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# Schöningen: the history and results of 20 years archaeozoological research

Thijs van Kolfschoten

*Since the discovery in 1992 of the first Palaeolithic artefacts in Quaternary deposits exposed in the Schöningen open-cast lignite mine, the Faculty of Archaeology (Leiden University) has been involved in the Schöningen Palaeolithic project initiated by Dr Hartmut Thieme (Niedersächsisches Landesamt für Denkmalpflege, Hannover). The locality Schöningen became world famous after one of the highlights of the Schöningen project, the discovery in 1995 and publication in 1997 of the Palaeolithic wooden throwing spears. The spears were found among thousands of remains of butchered horses in deposits referred to the locally defined Reinsdorf Interglacial. During the past two decades it has become clear that different stratigraphical horizons, exposed at a large number of sites, yielded Palaeolithic artefacts and archaeozoological finds. The larger mammal remains have been collected during the archaeological excavations. Special campaigns to collect smaller vertebrate fossils from the different outcrops have been organized since 1992. The analyses of the fossil vertebrate record by a large number of students of the Faculty of Archaeology, Leiden University, yielded important data that contribute to the reconstruction of the palaeoenvironment during hominin occupation of the region, to the (bio)stratigraphical dating of the sites and the long-distance correlation with other Palaeolithic sites, and above all to the debate on hominin subsistence and their hunting and exploration strategies. In addition, a number of other research projects with a focus on material from Schöningen (the study of insects, stable isotopes, aDNA, meso- and micro-wear study of molars and the application of Amino Acid Racemization data for stratigraphical purposes) have been initiated.*

## 1 INTRODUCTION

The village of Schöningen is located between Hannover and Berlin, c. 10 km south of the city of Helmstedt (fig. 1). The border checkpoint Helmstedt–Marienborn was until 1990 the largest and most important border crossing along the former border between East and West Germany and traffic going from West Germany to e.g. West Berlin, East Germany and Poland used this crossing. The village of Schöningen is located just west of the former border between West Germany and the former German Democratic Republic or East Germany.

The present-day landscape of the area between Schöningen and Helmstedt, east as well as west of the former Inner German Border, is characterized by the presence of remnants of huge quarries; the results of open-cast lignite exploitation (fig. 2). The open-cast mining of the Tertiary lignite in the region was started in 1874 by the company *Braunschweigische Kohlen-Bergwerke AG (BKB)* (Thieme and Maier 1995). In 1978 the BKB began to exploit the area (c. 6 km long and 1 km wide) east-north-east of the village of Schöningen. The so-called Schöningen open-cast lignite mine consisted initially of two separate quarries: a northern (*Baufeld Nord*) and a southern one (*Baufeld Süd*) (fig. 3).

In order to have access to the Tertiary lignite, the overlying Quaternary deposits had to be removed. Opening previous lignite quarries in the region and digging away the Quaternary sediments revealed many interesting archaeological finds. However, there was no systematic archaeological study of the destroyed areas until 1983 when Dr Hartmut Thieme, former student of Professor Dr G. Bosinski (Cologne) and employed at the *Niedersächsisches Landesamt für Denkmalpflege* (Hannover) since 1982, started the long-term project entitled: *Archäologische Schwerpunktuntersuchungen im Helmstedter Braunkohlrevier (ASHB)*. During the first decade of the project, when the mining activities were restricted to the northern quarry, large areas (more than 350,000 m<sup>2</sup>) have been investigated and many interesting archaeological finds (for example pottery but also (human) skeletons) of e.g. Neolithic and Bronze Age have been discovered and a number of (rescue) excavations have been carried out (Thieme and Maier 1995).

Early 1992 the *BKB* started to exploit the southern quarry of the Schöningen open-cast lignite mine and in March 1992 Dr Hartmut Thieme discovered the first Palaeolithic large mammal bones and artefacts in sediments 8-15 m below the surface. In the summer of 1992 a three month rescue excavation at the Palaeolithic site Schö 12 was undertaken. The author was invited by Hartmut Thieme and together with Wil Roebroeks, Wim Kuijper and Kelly Fennema, he visited the excavation. Since then the Faculty of Archaeology, Leiden University has taken part in the Schöningen research and the author is since 1992 a member of the formally established Research Team (Dr H. Thieme (fig. 4), (Project

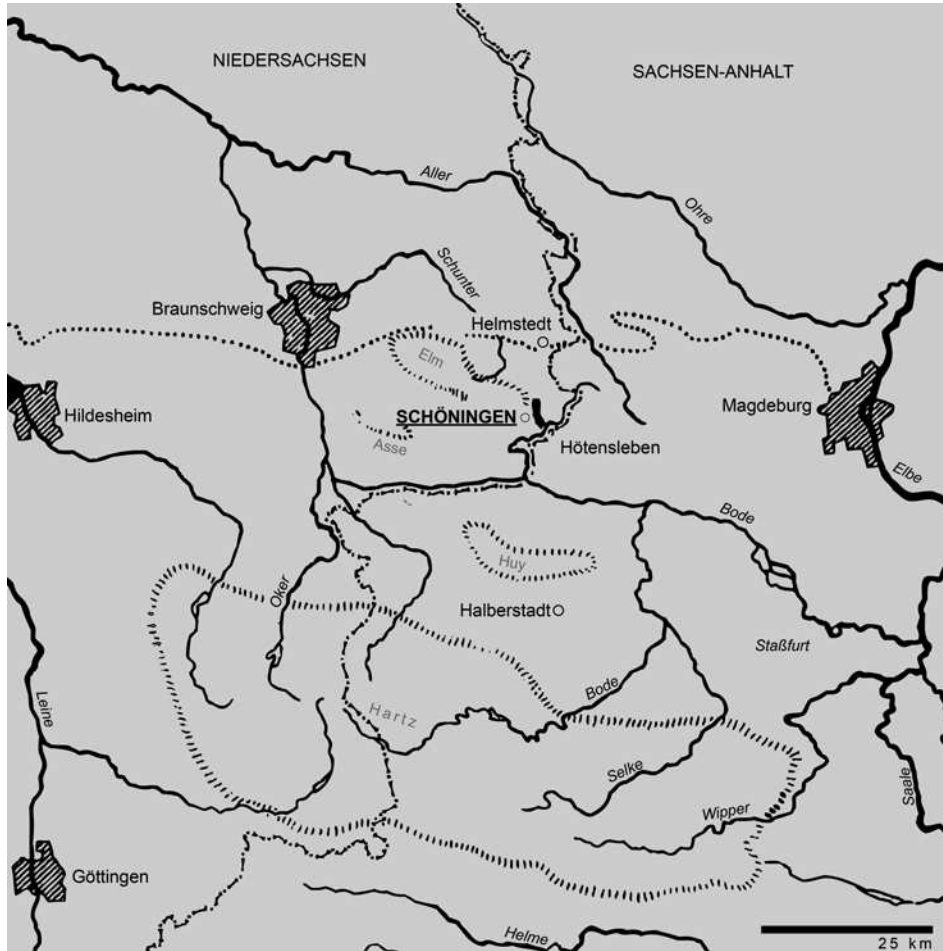


Figure 1 Location of the village of Schöningen. (from Thieme and Maier, 1995).



Figure 2 The Schöningen open-cast lignite quarry. (Photo Thijs van Kolfshoten).

leader, Archaeology), Professor Dr D. Mania (Geology, Malacology), Professor Dr B. Urban (Botany) and Professor Dr Th. van Kolfshoten (Zoology). The Leiden contribution should concentrate on the study of the vertebrate remains from the Pleistocene deposits and focus on archaeozoological as well as paleoenvironmental and biostratigraphical questions.

The larger mammal remains have been collected during the past 20 years in the frame of the archaeological excavations conducted by Dr H. Thieme and his team, and in addition special campaigns to collect smaller vertebrate remains were organized by the author almost every year since 1992. The result so far is more than 20,000 Palaeolithic larger mammal fossils and over 7000 identifiable smaller mammal remains; a record that offers the possibility to investigate the (biostratigraphical) age of the find horizons, the environmental conditions during the hominin occupation of the region, and hominin subsistence and hunting strategies.

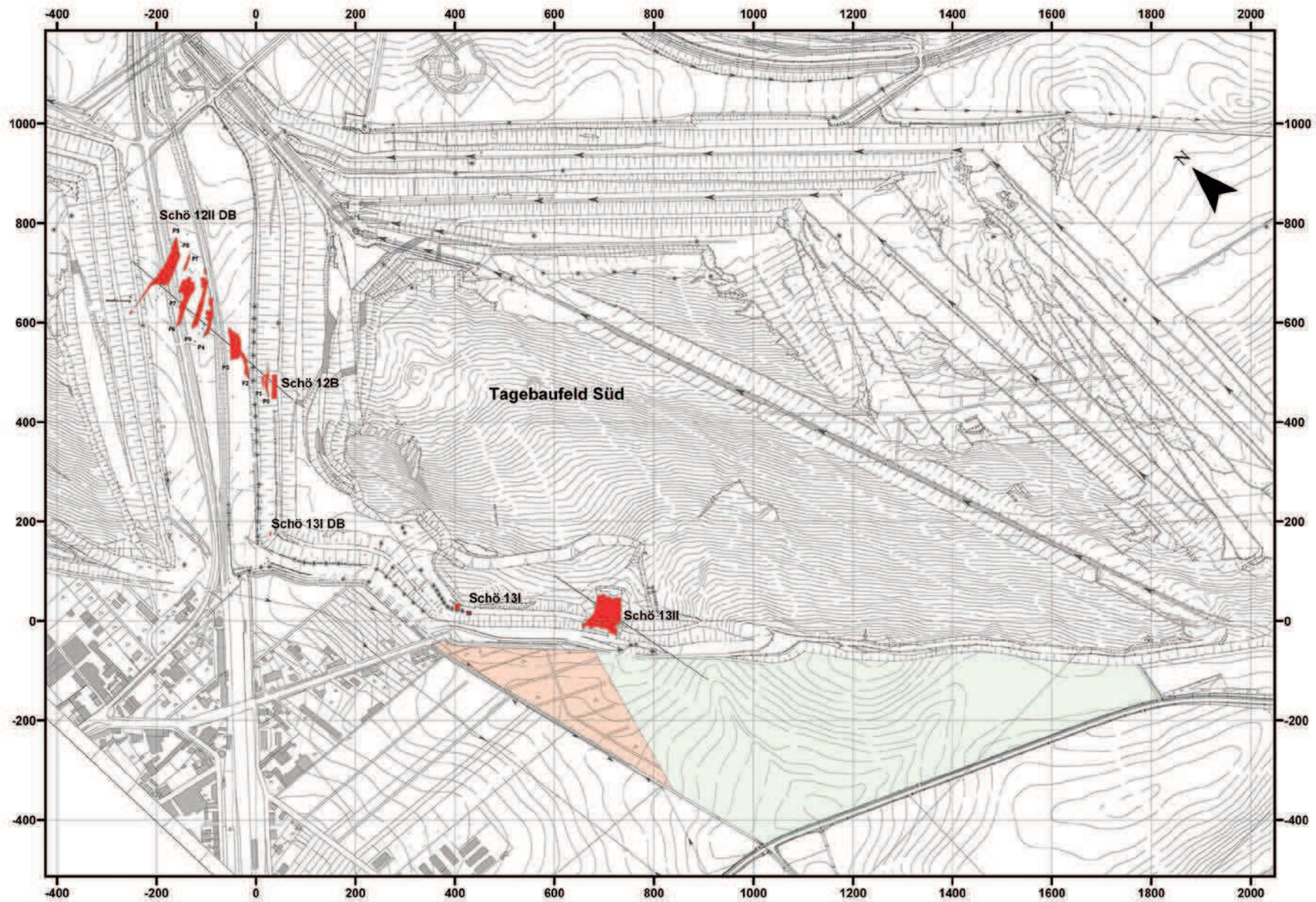


Figure 3 Map of the southern quarry and the position of the different archaeological sites. (map produced by Utz Böhner, NLD – Hannover).



Figure 4 Dr Hartmut Thieme. (Photo Thijs van Kolfshoten).

## 2 GEOLOGICAL SETTING

To put the finds/assemblages in a broader perspective, the geological setting of the Quaternary deposits exposed due to the mining activities is summarized. Unconsolidated lignite-bearing Palaeogene deposits form the base of the sequence. These deposits are, in the area of the Schöningen open-cast lignite quarry, covered by late Quaternary sediments with at the base Elsterian till deposits. The Scandinavian ice sheets covered the area during the Elsterian as well as the Saalian (Drenthe) glaciation (fig. 5). Dietrich Mania investigated in great detail the Quaternary deposits and recorded in the period from 1992 until 2008 many exposed sections (several are more than 100 m long). According to his model, there is on top of the Elsterian till a series of erosional channels (Mania 1995; Thieme 1999) (fig. 6). The Schöningen Channels I-III date from the period between the Elsterian and the Saalian (Drenthe) glaciations and the infill of the succeeding channels covers three interglacial/glacial cycles. Best exposed in the past 20 years are the deposits of the second channel (Schöningen II), filled with sediments that date from the Reinsdorf Interglacial and the ensuing cold stage. The depositional sequence contains five levels of organic muds and peats with loess deposits on top (figs 7 and 8). The lowermost mud and peat deposits (level 1) represent the interglacial optimum of the Reinsdorf Interglacial, whereas the upper levels (4 and 5) represent cool temperate phases. Levels 1-4 yielded archaeological as well as zoological remains. The famous spears are from level 4 of the Schöningen II sequence. The notation of the different sites and levels (e.g. Schö 13 II-4) refers to a specific geographical position in the investigated area (13), to a particular channel (II) and to a specific level within the sedimentological sequence.

During the past decades Brigitte Urban studied the botanical record from the Quaternary deposits in the area of the northern as well as the southern quarry. Based on distinctive botanical features, she referred the interglacial deposits in the three channels exposed in the southern quarry (fig. 6), to the Holsteinian Interglacial, and the locally defined Reinsdorf



Figure 5 Location of Schöningen and the maximal extent of the Middle and Late Pleistocene ice sheets E = Elsterian glaciation; D = Saalian - Drenthe glaciation; WA = Saalian-Wacke glaciation; WE = Weichselian glaciation) (modified after Lang *et al.* 2012).

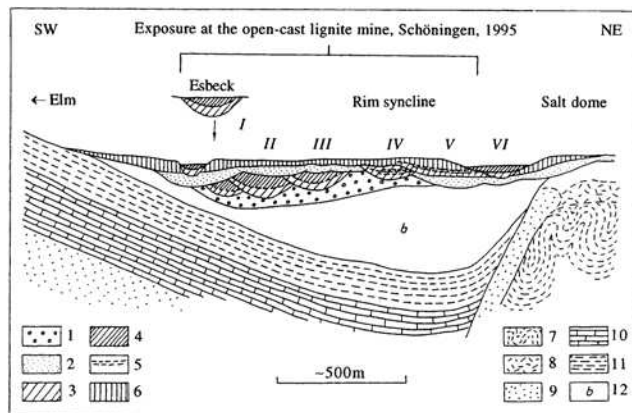


Figure 6 Schematic section through the Quaternary sedimentary cycles Channel I-VI of open-cast lignite mine Schöningen (modified after Mania 1995).

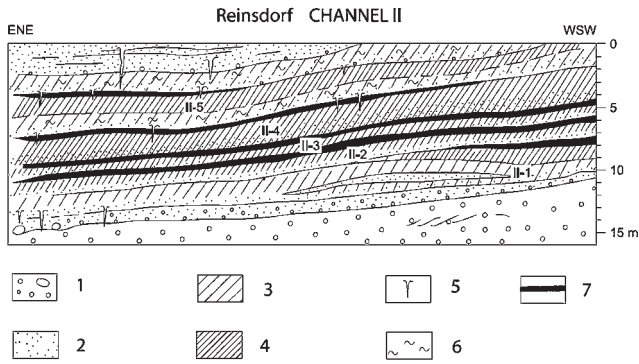


Figure 7 Scheme of the Reinsdorf sediment sequence (Channel II, levels II-1 to II-5) discordantly overlying Elsterian glacial sediments. Legend: 1: Till, gravel and fluvioglacial sediments (Elsterian); 2: sand; 3: basin silt; 4: silty and calcareous mud; 5: ice wedges; 6: solifluction layers; 7: fen peat. Lithology of Channel II sediment levels: II-1, sands and silts, fen peat, wooden remains; II-2, II-3, II-4, silty and calcareous mud, intercalated peat layers (black); II-5, basin silt, silty and calcareous mud, peat (black) (from Urban *et al.* 2011).

Interglacial and Schöningen Interglacial (Urban, 1995). The Schöningen sections have also been studied by Kier van Gijssel (Faculty of Archaeology, Leiden University) and he regards these sections as one of the key stratigraphical sequences for the Middle Pleistocene of Northwest and

Central Europe. In his thesis entitled “A continent-wide framework for local and regional stratigraphies: application of genetic sequence and event stratigraphy to the Middle Pleistocene terrestrial succession of Northwest and Central Europe” he correlates the Holsteinian Interglacial with Marine Isotope Stage (MIS) 11, the Reinsdorf Interglacial with MIS 9 and the Schöningen Interglacial with MIS 7 (van Gijssel 2006) (table 1).

Jörg Lang studied the Pleistocene deposits in the Schöningen area during more recent years and integrated the data of only four outcrop sections, 744 borehole logs and high-resolution shear wave seismics. He and his co-authors concluded that the Elsterian and overlying deposits are located in an elongated trough formed as a tunnel valley below the Elsterian ice sheet. During the following interglacial a lake was formed, and lacustrine sediments accumulated and laterally stacked in a shallow-water deltaic setting (Lang *et al.* 2012). Lang *et al.* (2012) correlate the deposits overlying the Elsterian till, including those exposed at the sites of Schö 12 II and Schö 13 II (referred to the Reinsdorf Interglacial by Urban (1995) and others), to the Holsteinian Interglacial and they regard the Holsteinian as the continental equivalent of MIS 9. A hypothesis that is heavily disputed, and also the mammalian data do not support this interpretation (van Kolfschoten in press). The age of the deposits including the spear horizon is still a matter of debate.



Figure 8 Picture of the site Schö 13 II with the levels 1 to 4. (Photo J. Serangeli).

		MIS	NW European stages	Schöningen sequence
<b>HOLOCENE</b>		1		
<b>PLEISTOCENE</b>	late	5d-2	Weichselian	
		5e	Eemian	
	middle	6	Saalian	
		7		
		8		
		9		
		10		
		11	Holsteinian	Holsteinian Interglacial
		12	Elsterian	
		13	Cromerian Complex	
		14		
		15		
	16			

Table 1 Stratigraphical position of the Holsteinian, Reinsdorf and Schöningen Interglacials and the correlation with the Marine Isotope Stages (MIS) according to van Gijssel (2006).

### 3 THE SCHÖNINGEN PROJECT - HISTORICAL HIGHLIGHTS

During the first 9 years (1983 – 1992) of the Schöningen project (*Archäologische Schwerpunktuntersuchungen im Helmstedter Braunkohlrevier*) the archaeological research and large-scale excavations were restricted to the Holocene deposits and finds in the northern quarry. In that period, palaeobotanist Brigitte Urban, involved in the Schöningen project since the start, investigated together with Hartmut Thieme also the Pleistocene outcrops exposed in that quarry and recorded different interglacial sequences. However, no Palaeolithic artefacts were recovered during that period. Only after Pleistocene deposits in the southern quarry became exposed, were the first Palaeolithic artefacts, associated with vertebrate remains, discovered. That discovery was the start of so far 20 years of Palaeolithic archaeozoological research in Schöningen; a period of 20 years with a number of historical highlights.

**1992** The discovery of the **first Palaeolithic artefacts** in the Schöningen region in Middle Pleistocene deposits. The stone artefacts and artificially modified pieces of wood were found in association with a large number of mammalian fossils. The discovery resulted in a rescue excavation (site Schö 12) that took three months. During that excavation more artefacts could be collected and also a large number of bones from large mammals. Several bones show clear indications of hominin butchering activities.

**1994** In June 1994 a new archaeological site (**Schö 13 I**) was discovered. The site is located at the south-western

edge of the southern quarry, about 500 m south of the Palaeolithic site Schö 12. The deposits that yielded the artefacts and bones are from Channel I and are stratigraphically older than the Schö 12 finds from Channel II.

**1994** Excursions, organized in the frame of the general meeting of the International Union for Quaternary Research (**INQUA**) in Berlin (August 1994), visited the excavations at Schöningen.

**1994** The mining activities continued in a south-eastern direction and in September 1994, in an area about 250 m southeast of the site Schö 13 I, artefacts and bones were discovered in a Channel II exposure (site **Schö 13 II**). One of the most spectacular finds at that moment was the discovery of a throwing stick (fig. 9). Hartmut Thieme recognized the importance



Figure 9 Schö 13 II-4 – throwing stick. (from Thieme 2007).



of the find and he was able to convince the mining company that the site should be excavated properly, and an area of about 3000 m<sup>2</sup> became available for long-term archaeological research.

**1995** A first (semi-popular) **book** with an overview of the results of the Schöningen project and the discovered archaeological, botanical and faunal finds and with e.g. detailed information of the 88 cm long Palaeolithic throwing stick was published by Hartmut Thieme and Reinhard Maier. The publication entitled *Archäologische Ausgrabungen im Braunkohltagbau Schöningen, Landkreis Helmstedt* contains also contribution of e.g. Mania, Urban, van Kolfschoten and Schoch (Thieme and Maier 1995).

**1995** The most spectacular finds were discovered in autumn 1995: **wooden spears** (fig. 10) that resemble modern javelins, made as projectile weapons rather than thrusting spears or lances. The well-elaborated throwing spears were found amongst a large number of butchered animal bones (mainly horse).

**1997** The publication of the wooden spears from Schö 13 II-4 in *Nature* (Thieme, 1997) made the site world famous and many archaeologists regarded the wooden spears as one of the major discoveries in Palaeolithic research in the past decades. It was concluded, and generally accepted, that these spears were used to hunt large mammals. The discovery had significant implications for Palaeolithic archaeologists. The assumption that Early and Middle Palaeolithic hominins were scavengers, a model that was fashionable since the early 1980s, was since the discovery of the Schöningen spears “definitely” replaced by a hunting scenario with considerable depth of planning combined with sophisticated and efficient hunting technology (Dennell 1997).

**2007** The spectacular archaeological finds were displayed for a larger public in a temporary **exhibition** set up in the *Braunschweigischen Landesmuseum* (24.11.2007 – 24.2.2008) and in the *Niedersächsischen Landesmuseum Hannover* (28.3.2008 – 27.7.2008). In the frame of this exhibition, Hartmut Thieme wrote (with support and contributions of many colleagues) a **book** entitled *Die Schöninger Speere - Mensch und Jagd vor 400.000 Jahren*. The book has 248 pages and presents many spectacular finds (e.g. the wooden spears) but also the preliminary results achieved by the different (sub)disciplines taking part in the Schöningen project. Summarizing information about e.g. the botanical remains, the molluscs, the fish, reptiles, amphibians and mammalian record is presented (Thieme 2007).

**2007** The federal state of *Niedersachsen* established a **scientific commission** that should act as an advisory board and conduct the Schöningen project. The commission decided that more time should be invested in the scientific publication of the Schöningen data and they agreed that it is impossible for Dr Hartmut Thieme to combine the coordination of the excavation and the publication of the data from the previous 15 years. Hartmut Thieme was given the choice, either to continue his leadership of the excavation and give the data of the previous years to someone who will publish these data, or to transfer the responsibility and coordination of the excavation to someone else and focus the last five years before his retirement on the publication of the fantastic results he achieved. In the end he decided to accept the second option. For Hartmut Thieme this was a difficult decision and it is obvious that for him the establishment of the commission and the decisions they took (e.g. the



Figure 10 Schö 13 II-4 – wooden spear no. III. (Photo Thijs van Kolfschoten).

- choice that commission gave him), cannot be classified as historical highlights of the Schöningen project.
- 2008** The commission decided that Professor Dr Nick Conard (Tübingen) (member of the commission) should take over the excavations in Schöningen, and **Dr Jordi Serangeli** was appointed as scientific leader and coordinator of the excavations in Schöningen starting 1st June 2008.
- 2009** In 2009 it was decided to build a **research and experience centre (paläon)** in Schöningen at the edge of the southern quarry not far from the site Schö 13 II. The official opening will be in the spring of 2013.
- 2009** The age of the Palaeolithic finds has for many years been a matter of debate. In order to clarify this issue, a **workshop** was organized in Hannover (30.10.2009) where the different disciplines involved in the debate presented their data and views. The general feeling was that there is a kind of consensus that the spears have an age of about 300 – 325 ka. However, there is still debate about the stratigraphical position of the finds in a broader European context. The proceedings of the workshop will be published in a special volume that is part of the newly established series of publications that will present the scientific results of the Schöningen project.
- 2012** Since the University of Tübingen has been involved in the Schöningen project, the Schöningen team has expanded and different studies have been initiated, e.g. the investigation of the postulated fireplaces. The preliminary results of the research so far, including the results of the extensive geological research by Jörg Lang (Hannover), the archaeozoological analyses conducted by Thijs van Kolfschoten and his team, and the isotope analyses (Margot Kuitens et al.) were presented at the annual meeting of the **Society for American Archaeology (SAA)** in April 2012 in Memphis (USA).

There will certainly be new highlights in the near future, for instance the opening of the *paläon*, the new research and experience centre in Schöningen (Spring 2013). Although not a highlight, the retirement of Dr Hartmut Thieme in November 2012 and the appointment of a successor, combined with the establishment of the research and experience centre will lead to major changes in the Schöningen project but hopefully also result in new, scientific highlights.

#### 4 THE ARCHAEOZOOLOGICAL CONTRIBUTION IN THE PAST 20 YEARS

The Palaeolithic excavations in the past 20 years are restricted to the western edge of the southern quarry (fig. 3), starting in 1992 with the site Schö 12B, followed in 1994 by

excavations at the site Schö 13 I, and later that year a start was made with the excavation of the site Schö 13 II. The site Schö 13 II-4 has been the main focus of the Schöningen project since 1994. Several years ago, the mining company decided to terminate their mining activities in the area. No further expansion of one of the quarries; the company will only dig away the dam that separates the southern from the northern quarry and exploit the lignite that forms the lower part of that dam; a process that should be finished in 2013. The Quaternary deposits of the dam area yielded two clusters of sites, Schö 13 I DB and Schö 12 II DB.

A permanent team of at least 5-6 excavators have been digging these sites, 9 months a year, for the past 20 years and they collected apart from artefacts thousands of mammalian fossils. At the site, the fossils were removed from the sediment. Bigger specimen or delicate remains were taken out in blocks of sediment. During the first years all finds were transported to Hannover for conservation. Later, when the conservation capacity in Hannover proved to be not large enough, it was decided to store the botanical and vertebrate finds (including the blocks of sediments with finds) in cold storage in Barsinghausen, near Hannover with the consequence that the material was no longer accessible for further investigation. That situation changed in 2007 when it was decided that the material should be investigated. The fossils vertebrate remains, except for a number of larger finds (e.g. a horse skull and a bison skull) that are still in the sediment blocks, were transported from cold storage in Barsinghausen to Leiden for conservation, numbering, identification and data input of the more than 15,000 specimens; a process that is almost finished. This offered the possibility to investigate the entire fossil large mammal record excavated from 1992 until June 2008, when Tübingen University took over the excavation, as well as the study of the excavated finds.

The different sites and exposed deposits appeared to be also rich in smaller vertebrates that could be relevant for palaeoenvironmental reconstructions and for biostratigraphical correlation between the different sites within the Schöningen area, as well as the correlation between the Schöningen sites and other Palaeolithic sites. Special campaigns to collect smaller vertebrate remains from the different outcrops have therefore been organized since 1992. Every year a group of students of the Faculty of Archaeology, Leiden University visits Schöningen and under supervision of André Ramcharan and Thijs van Kolfschoten, they take sediment samples from specific layers (fig. 11), soak these sediments for a few hours (fig. 12), and fractionate the sediment samples using a set of sieves and water (fig. 13). The sediment fraction smaller than 1 mm will be washed away and the larger fractions will be dried and sorted either at the site or at the institute in Leiden.



Figure 11 Taking sediment samples (May 2009).  
(Photo Thijs van Kolfshoten).



Figure 12 Soaking the sediment samples in buckets (June 2010).  
(Photo Thijs van Kolfshoten).



Figure 13 Fractionating the sediment samples using a set of sieves and water (June 2012). (Photo Thijs van Kolfshoten).

#### 4.1 The Schöningen fossil vertebrate record

The oldest Quaternary fossil remains have been excavated at the site Schö 13 I. The Channel I site yielded a small amount of small mammal remains (not very well-preserved molars of the genera *Arvicola* and *Microtus*) as well as 161 large mammal fossils: mammoth, horse, red deer and bison. Preliminary investigations suggest rather open conditions but the material is still under study. The site Schö 13 I DB did not yield any vertebrate remains.

The vast majority of the vertebrate fossil remains are from deposits in Channel II with its five depositional phases (1-5). Within this channel there are two concentrations of sites: a) Schö 12 (with the sites/levels Schö 12 A, Schö 12 B, Schö 12 II-1, Schö 12 II-2, Schö 12 II-3, Schö 12 II-4, Schö 12 II-5) and b) Schö 13 (with the sites/levels Schö 13 II-1, Schö 13 II-2, Schö 13 II-3, Schö 13 II-4, Schö 13 II-Berme).

The sites Schö 12 A and Schö 12 B, excavated in 1992, yielded more than 800 large mammal remains and several hundred molars of small mammals. The site Schö 12 B in the lower part of the Channel II infilling yielded a fauna including e.g. *Sorex minutus*, *Sorex (Drepanosorex) sp.*, *Sorex sp.* (cf. *Sorex araneus*), *Desmana sp.*, *Castor fiber*, *Lemmus lemmus*, *Clethrionomys glareolus*, *Arvicola terrestris cantianus*, *Microtus (Terricola) subterraneus*, *Microtus arvalis*, *Microtus agrestis*, *Microtus oeconomus*, *Apodemus sp.*, *Ursus sp.*, Mustelidae, *Elephas antiquus*, *Dicerorhinus kirchbergensis*, *Equus mosbachensis*, *Sus scrofa*, *Cervus elaphus*, *Capreolus capreolus*, *Bos/Bison*, indicating interglacial conditions and a forested environment (van Kolfshoten 1993; 1995; 2007; van Zijderveld 1995; Fennema 1996; Voormolen 1996).

The Quaternary deposits in the Schö 12 area became accessible again after 15 years when in 2007 a start was made to dig away the dam that separated the northern from the southern quarry. All the levels (1-5) exposed in Channel II appeared to yield artefacts and vertebrate remains. The new excavations in the Schö 12 area yielded a number of spectacular finds, for example an incomplete skull with both antlers of a giant deer (*Megaloceros giganteus*) (fig. 14), an incomplete skull with horn cores of a water buffalo (*Bubalus cf. murrensis*) (fig. 15) and an incomplete skull of an Aurochs associated with an almost complete postcranial skeleton (Böhner *et al.* 2010). The faunal assemblages from the dam area have not yet been investigated in detail.

Most of the larger mammal material was collected from the site Schö 13 II and in particular from deposits referred to channel II depositional phase 4 (Schö 13 II-4), the horizon with the famous wooden spears. More than 12,000 large mammal remains are recorded from the site Schö 13 II-4 representing a variety of species (table 2) (van Kolfshoten *et al.* 2007). The material is not equally distributed over the



Figure 14 The giant deer *Megaloceros giganteus*: posterior part of the skull with right antler excavated at site Schö 12 II-1. (Photo Wolfgang Mertens).



Figure 15 Lateral view of the posterior part of the water buffalo *Bubalus cf. murrensis* excavated at site Schö 12 II-1. (Photo Wolfgang Mertens).

excavated area; there is an area with a high concentration with up to 150 specimens per square metre (fig. 16). The lower levels at the site (Schö 13 II-1, Schö 13 II-2 and Schö 13 II-3) also yielded large mammal remains but the

Faunallist Schö 13 II-4	nr. specimen
Aves	57
Carnivora	7
Proboscidea	1
<i>Stephanorhinus kirchbergensis</i>	2
<i>Stephanorhinus hemitoechus</i>	1
<i>Stephanorhinus</i> indet.	2
<i>Equus mosbachensis</i>	3693
<i>Equus hydruntinus</i>	1
<i>Sus scropha</i>	1
<i>Cervus elaphus</i>	116
<i>Megaloceros giganteus</i>	7
Cervidae indet.	43
<i>Bos primigenius</i>	9
<i>Bison priscus</i>	9
<i>Bos/Bison</i>	129
Large mammal	4080
Medium mammal	210
Indet.	1889

Table 2 List of taxa recorded at the site Schö 13 II-4.

numbers are much lower. This is partly due to the fact that only a restricted part of these levels has been excavated but also due to a lack of big concentrations as we know from Schö 13 II-4. Several students from the Faculty of Archaeology, Leiden University studied parts of the fossil assemblages from these sites and presented the results in their BA or MA theses (van Asperen 2004; Matze 2010; Berkholst 2011).

All the investigated archaeological find horizons yielded remains of smaller vertebrates. To collect these remains special campaigns have been organized in the past 20 years; campaigns that resulted in several thousand identifiable fossils representing fish, reptiles, amphibians, birds and mammals. A number of Bachelor and Master theses are devoted to the Schöningen small mammal record (e.g. Huyghebaert 2003; van der End 2008; Knul 2009). Merel Herzberg studied, supervised by Dr G. Böhme (Berlin), part of the herpetofauna from Schö 12B (Herzberg 2000).

#### 4.2 The results so far ...

Part of the fossil mammalian remains from Schöningen have been studied and analysed. The scope of the main research is four fold: palaeoenvironmental, biostratigraphical, archaeozoological and paleontological.

##### 4.2.1 Palaeoenvironmental research

The palaeoecological analyses of the Reinsdorf Channel II sequence 1-5 showed a number of interesting results. The mammalian faunal record from the base of Channel II indicates that the infilling of Channel II started during an interglacial optimum. The occurrence of species such as the dormouse *Eliomys* sp. and the wild boar *Sus scrofa* confirm

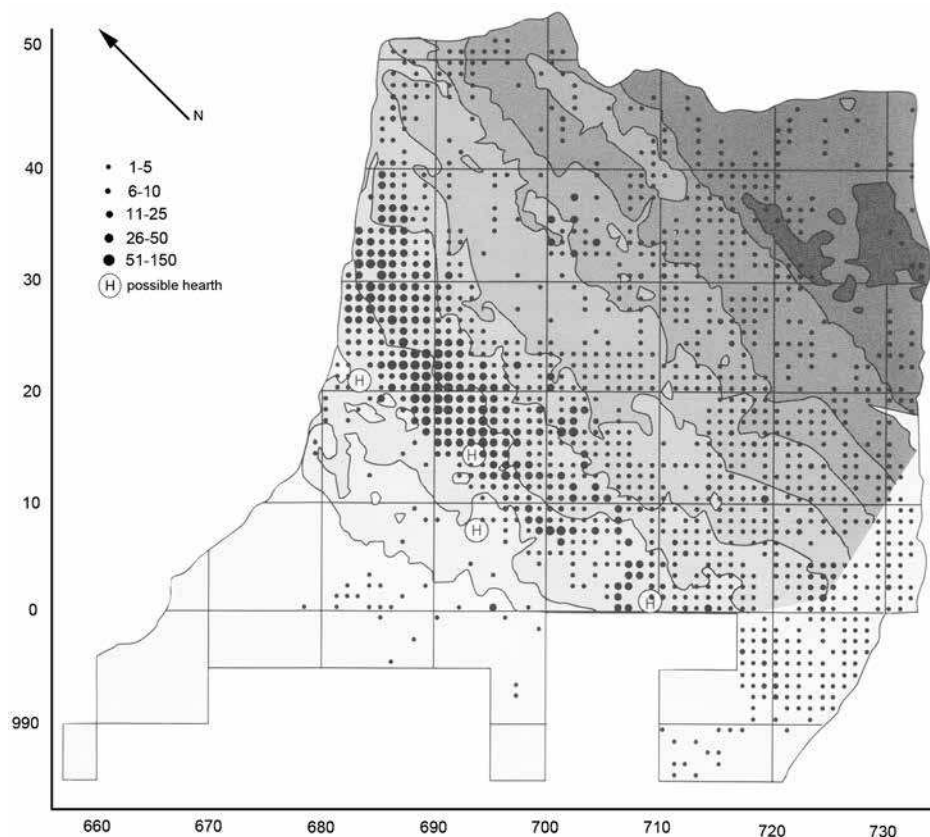


Figure 16 Map of the site Schö 13 II-4 showing the distribution of the recorded larger mammal remains. (map produced by Utz Böhner, NLD – Hannover).

the interglacial character of the fauna. The mammalian record clearly shows that early interglacial phases are not recorded and that there is a stratigraphical hiatus between the Channel II deposits and the underlying Elsterian sediments. Only at the very base of the Channel II sequence, a few remains of the collared lemming *Dicrostonyx* sp., indicative of glacial climatic conditions, have been found. These finds are regarded as re-deposited remnants dating from a glacial phase pre-dating the Reinsdorf Interglacial.

The fossil remains from the Channel II sequence 1-5 are from a period of changing climate, from the transition from an interglacial optimum at the base to the beginning of the following cold stage at the top of Channel II. However, the changes in the mammalian record are not as obvious as one would expect. The faunal assemblages from level 1 indicate interglacial conditions and a forested environment alternated with areas of more open, steppe vegetation. Several forest dwellers (e.g. *Stephanorhinus kirbergensis*, *Sus scrofa*) that occur in Channel II level 1 have also been recorded in the faunal assemblage of Channel II level 4 (table 2). The

sequence did not yield assemblages that clearly indicate climatic deterioration and the occurrence of glacial conditions. The fact that other proxies indicate climate change (Böhme 2007; Urban 2007) might indicate that the faunal changes were relatively minor and/or that the mammalian fauna had a high degree of resilience for these changes.

#### 4.2.2 (Bio)stratigraphical research

From the start of the project there has been a debate on the age of the archaeological finds. Crucial in this debate is first of all the geological setting. The Reinsdorf Interglacial deposits with the spears are stratified between deposits of the Elsterian and Saalian glaciations, indicating that they are late Middle Pleistocene in age. Mammal fossils are important for detailed biostratigraphical dating because specific species evolve rather fast and others became extinct. In addition, with the mammalian remains long-distance correlation can be established and the locally defined stratigraphical units such as the Reinsdorf Interglacial can be incorporated in broader, European stratigraphical framework.

R. Musil (Brno, Czech Republic) studied a selection of the horse skulls from Schö 13 II-4 and put the results in a biostratigraphical framework based on the evolution of horses. He concluded that the horses from Schöningen 13 II-4 are clearly younger than the horses from Bilzingsleben II (Musil 2002). Eline van Asperen investigated the majority of the horse remains from the different stratigraphical horizons of the Schöningen sequence and showed that, compared to the horses from Bilzingsleben II, Schö 12 II-1 and Schö 12 II-2, the material from Schö 13 II-4 is relatively small and she confirmed Musil's assumption about the difference in age between Bilzingsleben II and Schö 13 II-4. (van Asperen 2003; 2004). In a recent publication van Asperen states that the Bilzingsleben II assemblage and those of the Schö 12 II and Schö 13 II sites most probably date from two separate interglacials and correlates the Bilzingsleben II fauna with MIS 11 and the Schö 12 II/Schö 13 II faunas with MIS 9 (van Asperen 2012).

Other students from Leiden also focused their investigations on the Schöningen material on stratigraphical questions (Huyghebaert 2003; van der End 2008; Knul 2009; Berkholst 2011) and concluded, based on e.g. the evolutionary stage of the *Arvicola terrestris cantiana* molars, that the Reinsdorf assemblages post-date the Lower Palaeolithic finds from Boxgrove (UK) and pre-date the Middle Palaeolithic/MIS 7 remains from Maastricht-Belvédère (the Netherlands). The SDQ-values<sup>1</sup> of the Schöningen water voles, one of the best represented species in the Schöningen record, indicate that a correlation between the Channel II faunal assemblage and the British MIS 11/Hoxnian (=Holsteinian) faunas is very unlikely. The Schöningen SDQ values are clearly much lower and also the rare occurrence of a so-called *Mimomys*-fold in the Schöningen record indicates that the populations from MIS 11 sites such as Barnham and Beeches Pit (Parfitt 1998; Preece *et al.* 2007), where the *Mimomys*-fold frequencies are much higher than in Schöningen, are more primitive and, hence, stratigraphically older. A correlation with younger (MIS 9) faunas seems to be most plausible.

**4.2.3 Archaeozoological and taphonomical research**  
Shortly after the discovery of the first Palaeolithic vertebrate remains from Schöningen, Boudewijn Voormolen, a student of the Faculty of Archaeology Leiden, started to investigate the material with an archaeozoological focus. He investigated first of all the Schö 12B remains (Voormolen 1996; 1997). Subsequently he started his PhD research for which he studied and analysed part<sup>2</sup> of the fossils from Schö 13 II-4, and concentrated his research e.g. on the preservation of the material and on the well-preserved marks: butchering or cut marks, gnawing marks and impact scars. His results were presented in a PhD thesis (Voormolen 2008a) and are published in an issue of *Journal of Taphonomy* (Voormolen 2008b).

Large mammals Schö 13 II-4	N
bones with cutmarks	1104
bones with impact marks	1040
bones with cut- & impactmarks	442

Table 3 The number of bones from the site Schö 13 II-4 with cut marks and/or impact features.

In the past few years almost all material (> 12,000 records) excavated at the Schö 13 II-4 site became available for detailed investigation. The distribution of the Schö 13 II-4 fossil vertebrate remains is shown in fig. 16. Analyses of the fauna show that a variety of species are represented at the site (table 2) and that many bones show traces of hominin interference (table 3) (Afkir 2011). The marks on the (horse) bones indicate skinning, dismembering, (restricted) filleting, removing of the periosteum, marrow extraction, and the use of bones as tools (figs 17 and 18). The fossil material is very well preserved and does not show large variation in the degree of weathering. This suggests that we are dealing with material that has been accumulated during a relatively short period of time and not with a palimpsest of material from different (butchering) episodes.

#### 4.2.4 Palaeontological research

The identification of the variety of species represented in the different faunal assemblages is also an interesting challenge for vertebrate palaeontologists. R. Musil (Brno, Czech Republic) studied the horse skulls from Schö 13 II-4. Eline van Asperen examined the horse remains from the different levels and published part of the results (van Asperen 2012). In order to compare the horse from Schöningen with the fossil horses from Eastern Europe and Asia, Dr Tatiana Kuznetsova (Moscow, Russia) recently measured part of the material from Schöningen. The red fox *Vulpus vulpus* (Carnivora, Canidae) from Schö 13 II-4 has been studied and the details published (van Kolfshoten 2003). The characteristics of other taxa are being investigated by Leiden students, e.g. the Rhinocerotidae by Boxmeer (2011) and the Cervidae by den Engelsman (2011).

#### 5 ADDITIONAL PROJECTS

Apart from the archaeozoological studies listed above, a number of other research projects with a focus on material from Schöningen has been initiated. The projects vary from a) the study of insects, b) the reconstruction of palaeo-diet using stable isotope data and meso- and microwear data, c) the search for molecular (aDNA) data, and d) measuring Amino Acid Racemisation data for stratigraphical purposes and for long-distance correlation between sites.



Figure 17 Bone fragment from site Schö 13 II-4 with long scraping marks and green bone fractures indicating removal of the periosteum and marrow processing. (Photo Thijs van Kolfschoten).



Figure 18 Distal end of a metatarsus from a horse *Equus mosbachensis*. The damages indicate that the bone was used as hammer during stone tool production or curation. Bar = 1 cm (Photo Monika Knul).

### 5.1 Entomology

The occurrence of insect remains in the Schöninggen deposits is obvious and the late Russell Coope and other entomologists indicated that the study of insects (Coleoptera in particular) can be successfully applied to collect detailed (local) environmental data on temperature, humidity, the occurrence of specific plants or dung etc. (Coope 2010). However, only a few sediment samples have been investigated so far by I. Benjamins (Leiden University) under supervision of Professor P. Buckland (Sheffield, UK) (Benjamins 2005). Samples for further research have been taken and are stored.

### 5.2 Isotope research

The fact that most of the Schöninggen fossil remains are so extremely well preserved triggered the idea that the bones, despite their age, might contain collagen that potentially could be used for isotope research in order to collect additional environmental data, information about diet of the various taxa, and information about the migration of species. Karen van der Veen (Leiden) tested (supervised by Professor Dr J. van der Plicht, Center for Isotope Research, Groningen University and Faculty of Archaeology, Leiden University) the presence of collagen in the Schöninggen bones and the impact of the preservative Mowilith on the results. She indicated the presence of collagen and showed that there is no significant difference between the isotope data from bones treated with Mowilith and from untreated bones (van der Veen 2010). Reason enough to start a pilot and investigate in more detail the bones from Schöninggen. Margot Kuitems (Leiden), financially supported by the Leiden University Foundation (LUF), sampled 90 bones from different taxa (Elephantidae, Equidae, Rhinocertidae, Cervidae and Bovidae) and from different stratigraphical horizons. The stable isotope ( $^{13}\text{C}$ ,  $^{15}\text{N}$ ) signals are surprisingly good; they vary and the different taxa show clear clusters (Kuitems *et al.* in prep.). One of the remarkable preliminary results is the indication that the Schöninggen horses are predominantly browsers. In order to verify this, the meso- and microwear characteristics of the (pre)molars of the Schöninggen horses are being investigated in close cooperation with Florent Rivals (Tarragona, Spain). The preliminary results have been presented at the annual meeting of the Society for American Archaeology (SAA) (2012 April, Memphis, Tennessee, USA). The isotope research will be continued by Margot Kuitems in the frame of a PhD project (supervisors: Professor Dr J. van der Plicht / Professor Dr M. van Kolfschoten and Professor Dr H. Bocherens (Tübingen University)).

### 5.3 aDNA research

The fact that the collagen of the Schöninggen bones is so well preserved, taking the age of the bones into account, offers the possibility of retrieving aDNA from the fossils remains. However, the test carried out by Aline Nieman and Dr Klaas Vrieling (DNA Marker point, Faculty of Sciences, Leiden University) did not yield positive results so far.

### 5.4 Amino Acid Racemisation (AAR)

The AAR method is generally and successfully applied in Quaternary Research in the United Kingdom, France and the Netherlands in the establishment of the stratigraphical position of sites and the long-distance correlation between sites. Molluscs and in particular the opercula of *Bythinia* appeared to be very useful. Mollusc remains have been

collected from the sediment samples taken for palaeozoological research and Professor Dr K. Penkman (York, UK) analyses the samples. Only preliminary results are available so far.

## 6 SUMMARIZING CONCLUSIONS AND THE FUTURE

The Schöningen project is in many aspects unique and the involvement of the Faculty of Archaeology in the investigations of the Palaeolithic finds in the past 20 years was important, not only for the Schöningen project itself but also for the faculty. Many students participated in the annual field work organized by the faculty (and several students extended their stay in Schöningen to excavate longer). The huge amount of finds formed the base for many bachelor and master theses with a variety of topics, as well as a PhD thesis discussing the Schöningen 13II-4 Kill and Butchery site. The investigations yielded important data for the reconstruction of the palaeo-environment during hominin occupation of the region, the (bio)stratigraphical dating of the sites, the long-distance correlation with other Palaeolithic sites and above all data on hominin subsistence and their hunting and exploration strategies. For a number of reasons mentioned above, taking the number of sites and the huge amount of finds into account, only little has been published so far. However, the “old” material is now accessible and the flow of new material is decreasing. This offers the possibility to merge the data presented in the Bachelor and Master theses with unpublished data and to prepare for international journals a number of manuscripts presenting the Schöningen material and discussing different topics. A special issue of the *Journal of Human Evolution* with contributions devoted to the Schöningen Palaeolithic finds is in preparation and due to appear in 2013.

### 6.1 Future Research

In the near future, the Faculty of Archaeology will still be involved in the Schöningen project and participate in the archaeozoological research. Most of the larger mammal remains, excavated before the University of Tübingen became involved (i.e. May 2008), have been identified and analysed but the material from a number of sites/levels still has to be studied in detail which will take at least a few years. This is also the case with the smaller mammal remains, collected in the past 20 years. The stable isotope research project started a few years ago and will continue in close cooperation with Tübingen University. However, changes in the organization (e.g. the fact that colleagues from Tübingen University are now leading the excavation and analysing the larger mammal remains) and the opening of the research and experience centre *paläon* will finally change the role of Leiden in the project. The involvement of Leiden in the research of hominin subsistence and their hunting and exploration strategies will decrease and the Leiden focus

might be more on taphonomical, palaeoenvironmental and biostratigraphical questions. For the future it is important to continue the organisation of the annual field school in order to collect small vertebrates from newly exposed deposits. One very important issue is to merge the environmental results obtained by the different disciplines: botany (pollen as well as botanical macro remains), malacological data, data based on the fish, reptile and amphibian record, geological (sedimentological) data and so on. The same applies to the biostratigraphical research, where merging of the data from the different disciplines is one of the most important issues for the near future. Next to this the study of the zoological remains from a paleontological point of view will be continued. It is obvious that also in the future the Leiden research in Schöningen will take place in close cooperation with the institutions involved, in particular the *Niedersächsisches Landesamt für Denkmalpflege* (NLD, Hannover) (Professor Dr S. Winghart, Dr H. Thieme, Dr U. Böhner) and *Abteilung für Ältere Urgeschichte und Quartärökologie, Institut für Ur- und Frühgeschichte und Archäologie des Mittelalters, Universität Tübingen* (Professor Dr N.C. Conard, Dr J. Serangeli and others) and also in close cooperation with many scientists that played a role so far and those who will play a role in the future, e.g. Professor Dr B. Urban (Lüneburg), Professor Dr D. Mania (Jena), Professor Dr M. Frechen (Hannover), and Professor Dr Jutta Winsemann (Hannover).

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## Notes

1 Representatives of the genus *Arvicola* are an important biostratigraphic marker for the Middle and Late Pleistocene. The molars of the water vole show evolutionary changes in their enamel. During this period the thickness of the enamel of the trailing edges, compared to the leading edges, changes. The differences in enamel thickness are expressed in so-called *Schmelzband-Differenzierungs-Quotient* (SDQ)-values (Heinrich 1978).

2 About 4600 mammal remains from Schö 13 II-4 were conserved and numbered in Hannover before 2000 and were available for Voormolen's archaeozoological analyses.

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