

THE SCHÖNINGEN MAMMALIAN FAUNA IN BIOSTRATIGRAPHICAL PERSPECTIVE

Since the discovery of the first Palaeolithic artefacts in Schöningen/Baufeld-Süd (Schö 12) by Dr. Hartmut Thieme the Faculty of Archaeology, Leiden University takes part in the Schöningen research, concentrating on the study of the vertebrate remains from the Pleistocene deposits. The study focuses on archaeozoological (Voormolen 2008a; 2008b) as well as paleoenvironmental and biostratigraphical questions (e.g. Thieme 2007; Thieme et al. 1993; van Kolfschoten 1993; 2003; 2007).

The larger mammal remains have been collected during the past 17 years in the frame of the archaeological excavations conducted by H. Thieme and his team. Special campaigns to collect smaller vertebrate remains have been organized almost every year since 1992. The result so far is more than 15 000 larger mammal fossils and over 7000 identifiable smaller mammal remains. Part of the material has been studied and biostratigraphically analyzed and the preliminary results are put in the context of what is known about the faunal changes during the later (post-Elsterian) part of the Middle Pleistocene.

LATE MIDDLE PLEISTOCENE FAUNA EVOLUTION

The European fossil mammalian record of the later part of the Middle Pleistocene is rather well known. It indicates that generally speaking, the present-day mammalian fauna has been established during that period of time. Relict species from the Early or early Middle Pleistocene such as *Talpa minor*, *Trogotherium cuvieri* and *Pliomys episcopalis* survived the Elsterian glacial period but gradually disappeared during the late Middle Pleistocene. What remained was a »modern« fauna that consists of species that still occur in Europe or species that gradually evolved into the present-day forms. But also this »modern« fauna underwent big changes in the past 400ka due to changes in climate and environment what resulted in (local) extinction, migration and dispersal of species as well as the evolution of species.

Changes in the geographical distribution of mammal species (due to migration/dispersal) is certainly the major factor in the changes of composition of the Quaternary faunas in a specific region. These fluctuations are first of all caused by the alternation of the available habitats due to the changes in climate and environment (van Kolfschoten 1995b). Eurasian cold stage faunas from the last and penultimate glacial period are characteristic and rather well known; species such as *Dicrostonyx gulielmi*, *Lemmus lemmus*, *Mammuthus primigenius*, *Coelodonta antiquitatis* and *Rangifer tarandus* expanded their range southwards and occur together with species which prefer a more steppic environment such as ground squirrels (*Spermophilus undulates*) and hamsters (*Cricetulus migratorius* and *Cricetus cricetus*) that expanded their geographical range north- and westwards. A rise in temperature led to more distinct steppic conditions in the lower latitudes. These steppic conditions resulted in the increase of the relative number of steppe elements. Lemmings and other cold stage indicators withdrew northwards and species such as the steppe lemming *Lagurus lagurus* migrated westward and invaded Northwestern Europe. A rise in temperature is followed, in certain areas such as the North European plain, by an increase of oceanic influences. That results in a climate, which induces a re-establishment of forests with thermophilous broad-leaved and conif-

erous trees and the return of forest dwellers such as glirids (*Eliomys quercinus*, *Muscardinus avellanarius*), wild boar (*Sus scrofa*), and cervids (*Cervus (Dama) dama* and *Capreolus capreolus*) (van Kolfschoten 1992). This general picture of alternating species, more or less the same species that »comes and goes«, is applicable to the late Middle and Late Pleistocene.

Biostratigraphically important is also the extinction of species. Several examples demonstrate the global or local extinction of species. Well known are the Late Pleistocene – early Holocene extinctions of mainly larger mammals that can be observed in almost every continent. In Central Europe species such as *Ursus spelaeus*, *Mammuthus primigenius*, *Coelodonta antiquitatis*, *Equus hydruntinus* and *Megaloceros giganteus* disappeared at the end of the Late Pleistocene or the beginning of the Holocene. Extinction in the smaller mammal fauna of Eurasia can be observed in Middle Pleistocene faunas. Species such as *Drepanosorex savini*, *Talpa minor* and *Trogontherium cuvieri* are relicts from the Early Pleistocene that became extinct during the Middle Pleistocene. Extinction is often preceded by a strong reduction of the geographical range of a species and a retreat to a refugial area. The Late Pleistocene European rhinoceros species *Stephanorhinus kirchbergensis* and *Stephanorhinus hemitoechus* show a progressive southward contraction of their geographical range before getting extinct before the Late Glacial Maximum (Stuart 1993; 2005; Stuart et al. 2004) whereas the youngest record of the giant deer *Megaloceros giganteus* has been found in Western Siberia (Stuart et al. 2004).

The evolution of species is another important aspect in discussions about that age of an (archaeo)zoological assemblage in particular if we are dealing with Palaeolithic assemblages. There are a number of species that clearly evolve even in a relative short period as the Quaternary. The evolution is, in some cases rather rapid, in others rather slow and not all the evolutionary changes occur in the same period of time. Some species mainly evolve during the Early Pleistocene whereas others show clear changes during a later phase of the Quaternary. Remarkable is the fact that many species show comparable evolutionary changes. A general feature in the evolution is: a) the increase in the height of the crown of the (pre)molars and b) the increase of complexity of the enamel pattern of the (pre)molars. Both features are related to the adaptation to more abrasive nutrition. The deterioration of the climate led to the reduction of woodland vegetation and an expansion of a more open habitat with a dominance of grasses. For many herbivores this implies a change to more abrasive food. Among the species that show a clear evolution during the Quaternary and are e.g. the mammoths belonging to the lineage *Mammuthus rumanus* – *Mammuthus meridionalis* – *Mammuthus trogontherii* – *Mammuthus primigenius* (Lister 1992; Lister et al. 2005) and a large number of voles representing different vole-lineages including the *Mimomys* – *Arvicola* lineage (Heinrich 1987; Neraudeau et al. 1995).

Change in size is another feature that can be observed in a number of Quaternary species. Pleistocene wolverines show a remarkable increase in size during the Middle Pleistocene. The same, however less extensive, can be seen in e.g. wolves. Late Pleistocene caballoid horses, on the other hand, decrease in size from the later part of the Middle Pleistocene onwards. Changes in size are generally not unidirectional and are therefore not a good feature for biostratigraphical purposes. It can only be used in combination with other data.

Although the palaeozoological record of the late Middle and Late Pleistocene is rather extensive there is no well-established, detailed and widely accepted formal biozonal (on the mammalian record based) subdivision of that time span applicable for Eurasia. Biozonations as we know from the Tertiary or the early Quaternary are too coarse for the detailed information Palaeolithic archaeologists are looking for. The occurrence of an *Arvicola* – *Microtus* mammal assemblage indicates that we are in the Toringian biozone. The first occurrence of the genus *Arvicola*, marking the beginning of the Toringian, dates around 0.5 Ma ago (van Kolfschoten 1990; von Koenigswald / van Kolfschoten 1996). The Toringian is too short and the

geographical differences in the local development of the mammalian fauna too big, to define a useful subdivision of that particular biozone applicable for e. g. Europe. The stratigraphical setting of Middle and Late Pleistocene strata offers in many cases the possibility to correlate them to regional stages such as the widely adapted North West European Stages. Furthermore, there is a tendency to use the Marine Isotope Stages (MIS) as a reference in the debate on the age of continental finds, in spite of the very restricted number of direct correlations between continental and marine zonations.

EVOLUTION WITHIN THE GENUS *ARVICOLA*

As stated above, most species do not show a clear evolution during the late Middle and Late Pleistocene; there is however one exception and that is the water vole of the genus *Arvicola*. *Mimomys savini*, a vole with rooted molars, is the ancestor of the living water vole *Arvicola terrestris*. *Mimomys savini* occurred in the European faunas during the late Early and the early Middle Pleistocene. The transition of populations of water voles with rooted molars to populations with more hypsodont, unrooted molars referred to the genus *Arvicola*, took place during the first half of the Middle Pleistocene. This transition seems to be well established since populations with a small percentage of rooted molars are known from several localities in Germany, Italy, Czech Republic and Russia. The genus *Arvicola* with unrooted molars shows clearly a gradual evolution in the differentiation in the thickness of the enamel since its appearance during the early Middle Pleistocene. Looking at the occlusal surface of the molars one can observe clear changes in the differentiation of the enamel. The occlusal surface of the molars of voles shows a number of dentine field covered with enamel at the outer side. The anterior enamel edge of the salient angles of the lower molars is concave, the posterior convex. The concave edges occlude first during the longitudinal movement of the mastication; they are the so-called leading edges. The convex edges are the trailing edges. In a large number of living species the enamel of the trailing edges are much thinner than that of the leading edges i. e. the so-called *Microtus* enamel differentiation. The opposite (the *Mimomys* enamel differentiation) can be observed in many more primitive species. The transition of trailing edges that are thicker to a situation in which the leading edges are relatively thicker is called the evolution in the differentiation in the thickness of the enamel.

The enamel differentiation appeared to be an important marker to indicate the evolutionary stage of *Arvicola* and hence the relative age of the fossil record. Many palaeozoologists noted the evolutionary changes and used these characteristics to date late Quaternary faunas biostratigraphically. The evolution of *Arvicola*, as is indicated by von Koenigswald (1973) for fossils of Central European faunas, could also be traced in the British faunas (Sutcliffe / Kowalski 1976) and Jánossy (1976) noticed the same evolution in the Hungarian faunas. To quantify the differences in the enamel thicknesses Heinrich (1978) proposed to calculate the enamel thickness quotient and launched the so-called Schmelzband-Differenzierungs-Quotient (SDQ) values. He measured the enamel thickness on both sides of the salient angles of the m1, dividing the value of the trailing edge by the one of the leading edge and multiplying the quotient by 100. The SDQ of one molar is the mean of the SDQ-values of all salient angles. High values indicate rather primitive populations whereas low values means more advanced forms. Establishing the evolutionary stage of the fossil *Arvicola* remains appears to be a valuable, widely used, tool to subdivide the fossil record biostratigraphically (Heinrich 1987; van Kolfschoten 1990; 1992; von Koenigswald / van Kolfschoten 1996; Parfitt 1998; Preece et al. 2007). It became one of the most applied tools to date and to characterize the different glacial as well as interglacial faunal assemblages that can be correlated with the stratigraphical subdivision of the late

Schöninghen Mammalian fossil record	Schö 13 I	Schö 12 B	Schö 13 II-4
Order Insectivora			
<i>Sorex minutus</i>		x	x
<i>Sorex (Drepanosorex) sp.</i>		x	x
<i>Sorex sp. (cf. Sorex araneus)</i>		x	x
<i>Neomys newtoni</i>			cf.
<i>Desmana sp. (aff. D. moschata)</i>		x	x
<i>Talpa europaea</i>			x
Order Rodentia			
<i>Castor fiber</i>		x	x
<i>Trogontherium cuvieri</i>		x	x
* <i>Dicrostonyx sp.</i>		x	
<i>Lemmus lemmus</i>		x	x
<i>Clethrionomys glareolus</i>		x	x
<i>Arvicola terrestris cantianus</i>	x	x	x
<i>Microtus (Terricola) subterraneus</i>		x	x
<i>Microtus arvalis</i>		x	x
<i>Microtus agrestis</i>		x	x
<i>Microtus oeconomus</i>		x	
<i>Microtus gregalis</i>			x
<i>Microtus sp.</i>	x		
<i>Apodemus sp.</i>		x	
Order Carnivora			
<i>Panthera (Leo) sp.</i>			
<i>Canis lupus</i>			x
<i>Vulpes vulpes</i>			x
<i>Ursus spelaeus</i>		x	
<i>Ursus thibethanus</i>		x	
<i>Mustela erminea</i>			x
<i>Mustela nivalis</i>			x
<i>Mustela sp. (large mustelid)</i>			x
<i>Martes sp.</i>			x
Order Proboscidea			
Elephantidae gen . et sp. Indet.			
<i>Elephas antiquus</i>		x	
<i>Mammuthus sp.</i>	x		
Order Perissodactyla			
<i>Equus mosbachensis</i>		x	x
<i>Equus sp.</i>	x		
<i>Stephanorhinus kirchbergensis</i>		x	x
<i>Stephanorhinus hemitoechus</i>			x
Order Artiodactyla			
<i>Sus scrofa</i>		x	
<i>Cervus elaphus</i>	x	x	x
<i>Megaloceros giganteus</i>		x	
<i>Capreolus capreolus</i>		x	
<i>Bos primigenius</i>			x
<i>Bison priscus</i>			x
<i>Bison sp.</i>	x		
<i>Bos/Bison</i>		x	

Tab. 1 Preliminary list (March 2010) of mammalian species represented in the Schöninghen sites Schö 13 I, Schö 12 B and Schö 13 II-4. **Dicrostonyx sp.* are regarded as contamination, reworked from older levels dating to a preceding cold phase.

Middle Pleistocene with three interglacial phases between the Elster and Saale (Drenthe) glaciations as put forward by various authors (e.g. Urban 1995; van Gijssel 2006; Mania 2007).

THE SCHÖNINGEN FOSSIL MAMMALIAN RECORD

The base of the Quaternary sequence exposed at the Schöningen open-cast lignite quarry is formed by Elsterian till deposits. On top of these deposits a late Quaternary sedimentary sequence is preserved (Thieme / Maier 1995; Mania 2007). D. Mania (together with H. Thieme and B. Urban) investigated and recorded in great detail the Quaternary deposits in the southern quarry (Schöningen–Baufeld-Süd) and he concluded that the Quaternary deposits on top of the Elsterian till are situated in six erosional channels and the channel infillings represent different climatological cycles (Mania 1995). Channel I-III cover the time span between the Elster and the Saale glaciation, Channel IV-VI postdate the Saale glaciation. The deposits from the Channels I-III were assigned by a number of authors (Urban 1991; 1993; 1995; Jöris / Baales 2003; van Gijssel 2006; Thieme 2007) to three different interglacials i. e. the Holsteinian Interglacial and the locally defined Reinsdorf Interglacial and Schöningen Interglacial.

Vertebrate remains are collected from two channel or depression infillings, Channel I (site Schö 13 I) and Channel II (sites Schö 12B and Schö 13 II) (**tab. 1**). The archaeological site Schö 13 I yielded a small amount of mammalian remains representing small mammals (not very well-preserved remains of the genera *Arvicola* and *Microtus*) as well as large mammals: mammoth (*Mammuthus* sp.), horse (*Equus mosbachensis*), red deer (*Cervus elaphus*)/bison (*Bison* sp.) (Thieme 2007). The mammalian record suggests rather open conditions; it is, however, too small to give detailed information about the environmental conditions and the age of deposition.

Channel II with its five depositional phases (1-5), yielded a very rich mammalian fauna. Most of the larger mammal material has been collected from deposits referred to depositional phase 4 (Schö 13 II-4), the famous wooden spear horizon. But from the sites Schö 12 B and Schö 13 II we know that also the levels 1, 2, and 3 are rich in mammalian remains. 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 (Fenne- ma 1996; van Kolfschoten 1993; 1995a). The mammalian fauna indicates furthermore that there is a stratigraphical hiatus between the base of the Channel II deposits and the underlying Elster deposits. The fragmentary remains of the arctic lemming (*Dicrostonyx sp.*) are regarded as contamination, reworked from older levels dating to a preceding cold phase.

The site Schö 13 II yielded more faunal remains also from the upper depositional phases, from Channel II levels 1, 2, 3 and 4. Thousands of fossil remains of smaller and, in particular, larger mammals have been revealed. The investigation of the mammalian fossil remains from Schöningen is in progress and the results presented so far (e.g. van Kolfschoten et al. 2007; Heinrich / van Kolfschoten 2007), as well as in this paper, should therefore be regarded as preliminary. The mammalian fauna from level 4 (the spear horizon; Schö 13 II-4) is diverse although less diverse than the fauna from level 1 (Schö 12 B). The small mammal fauna includes e.g.: *Desmana moschata* (**fig. 1**), *Sorex sp.*, *Trogontherium cuvieri*, *Lemmus lemmus*, *Arvicola terrestris cantianus* (**fig. 2**), *Microtus arvalis*, *M. agrestis*, *M. gregalis* and *M. (Terricola) subterraneus*.



Fig. 1 *Desmana moschata* (Schö 13 II-4). Lower mandible sin. with p2 – m3. – **a** occlusal view. – **b** side view. – (Photo A. Ramcharan).



Fig. 2 *Arvicola terrestris cantianus* (Schö 13 II-4). Lower mandible dext. with l, m1 and m2. – **a** occlusal view. – **b** side view. – (Photo A. Ramcharan).

The large mammal fauna includes the small and medium-sized carnivores *Mustela erminea*, *Mustela nivalis*, *Mustela sp.*, *Martes sp.*, *Canis lupus*, and *Vulpes vulpes*. A member of the Order Proboscidea is present in the fauna. *Equus mosbachensis* is the most numerous species in the fauna, accounting for over 95% of the identifiable remains (see also Musil 2002). The Artiodactyla are represented by *Cervus elaphus*, (cf.) *Bos primigenius* and (cf.) *Bison priscus* (fig. 3). The fauna indicates a more open environment. Cold-adapted



Fig. 3 Metacarpus dext. *Bos primigenius* (left), and *Bison priscus* (right) (Schö 13 II-4). (anterior view). – (Photo M. Knul).

species are, however, absent and the occurrence of *Bos primigenius* in the Schöningen 13 II-4 assemblage is indicative of a still interglacial climate, though less warm than the interglacial maximum climate of Schöningen 12 B.

THE RELATIVE AGE OF THE SCHÖNINGEN MAMMALIAN RECORD

The fossil mammalian record from Schöningen is characterised by an *Arvicola* – *Microtus* mammal assemblage which indicates that both assemblages (from Channel I and II) are of Toringian age, a biozone with

a maximum age of about 500ka (Roebroeks / van Kolfschoten 1995). The oldest Toringian faunas such as Mosbach, Miesenheim I, Mauer, Boxgrove have a pre-Elsterian/Anglain age and are correlated with the late Cromerian (van Kolfschoten 1990) or with MIS 15 and/or MIS 13. The mammalian record from Channel I is too poor to give a precise age indication. A post-Elsterian age as deduced from the lithostratigraphical position of the fossil record is supported by the evolutionary state of the finds. The faunal record from Channel II is much richer and far more indicative. The fauna from Channel II contains relicts from the early Middle Pleistocene (*Sorex [Drepanosorex] sp.*, *Trogontherium cuvieri*). This feature, together with the high SDQ values (the mean SDQ values are: Schö 12 B: 125,4; Schö 13 II-1: 124,0; Schö 13 II-2: 118,9; Schö 13 II-3: 117,7; Schö 13 II-4 115,2) indicates that we are dealing with a Toringian fauna that is relatively speaking, old. There is no doubt that the fauna is younger than the small mammalian assemblage from Schöningen Channel I and e.g. Bilzingsleben II (Heinrich 2003) and older than those from e.g. the German localities Weimar-Ehringsdorf, Ariendorf, Schweinskopf and Maastricht-Belvédère (the Netherlands) (van Kolfschoten 1990) and Cagny l' Epinette (France) (Tuffreau et al. 1995) and many more late Middle Pleistocene, Palaeolithic sites.

DISCUSSION AND CONCLUSIONS

Summarizing one can conclude that the fossil mammalian record from Channel I and II have a post-Elsterian character and the presence of relicts from the early Middle Pleistocene as well as the evolutionary stage of the *Arvicola* molars indicate an age predating many well-known late Middle Pleistocene interglacial faunas. The stratigraphical framework established by Mania and Thieme and applied in the Schöningen research so far indicates three interglacial phases between the Elsterian and Saalian (Drenthe) glaciations: Holsteinian, Reinsdorf Interglacial and Schöningen Interglacial. The existence of three major warm episodes (interglacials) is shown in a large amount of publications on late Middle Pleistocene sequences in e.g. Great Britain and France (for more detailed information on this topic the reader is referred to e.g. van Gijssel 2006). A plausible correlation between the three interglacials and the standard MIS curve is presented in **table 2**. A correlation between Reinsdorf Interglacial and MIS 9 implies that localities (e.g. Weimar-Ehringsdorf, Maastricht-Belvédère and Cagny l' Epinette) with a late Middle Pleistocene record that is, based on biostratigraphical evidence, younger than the Reinsdorf Interglacial data, could be correlated to the Schöningen Interglacial or MIS 7.

However, Meijer / Cleveringa (2009) introduced the so called Oostermeer Interglacial which they correlate with MIS 7 and they argue that the interglacial deposits at Maastricht-Belvédère (the Netherlands) should be correlated with MIS 9. The mammalian fauna from Maastricht-Belvédère is, however, much more advanced than the Reinsdorf Interglacial fauna from Schöningen Channel II. Meijer / Cleveringa's proposal implies that the Reinsdorf sequence would be at least one interglacial older i.e. should be correlated with MIS 11.

Furthermore, there is an on-going debate about the number of interglacials (2 or 3) between the Elsterian and Saalian glaciation (Geyh / Müller 2005) and hence, the status of the Reinsdorf Interglacial and whether or not, the deposits of Channel II should be correlated with the Holsteinian Interglacial. For the interpretation of the Schöningen sequence it implies also a debate on the issue if the deposits of Channel I and Channel II represent two different interglacial cycles or originate from a single interglacial phase. The fauna from Channel I is so far too poor to confirm or reject any option. Data from other disciplines might be more discriminating. Based on the mammalian biostratigraphical evidence a Holsteinian age for the Channel II

		MIS	NW European stages	Schöningen sequence	
Holocene		1			
Pleistocene	Late	5d-2	Weichselian		
		5e	Eemian		
	Middle	6	Saalian		Schöningen Interglacial
		7			
		8			
		9			Reinsdorf Interglacial
		10			
		11	Holsteinian	Holsteinian Interglacial	
		12	Elsterian		
		13	Cromerian Complex		
		14			
15					
16					

Tab. 2 Stratigraphical position of the Holsteinian, Reinsdorf and Schöningen Interglacial and the correlation with the Marine Isotope Stages (MIS) according to Van Gijssel (2006). (For additional information about this table see text: discussion and conclusions).

assemblage cannot be excluded. Central European mammalian faunas that are beyond any doubt Holsteinian in age are, unknown so far (von Koenigswald / Heinrich 1999).

The post-Anglian (= Elsterian) mammalian record from Great Britain is more extensive and the stratigraphical position of the faunal assemblages, that in many cases derive from deposits exposed in the terraces of the former river Thames, is rather well known. The stratigraphical framework for the late Middle Pleistocene (post-Anglian/ Elsterian) continental deposits shows the existence of three major interglacials. For the designation of these interglacial phases the term MIS 11/Hoxnian (= Holsteinian) is used whereas for the younger interglacials the MIS terminology (MIS 9 and 7) is used to indicate the younger late Middle Pleistocene warm episodes. Correlation between the faunal record from Schöningen and the different English faunal assemblages referred to MIS 11-MIS 7 so far only supports the »old« age. The occurrence of the early Pleistocene relict species in the Schöningen record such as the giant beaver *Trogotherium cuvieri* suggests a correlation with the Hoxnian (= Holsteinian) MIS 11 faunas. In the English record *Trogotherium cuvieri* is absent in the MIS 9 faunas (a.o. Roe et al. 2009). However, the SDQ-values of the Schöningen water voles, one of the best represented species in the Schöningen record indicates that a correlation between the Channel II faunal assemblage and the British MIS 11 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 (>20%) than in Schöningen (<5%), are more primitive and, hence, stratigraphically older. The well represented horse remains from Schöningen also do not exclude nor confirm a correlation with the British MIS 11 or MIS 9 horses. The late Middle Pleistocene caballoid horses of the British Isles are rather variable and the horses from the three interglacial phases (MIS 11, 9 and 7) display differences in size and shape (van Asperen 2009). Van Asperen (2009, 446) states: »However, the changes in size and shape do not follow a unidirectional trend, but fluctuations can be observe, which can be interpreted as ecomorphological response to the fluctuating climate ...« The observed differences between the Schöningen horses and the British record should therefore not only be interpreted in a (bio)stratigraphical sense. In order to correlate the Schöningen record and the one from the British Isles it is important to take into account and investigate the regional differences for many species and to interpret the mammalian record in their environmental context.

Summarizing it can be stated that based on the available data it seems unlikely that the Schöningen mammalian record from Channel II correlates with MIS 11/Hoxnian. A correlation with MIS 9 seems most plausible and is supported by other data (see Sierralta et al. this volume). The suggestion to correlate Channel II with the Holsteinian Interglacial based on botanical evidence (see Bittmann and Urban / Sierralta this volume) raises many questions. The Holsteinian Interglacial is assumed to be the first interglacial phase after the Elsterian/Anglian correlated with e. g. the Hoxnian. There are also arguments that support a correlation between the Holsteinian Interglacial and MIS 11 (e. g. Koutsodendris et al. 2010). If one assumes that there are three interglacial phases between the Elsterian and Saalian (Drenthe) glaciations and combines the different proposals, one could conclude that the Holsteinian Interglacial is complex and that the »Holsteinian Complex« or »Holsteinian s.l.« covers two warm episodes that are from a botanical point of view, rather similar. If that is the case, it has to be discussed and decided which one of the two interglacial episodes has to be regarded as the Holsteinian s.s., the classical Holsteinian. The Holsteinian Interglacial s.s. could be the first warm episode after the Elsterian (and the continental equivalent of the British Hoxnian) or the second warm episode after the Elsterian. An interesting dilemma that has to be solved in an international discussion taking into account data from different countries with a good late Middle Pleistocene, geological (stratigraphical) as well as biological, record including the Schöningen sequence. Pending this debate, the author prefers to use the stratigraphical subdivision of the late Middle Pleistocene that is presented in **table 2**. A subdivision that is presented in many papers and is based on the assumption that the Holsteinian s.s. is the first interglacial after the Elsterian followed by an interglacial that is assigned to the locally defined Reinsdorf Interglacial. Correlation between the mammalian fauna from Channel II and the second interglacial episode after the Elsterian underlines the main conclusion of this paper i. e. that the mammalian fauna postdates Hoxnian faunas and should be correlated with the second interglacial after the Elsterian and hence, that there is a substantial stratigraphical hiatus between the deposits of Channel II that yielded the mammalian record and the underlying Elsterian till.

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ZUSAMMENFASSUNG / ABSTRACT

Die Schöninger Säugetierfauna in biostratigraphischer Perspektive

Die paläolithischen Ausgrabungen in Schöningen/Baufeld-Süd und die speziellen Kampagnen zur Aufsammlung kleiner Wirbeltierreste lieferten eine große Menge großer und kleiner Säugetierreste aus den Füllungen zweier Rinnen oder Senken, Rinne I (Fundstelle Schöningen 13 I) und Rinne II (Fundstellen Schö 12B und Schö 13 II) mit ihren fünf Ablagerungsphasen (1-5). Die Faunengemeinschaften aus dem unteren Bereich von Rinne II weisen auf interglaziale Verhältnisse in einer (teilweise) bewaldeten Umwelt; dabei besteht ein stratigraphischer Hiatus zwischen der Basis von Rinne II und den liegenden Elster-Ablagerungen. Das Vorkommen von Relikten aus dem frühen Mittelpleistozän sowie der Evolutionsstand der Molaren von *Arvicola* zeigen ein höheres Alter als viele bekannte Interglazialfaunen aus dem späten Mittelpleistozän. Die Fauna aus der Rinne II wird mit dem hier definierten Reinsdorf-Interglazial verbunden. Der Vergleich zwischen dieser Rinne II aus Schöningen und den gut untersuchten und reichen britischen Funden zeigt, dass das Fundmaterial aus Reinsdorf jünger ist als die Faunen des Hoxnian (MIS 11) und dass eine Korrelation mit jüngeren Faunen (MIS 9) sehr wahrscheinlich ist.

The Schöningen mammalian fauna in biostratigraphical perspective

The Palaeolithic excavations in Schöningen/Baufeld-Süd and the special campaigns to collect smaller vertebrate remains have resulted so far in a large amount of larger and smaller mammal remains collected from two channel or depression infillings, Channel I (site Schö 13 I) and Channel II (sites Schö 12B and Schö 13 II) with its five depositional phases (1-5). Faunal assemblages from the lower part of Channel II indicate interglacial conditions with a (partly) forested environment as well as the existence of a stratigraphical hiatus between the base of Channel II and the underlying Elsterian deposits. The presence of relicts from the early Middle Pleistocene as well as the evolutionary stage of the *Arvicola* molars indicates an age predating many well-known late Middle Pleistocene interglacial faunas. The fauna from Channel II is correlated with the locally defined Reinsdorf Interglacial. Comparison between the Schöningen Channel II fauna and the well-studied and extensive British record indicates that the Reinsdorf mammalian record post-dates the Hoxnian/MIS 11 faunas and that a correlation with younger (MIS 9) faunas seems to be most plausible.