.0

Calcaneum

	Mi 2 33/30,1	Wa 6 96/55,78
Greatest length	165.0	(170.0)
Greatest breadth	53.0	-

Metacarpus III/IV

	Kä	
Breadth proximal	Gb 152	Gb 27
Breadth distal	85.5	82.5

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