Living on the edge (Schöningen 13II – 3)

Environmental reconstruction and investigation of plant usage and subsistence of early hominids during the Middle Pleistocene in Germany.

Alessandro De Lazzari

Clarys, B. (2023, February 22). *Artistic depiction of a Schöningen hunting scene* [Digital illustration]. Ars Technica. https://arstechnica.com/science/2023/02/neanderthals-spread-diverse-cultures-across-eurasia-before-we-came-along/

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Environmental reconstruction and investigation of plant usage and subsistence of early hominids during the Middle Pleistocene in Germany.

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Abstract

This Thesis' focus is a botanical reconstruction of the environment of Schöningen 13II-3, an archaeological site in the Lower Saxony region of Germany. This site, which is famous for its incredible preservation conditions and evidence for early human weapon use and hunting, has a wealth of studies on it, most of these concentrating on the spear horizon layer 13II-4.
This thesis investigates the layer under it, the layer 13II-3, where skeletal remains of a straight tusked elephant and microlith remains were found.
Two sediment samples were collected from layer 13II-3 with the intention of extracting and identifying plant macrofossils from them. These samples went through the processes of soaking in water and soap, sieving, picking and were identified at the botany lab at Leiden University. A set of extra samples previously sieved on site were also investigated, to broaden the range of identified plant remains.

The results reveal a flora dominated by aquatic and semi-aquatic taxa, including *Carex* spp., *Potamogeton* spp., *Zanichellia palustris*, and *Nuphar* spp. With outliers such as *Betula* macrofossils, indicating a shallow slow moving paleolake and wetland environment.
Based on this environmental reconstruction, this thesis then tries to look at plants that would have been of use to early hominids and attempts to link them to the hominid presence at the site and what their uses might have been for early hominids.

Although no direct evidence for plant use is present, the taxa identified in this study include several species with known nutritional and technological potential. The findings support the interpretation of Schöningen 13II-3 as a rich environment likely visited repeatedly by hominids rather than permanently occupied. This study demonstrates the value of archaeobotanical analysis to reconstruct local environments and contributes to a more integrated understanding of the interactions between hominin and the environment at Schöningen.

Keywords: Archaeobotany, Middle Pleistocene, Schöningen, plant macrofossils, hominin subsistence

1 Introduction

1. Archaeology during The Pleistocene

The Pleistocene was a period spanning from about 2.58 million to 11,700 years ago. This era significantly shaped the Earth and its inhabitants as we observe them today. This period, characterised by dramatic temperature and climate fluctuations, was the time of the Ice Ages, which radically altered the Earth's geography and its living organisms. During this era, key events took place, including the evolution of anatomically modern humans and other hominids, their global dispersal, the rise and fall of Pleistocene megafauna, and the invention of fire and art. The Pleistocene marked a time of profound change for the Earth and signified the origins of the human race.

1.2 Archaeology in Europe

The Pleistocene is considered the Era when archaeology begun in Europe.
Much of Europe's northern areas were covered by massive ice sheets, the Scandinavian ice sheets covered at times most of the Nordic countries, the British Isles, central Germany, and Poland extending across the Russian plains till the Arctic Ocean (Johnson & Hilton, 1999). These Ice sheets did not always cover Europe in massive glaciers; as fluctuations in the Earth's orbit, called the Milankovitch cycles lead to colder and warmer periods in the earth's climate causing the expansion and retreat of the ice sheet. These cycles change "the shape of Earth's orbit, known as eccentricity; the angle Earth's axis is tilted with respect to Earth's orbital plane, known as obliquity; and the direction Earth's axis of rotation is pointed, known as precession" (Cermak, 2024).
These changes in the Earth's orbit are thought to be the driver of glacial and interglacial variations, which involve the extent and retreat of ice sheets, resulting in a transition from a colder climate to a warmer one (Cermak, 2024).

During the Pleistocene, we see the spread of hominids to Europe and the beginning of the archaeological record. These dispersals in Europe were cyclical, with each hominid species having its own pathways to the continent and bringing with it its own lithic technologies.

The earliest hominids in Europe were *Homo Erectus* this was the first hominid species found outside of Africa. *Homo Erectus* was approximately 145 to 185 cm tall and weighed between 40 and 68 kg. The most complete fossil individual of this species is known as the 'Turkana Boy' currently in display at the National Museum of Kenya.
This early hominid species spread out of Africa and into the Near East around 1.9 million years ago (Carotenuto et al., 2016, p. 1) and then further into Eurasia through various highly debated pathways. The earliest site in Europe is considered to be Dmanisi in Georgia, where four hominid fossils, thousands of vertebrate remains, and more than one thousand stone tools were found, (Gabunia et al. 2001 p. 159: Lordkipanidze, D., et al. 2007, pp .305-307).

With the spread of *Homo erectus* in Europe, we also see the appearance of lithic technologies. Stone tools were essential to the survival of early hominins; some believed that these tools were what enabled *Homo erectus* to migrate and spread out of Africa to new continents. Early archaeological evidence supported a relatively late age for the dispersal, at some 1 million years ago (Ma). This bolstered the idea that the Acheulean technological innovation may have eased the exploration of new environments (Carotenuto et al., 2023, p. 1;).
This theory was later challenged by the finds at Dmanisi, but it is still highly probable that the introduction of the Acheulean lithic technology had a significant impact on the spread of hominins in Europe.

Acheulean stone technology was characterised by hand axes or bifaces that are large tools usually between 10 and 20 cm in length (Gowlett, 2015, p. 1). Other more recent hominids are found in Europe during this time, *Homo heidelbergensis*, a successor of *Homo erectus* and a possible predecessor of *Homo neanderthalensis*, inhabited Europe 600,000 to 200,000 years ago (McHenry & Henry, 2025). *Homo heidelbergensis* was first identified from a jaw found near the town of Mauer, southeast of Heidelberg, Germany. This hominid was widespread throughout Europe, inhabiting sites such as Boxgrove in England and Sima de los Huesos. *Homo Heidelbergensis* is still a highly debated topic, as there is evidence for it being an ancestor of *Homo sapiens* in Africa, but evolutionary evidence for it being a Neanderthal ancestor in Europe is contested (Buck & Stringer, 2014 p.214).

More recently in the archaeological record, some of the most publicly recognised hominids appear, with *Homo neanderthalensis* and *Homo sapiens*. These hominids are first recorded in Europe at around 430,000 years ago for Neanderthals, with early Neanderthal fossils found at Atapuerca, Spain (Quam et al., 2023 p. 2345). At around 45–43 thousand years ago, *Homo sapiens* reached Europe as well (Mylopotamitaki et al., 2024 p. 355).

1.3 Archaeology in Germany

Germany is the focus of this thesis. Here some crucial Pleistocene sites are found that offer insight into human evolution and behaviour during this era. One of the most famous sites is Mauer, where the iconic Heidelberg jaw (*Homo heidelbergensis*) was unearthed in 1907. The mandible, which dates to around 600,000 years ago, is the type specimen of the species and offers important morphological information about the transitional fossils between *Homo erectus* and *neanderthalensis* (Buzi et al., 2021).

Equally important is the Steinheim skull, found in southwest Germany, which has a mix of both primitive and modern features. Although it had been assigned to *Homo Steinheimensis* before, later retrodeformation and morphometric analyses now suggest its position in the *neanderthalensis* line, thus adding support to the view of a gradual, and regionally diverse evolution of Middle Pleistocene hominids (Buzi et al., 2021).

A further important archaeological site is that of Bilzingsleben, dating to around 350,000 years ago (MIS 9e). This large open-air settlement site has yielded hominin fossils classified as *Homo erectus*, as well as a large assemblage of lithic artefacts, wooden implements, and engraved bones. These engravings, some of the oldest known examples of non-utilitarian markings, suggest a degree of symbolic behaviour and cognitive complexity earlier than had previously been estimated (Bednarik, 2024 p. 695). In addition, the site is notable for its extremely well-preserved living surfaces and possible residential features, making it one of the most important Lower Palaeolithic sites in Europe. All of these sites provide the background for the understanding of the outstanding importance of Schöningen in Lower Saxony. This large Middle Pleistocene site has yielded an unparalleled collection of wooden spears, some measuring over two meters in length, along with butchered animal bones and stone tools, all dating to around 300,000 years ago.

These discoveries are the oldest known instances of intact wooden hunting weapons and suggest advanced planning, cooperative hunting practices, and possibly even social organisation among *Homo heidelbergensis* (Buzi et al., 2021). Schöningen is consequently a central case study for this thesis, with its outstanding preservation and context providing the chance to investigate early hominin behaviour and subsistence practices in northern Europe.

1.4 Schöningen

The site of Schöningen is situated in eastern Lower Saxony, Germany, between the towns of Helmstedt and Schöningen (Serangeli et al., 2015, p. 31; Conard et al., 2015, p. 2). The site is located within the Helmstedt-Staßfurt lignite basin, which spans over 70 km from northwest to southeast into Saxony-Anhalt (Lang et al., 2012; Conard et al., 2015, p. 2), as can be seen in Figure 1.

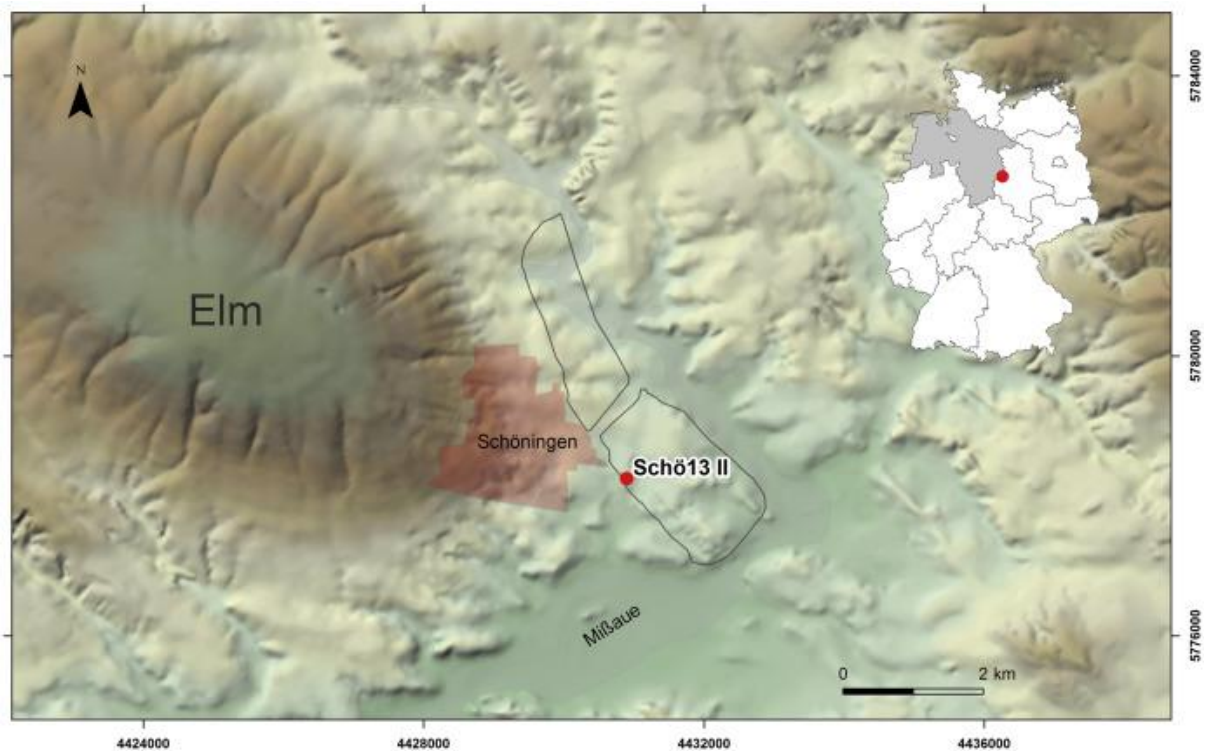

Figure 1: Location map of Schöningen. Map of Schöningen site 13 II within the open cast lignite mine (black outline) (Conrad et al, 2015, p. 3, Figure 2).

The site's history begins with an open-cast lignite mine and the Archäologische Schwerpunktuntersuchungen im Helmstedter Braunkohlerevier (ASHB) project (Conard et al., 2015, p. 2). In 1982, it was overseen by Hartmut Thieme, who set out to rescue the sites threatened by large-scale, open-cast lignite mining at Schöningen (Conard et al., 2015, p. 2). Later, Thieme established a research team after finding Palaeolithic artefacts and large animal bones. This team included Dietrich Mania (Geology, Malacology), Brigitte Urban (Botany), and Thijs van Kolfschoten (Zoology) (Conard et al., 2015, p. 2).

Thieme and his team proceeded to uncover many important artefacts in the coming years, such as the "Klämmschäfte" (handles) and the "Wurfholz" (throwing stick) (Conard et al., 2015, p. 2). At the beginning of the project, Thieme had to work quickly as the mining operations were progressing rapidly. An area called the "Sockel" was left by the mining company for Thieme and became the focus of his excavation in 1994 and 1995 (Conard et al., 2015, p. 2).

On November 1st, 1995, Thieme brought a group of 25 colleagues and local observers to the Schöningen 13 II-4 Horse Butchery Site to present his discoveries, which included spears, horse remains, fireplaces, and stone tools (Conard et al., 2015, p. 4). The finds uncovered by Thieme were exceptional and led to a continuation of the excavation of the site, which is still ongoing today (Conard et al., 2015).

The site of Schöningen has since then undergone extensive excavation and has been investigated using a multidisciplinary approach, with studies being conducted on stratigraphy, archaeology, archaeozoology, and archaeobotany (Serangeli et al., 2015; Conard et al., 2015). The site or locality, as it is more accurately described, consists of many different find layers and sub-sites with individual nomenclatures.

The locality is split into two major nominations, 12 and 13. The Roman numerals associated with these numbers indicate the depositional stage of the layer: "The Roman numeral II in Schöningen 12 II and Schöningen 13 II indicates that both sites contain the same sedimentary cycles from the paleolake and were formed during the same interglacial" (Serangeli et al., 2015, p. 31). Arabic numerals are further added to indicate the sedimentary cycles within the layers, with 1 representing the oldest sedimentary cycle and 5 the youngest (Serangeli et al., 2015, p. 31).

The site's layers 12 II and 13 II, which can be seen in Figure 2, have been dated to the Reinsdorf Interglacial by Brigitte Urban, and because the sequence of this interglacial at Schöningen begins with the climatic optimum, sedimentary cycles 1 through 5 span from that optimum to the onset of the Saalian glaciation (Serangeli et al., 2015, pp. 31–32; Urban & Bigga, 2015).

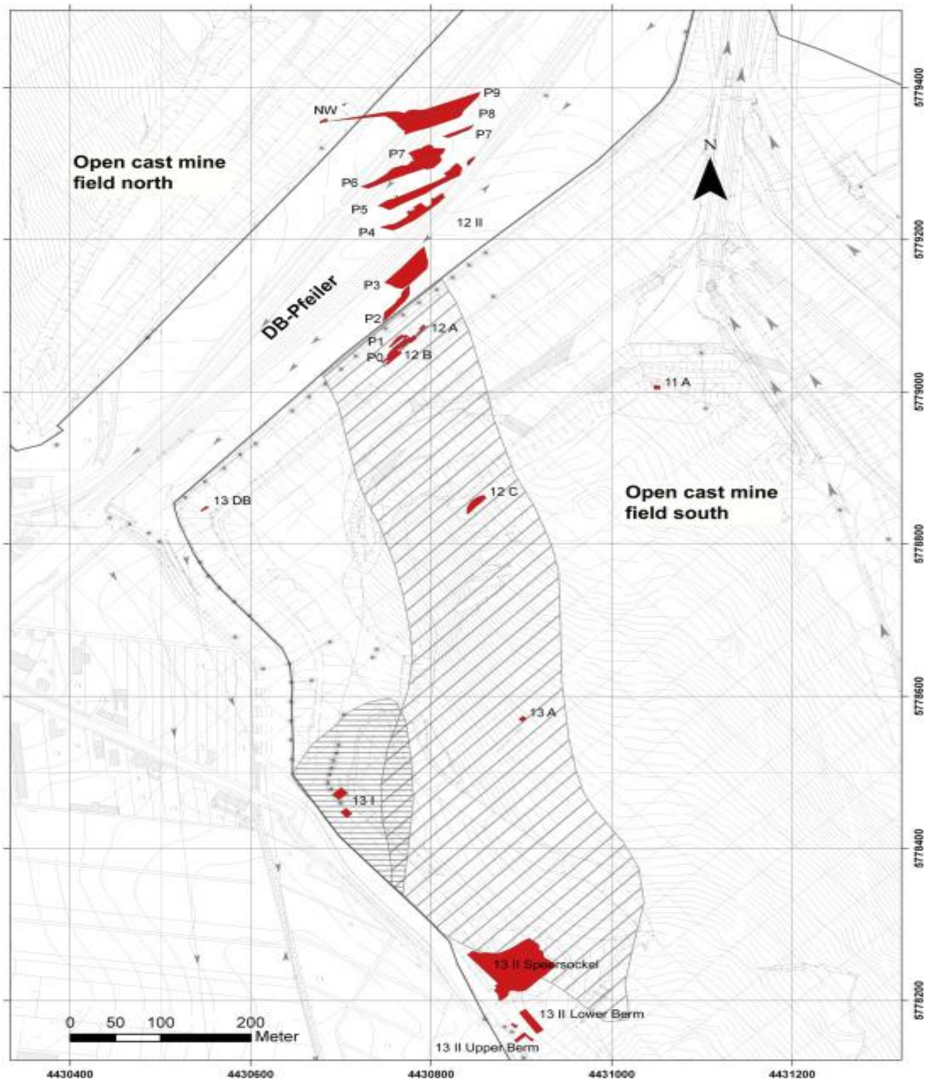

Figure 2: Location of different Schöningen sites. The map shows the location of the different Schöningen sites and finds within the open case lignite mine area and surrounding areas (Serangeli et al, 2015, p. 32, Figure 3)

1.4.1 Schöningen 13 II

Schöningen 13 II is the location of current excavations by Tübingen University, as seen in Figure 2. This site is located on the southwest side of the lignite mine (Serangeli et al, 2015, p. 32, Figure 3).

Schöningen 13 II-4 is the layer that has yielded arguably the most important finds at this site, a set of ten wooden hunting spears and two double-pointed spears, along with other wooden artefacts (Conard et al., 2015; Leder et al., 2024); the spears, as a reference, are important due to their correlation with understanding human complexity in the past. In this layer, as well as the remains of horses with signs of butchery proving possible community hunting, the spears also exhibit signs of being crafted very carefully and with skill, and some of them show signs of impromptu repairs (Conard et al., 2015; Leder et al., 2024).

These spears demonstrate how hominids at the time could create complex and well-crafted artefacts from high-quality materials, probably specifically chosen for their properties, and utilise them to their advantage as early as 300,000 years ago (Conard et al., 2015; Leder et al., 2024).

Apart from the clear presence of hominins at the layer of Schöningen 13II-4 demonstrated by the wooden spears and horse butchery evidence, the presence of hominins at earlier levels 1-3 has also been confirmed, although sporadic, typically through small concentrations across the layers, resulting in clustered finds of a few flint artefacts or worked bones.

This suggests that the site was likely not inhabited before layer 13 II-4, but rather served as a foraging or hunting site, or was a transitional area between other sites (Serangeli et al., 2015; Conard et al., 2015). The lack of evidence for permanent habitation is reflected in the sporadic artefact clusters and the absence of a larger assemblage that is usually associated with a home camp (Conard et al., 2015, p. 12).

1.4.2 Schöningen 13II - 3

Schöningen 13II-3 is the layer directly below Schöningen 13II-4, the famous spear horizon. This layer has been identified in recent excavations, but it has not been academically studied or thoroughly documented.

The most impressive find in this layer is the skeleton of a single female straight-tusked elephant; this skeleton is mostly complete and has been fully excavated (Venditti et al., 2022). Along with the elephant skeleton, flint artefacts were found in proximity to the remains, showing the presence of hominins (Serangeli et al., 2023, pp. 380–381). Evidence of elephant butchery was also found, along with the lithic tools (Venditti et al., 2022).

This layer is the one on which this investigation was conducted and is further described in the second chapter of this thesis.

1.4.3 Hunting ground or home camp?

The possibility of the Schöningen site being a place where hominids lived has been explored earlier in this thesis, but in this chapter, the environmental factors that made Schöningen an attractive site for hominids will be discussed and whether they made an impact on their permanent occupation of the site will be investigated.

Likely the biggest pull factor for hominids at the site was the presence of the paleolake. This abundant source of water and plants probably contributed to the presence of hominids in the area, as shown by the multiple layers of archaeological evidence at the site. Water is a necessary resource for life everywhere, and even in the temperate climate of the Reinsdorf interglacial the presence of a perennial water source would have made Schöningen an attractive site for not only hominids but also for animals.

Animal presence and evidence for animal exploitation can already be seen in this layer with a Eurasian straight-tusked elephant carcass being exploited by early hominids on site (Venditti et al., 2022). In later depositional stages, evidence for hunting is plentiful especially in the 13II-4 layer famously known as the spear horizon.

There is no evidence for perennial habitation of the site. In the elephant butchery layer traces, flint flakes were found, but the lack of larger tools shows that these hominids probably processed the carcass on site, retouched the large tools, leaving only flakes behind and then moved on. Moreover the absence of any remains that might indicate permanent dwellings such as no evidence of fireplaces and remains of structures points to what was said by Conard et al. (2015, p 2) "Any base camps or areas of longer occupation must have been located on dry ground in nearby but slightly upland settings that, if preserved at all, have yet to be excavated at Schöningen". This, alongside the possibly very high mobility of early hominids during the Reinsdorf interglacial period (Conard et al. 2015, p. 12), may suggest Schöningen was a recurring point of interest rather than a place of permanent occupation.

1.5 Research questions and aims

During Schöningen's extensive excavation history, a variety of approaches have been used to investigate the site this is due to the very good preservation conditions at the site. Organic remains such as bones, wood and plants are well preserved in comparison to many other sites, allowing archaeologists to further study this material which is usually rare.

In this thesis the preserved plant material was studied, specifically plant macrofossils found from layer 13II-3, to answer the following research questions:

1. What was the environment like at the site of Schöningen 13 II at the time of deposition of layer 13 II - 3?
2. How did the environment, and specifically plants, affect the presence and subsistence of hominids at the site?

To answer these two questions, samples were collected from layer 13II-3, and an analysis was carried of the plant macrofossils found in the sediment. The results of the analysis were used alongside information from previous research to make a speculative recreation of the environment at Schöningen and assess what role the flora played in the presence of hominids at the site.

2 Background chapter

2.1 The Pleistocene in Europe

The Pleistocene in Europe spanned a period of 2.58 million to 11,700 years ago, concluding with the end of Younger Dryas cold event (Johnson & Hilton, 1999). During the Pleistocene, glaciation events occurred in cycles tied to the Earth's irregular orbit (Milankovitch, 1941; Cermak, 2024). These glaciations led to the formation of large ice sheets and glaciers worldwide, as well as their expansion and subsequent retreat (Johnson & Hilton, 1999).
Such cyclical events are usually called glaciation events; times when the temperature reached its lowest points and when glaciers expanded furthest are called glacial maximums, while in between these maximums there are interglacial periods during which temperatures rise and ice sheets retreat. Central and northern Europe were mostly affected by the Scandinavian ice sheet and underwent glaciation events known as the Elsterian, Saalian, and Weichselian (Ehlers et al., 2011 p. 152; Johnson & Hilton, 1999).

These cycles created changes in both the physical landscape and the living environment. As the ice sheets expanded, they covered much of the northern hemisphere, with the Scandinavian ice sheets at times covering most of Great Britain, down to central Germany and Poland and much of the northern Russian plains up to the Pacific Ocean (Johnson & Hilton, 1999; Ehlers et al., 2011). During this epoch, glaciers in high mountain areas such as the Alps were also much larger and contributed to the changing of the European environment (Ehlers et al., 2011).

Massive ice sheets have drastic effects on the landscape as they are major erosional and depositional agents. Material eroded from the base of glaciers and ice sheets due to erosion caused by the friction and weight of moving ice was transported to the margin of the glacier and deposited there or at the base along its path (Ehlers et al., 2011). This process resulted in the displacement of large amounts of sediment from the central parts of the ice sheets and the deposition along their margins. A clear example of this is the stones used to form the Hunebeds (dolmens) in Drenthe in the northern part of the Netherlands, which originated from Scandinavia and were deposited during the Saalian Glaciation (The Ice Ages – Geopark De Hondsrug, 2023).

2.2 Schöningen 13II

Schöningen 13II is still being excavated today under the supervision of Tübingen University (Serangeli et al., 2015, p.27). This site is located on the southwest side of the lignite mine and can be seen in Figure 2 (Serangeli et al., 2015, p. 32).

From this site many discoveries were found, the most internationally recognized are the Schöningen spears seen in Figure 3. These are often considered as the oldest wooden tools found. The site, which remain under excavation, continues to yield new and important discoveries, such as animal remains including the Auroch skull shown in Figure 5.

Figure 3: Wooden spears of 13 II - 4. The picture shows the spears and wooden artefacts found at Schöningen Figure 3: Wooden spears of 13II - 4 (Leder et al., 2024, p. 3, Figure 1).

In the same layer as the spears, many animal remains showing signs of butchery were found. Suggesting possible community hunting, the spears also display signs of being crafted very carefully and with skill, and some of them exhibit signs of impromptu repairs. (Leder et al., 2024). These spears demonstrate how hominids at the time could create complex and well-crafted artefacts from high-quality materials, probably specifically chosen for their properties, and utilise them to their advantage as early as 300 ka (Leder et al., 2024 p.4).

2.2.1 Detailed stratigraphy

The site of Schöningen is characterised by incredibly well-preserved and thoroughly studied stratigraphy. It is essential to understand this to comprehend the broader geological and geographical processes that shaped the site's physical characteristics.

The stratigraphy at the site starts during the Elstrian glaciation as ice sheets moved over the site and cut through the preexisting sediments. The movement of the ice and the undercutting of the existing geography created a tunnel valley where the Schöningen site was found, this can be seen in figure 4.

These valleys were created by pressurised water underneath the glacial sheets that then cut into the sediment beneath it (Figure 4 A). These valleys are usually very deep but the rim-synclines of the Helmstedt-Staßfurt-saltwall probably provided a preferential path for the ice and meltwater flow according to (Lang et al., 2012, p. 101). The first layers deposited here were meltwater gravels and sands, deposited quickly by strong glacial streams (Lang et al., 2021, pp. 92, 93), followed by layers of sand and silt, indicating calmer depositional periods (Figure 4 B).

During the interglacial period of the Holsteinian, the tunnel valley slowly filled with water, creating the lake that is often referenced in studies about the paleoenvironment of Schöningen. The presence of the lake and its slow filling resulted in layers from this period being mostly composed of sand and silt with very high organic content (Lang et al., 2012), along with peat. This high concentration of organic material, most likely due to the anaerobic conditions of the lake, also facilitated the preservation of organic material.

These sediment layers are from around 300,000 years ago, a warm interglacial period and have presented many archaeological finds due to the favourable preservation conditions. When discussing about archaeology at the site, the layers deposited during this time period are often the ones most frequently referenced; from the layers come the Schöningen spears as well as many other finds and they are also the ones still currently being excavated.

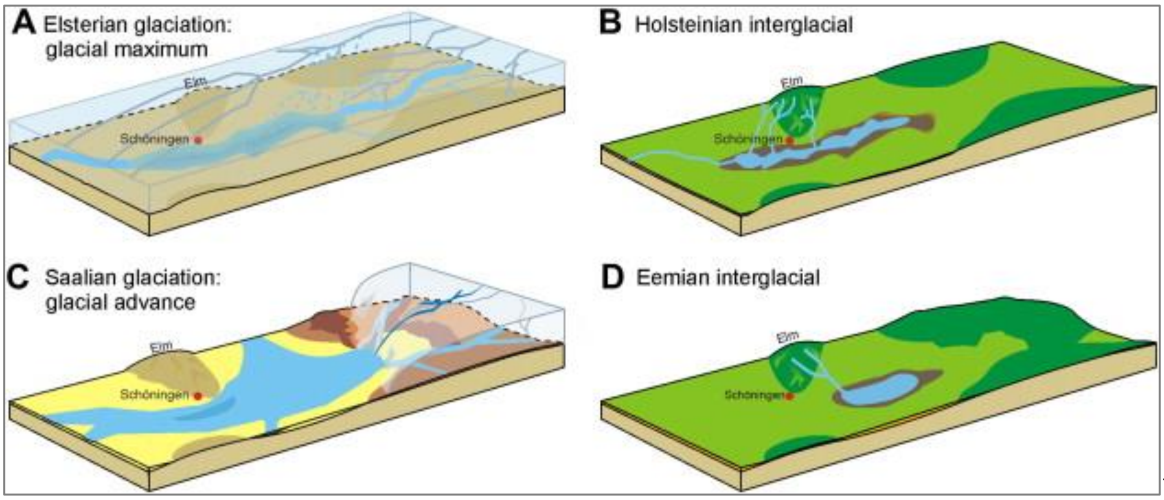

Figure 4: Schöningen Site formation through Glaciations and Interglacials. Figure depicts where and how the site of Schöningen existed and was affected by glaciers during glacial and interglacial periods. (Lang et al., 2012 p. 100).

2.2.2 Multidisciplinary approach to Schöningen 13 II

As seen in this chapter, Schöningen has been an area of study for many years and has been studied using varied techniques and for various disciplines of archaeology, from stratigraphy to archaeozoological analysis; the site of Schöningen has been studied thoroughly to investigate the site's origin, the wildlife that lived there, hominin presence and much more.

This multi faceted way of looking at a site helps archaeologists understand how the past looked for our ancestors and how they interacted with it. By understanding the type of places they lived, what animals or plants they lived amongst and how they adapted and used their surroundings helps us know how we got to where we are now (Renfrew & Bahn, 2016, p. 272).

However, Schöningen is not just one site, as stated earlier in this thesis and as noted by Serangeli et al. (2015 p.27), Schöningen is not only a singular archaeological site with remarkable finds; it is a vast locality that preserves a multifaceted archaeological landscape with numerous sites.

The abundance of finds present at this site is mostly attributed to its preservation conditions. The presence of a lake allows artefacts to be deposited and slowly covered by or transported to the water. Waterlogged conditions prevent air from reaching organic material, allowing for further preservation (Conard et al., 2015 p. 9). Lacustrine environments also tend to have low oxygen levels, especially at the bottom, where sediments are deposited. Low levels of oxygen slow down decomposing agents such as bacteria.

Lakes also tend to be cold and temperature-stable, further slowing down bacterial activity. These factors allowed sediment to cover the artefact without it eroding completely, after which it is safe from biological degradation and has a higher chance of surviving in the archaeological record.

Investigations on the organic material at Schöningen have been thoroughly conducted across multiple disciplines. The collection and identification of the zoological record from the site's many layers are extensive, including animals ranging from straight-tusked elephants to giant beavers (van Kolfschoten, 2013 p. 473).

Alongside the investigation into zoological elements, the site's conditions also allow for the examination of botanical remains; palynological and carpological analyses have been conducted (Urban & Bigga, 2015).

2.2.2.1 Zoology

Zoological remains at Schöningen are amongst the most discussed finds. Bones of large Pleistocene mammals, such as elephants, aurochs, and horses, have been a constant presence at the site and have helped create an understanding of the animals that inhabited the area during the Pleistocene's interglacials (van Kolfschoten, 2014; Serangeli et al., 2015; Conard et al., 2015).

2.2.2.2 Palynology

Palynology, the study of pollen spores, has been a valuable tool applied to the Schöningen site to enhance understanding of the environment (Urban & Bigga, 2015 p. 59). As previously stated, the site of Schöningen 13 is divided into multiple layers, and palynological investigations have been conducted in most of them. These analyses help to understand the broader climate of the area and the larger environment; spores, which are produced by many plants, travel further than other plant remains and can be used to understand climate conditions and plant presence across wider regions (Renfrew & Bahn, 2016 p. 252).

2.2.2.3 Carpology

Carpology, or the study of seeds and fruits, also known as plant macrofossils due to their relatively larger size compared to pollen, has been a lacking subject at Schöningen. The site provides ideal conditions for botanical remains to be preserved, and much material is indeed preserved (Bigga et al 2015, p. 92). Still, to date, research in this area has been limited, with only a few studies conducted.

The use of plant macrofossils provides a more localised view than palynology, as fruits and seeds tend to disperse over a much smaller area (Renfrew & Bahn, 2016 p. 254). As such, by identifying the plant remains found at the site, one can make an informed assumption about the plants present locally. This, along with palynological and zoological data, can help create a picture of the local environment at the site during the time of deposition.

2.3 Schöningen 13II - 3

Schöningen 13II-3 is the layer directly below Schöningen 13II-4, the famous spear horizon (Serangeli et al., 2015, p. 38). This layer has been identified in recent excavations, as a result, there is a lack of published reasearch.

The most impressive find in this layer is the skeleton of a single female straight-tusked elephant; this skeleton is mostly complete and has been fully excavated. This elephant, named Nelly, a female approximately 50 years old at the time of her death, was found mostly in an anatomically correct arrangement but missing its front left leg, scapula, and almost all foot bones (Serangeli et al., 2023, p. 380).

Along with the elephant skeleton, a total of 57 flint microflakes were found in an area of 64 m² around the elephant, as well as three bone tools, two of which show evidence of use for flint knapping (Serangeli et al., 2023, pp. 380–381). This clearly indicates hominid presence in this layer (Serangeli et al., 2023, pp. 380–381).

2.3.1 Stratigraphy of the layer

The layer 13II-3 has been subdivided into three sublayers, each with different depositional traits that point to different depositional environments: Sublevel 3b1, Sublevel 3b2 and Sublevel 4i. These sublayers can be observed in Figure 5.

2.3.1.1 Sublevel 3b1

Sublevel 3b1, as shown in Figure 5, is described by Urban and Bigga (2015) as "Silty-solid mud, unstratified" (Urban and Bigga, 2015, p. 62). This layer’s unstratified nature suggests a uniform depositional environment with little change to its depositional input, likely depositing in a wet and undisturbed environment.

2.3.1.2 Sublevel 3b2

Sublevel 3b2 is described as “Silty mud, flaky-layered, reworked molluscs, remains of Chara” (Urban & Bigga 2015 p. 64). It is also reported to have high amounts of poorly preserved pollen. Chara is a genus of algae, indicating an underwater or wet environment at the time of deposition. This, along with the presence of molluscs, confirms the presence of a water body.

2.3.1.3 Sublevel 4i

Sublevel 4i is described as Silty-calcareous Characeae mud containing molluscs and Anodonta shells; (Urban and Bigga, 2015, p. 62) this layer also has a high carbonate content. Again, in this layer, the presence of Characeae and Anodonta, a type of freshwater mussel, indicates that these layers were deposited under wet conditions.

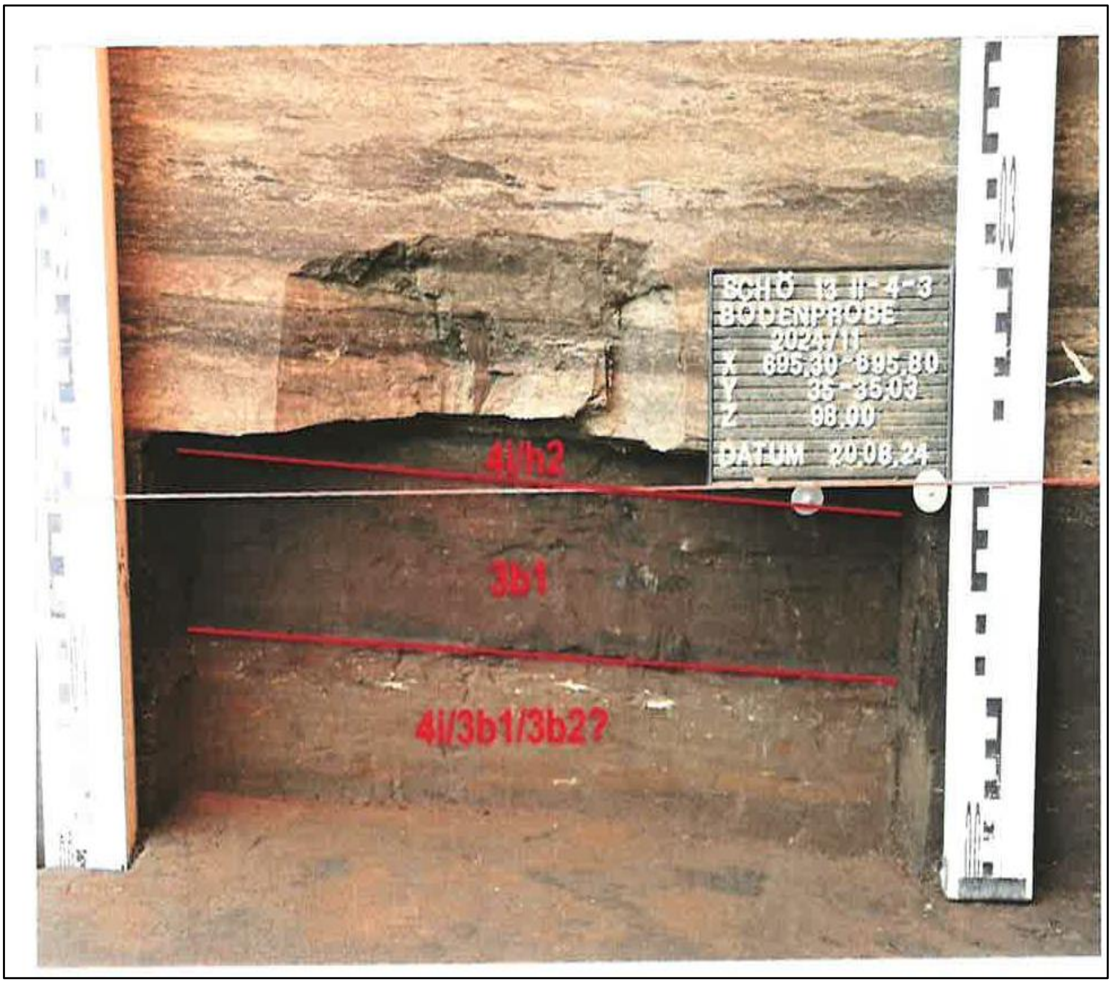

Figure 5: Image of layer IDs. Depicting the layers from which samples were collected, along with information about the site and area (Photographed by Manella Dennis).

3 Methodology

To begin this investigation, samples from layer 13II 3 were to be collected. This specific layer was chosen with the assistance of Dr. Michael Field for several reasons. First and foremost, the large presence of plant macrofossils in this layer was observed by examining the results of in situ sieving of the sediment from this layer by Dr. Field. After the botanical presence was confirmed, archaeological presence in the layer was confirmed with Dr Serangeli. He assured that the site was archaeologically significant, as evident in Figure 6, which depicts the preserved skull of an Auroch as well as the excavations occurred in the previous years which yielded the elephant skeleton and flint artefacts.

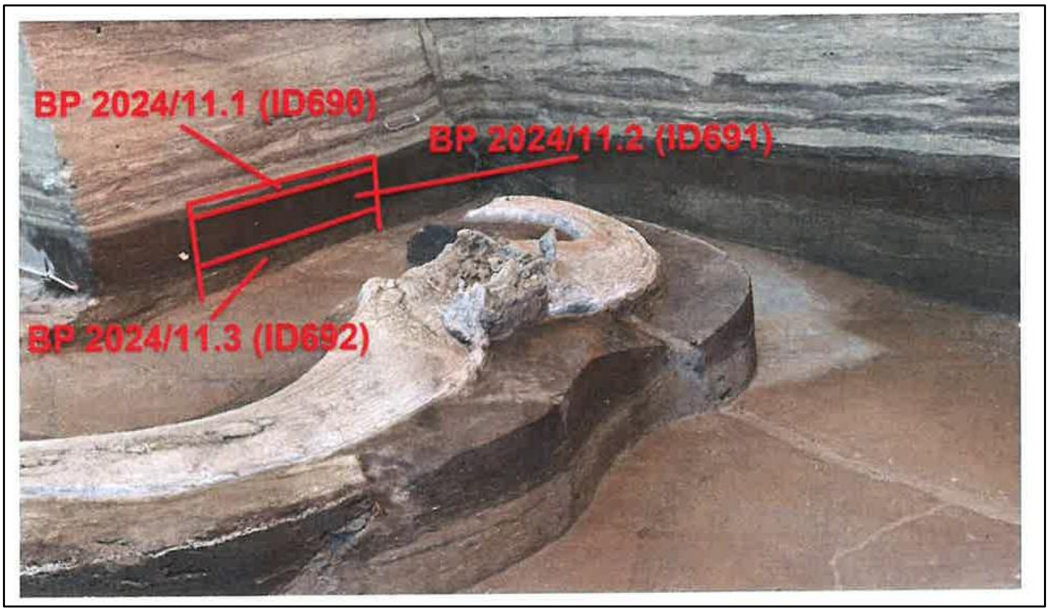

Figure 6: Picture of Auroch Skull and sample layers. Depicting the layers where the samples were taken from in comparison with the Auroch skull. (Photographed by Manella Dennis).

Following the suggestion of Dr. Field two soil samples were taken. Sample 691 from layer 3b1 and sample 692 taken from layer 4i/3b1/3b2, which can be seen in Figure 4, these samples were taken in comparison to the Auroch skull. They allowed for the investigation of the difference between the start of the depositional layer at the base of the Auroch skull and the depositional layer at the top of the skull.

3.1 Collection and Measurement

The samples were collected and shipped to the botany laboratory at Leiden University. Once at the lab, a controlled amount of the sample was selected for investigation. 0.150 cm^3 of soil from the samples was measured and is the samples used in the remainder of this paper.

A displacement method was used to measure the precise amount of soil. This method was carried out by filling a volumetric cylinder with water to a known precise amount and then noting this amount by adding soil from one sample till it reached an amount 150 cm3 higher than the known amount of water. This process was repeated for both samples, resulting in there being two 150 cm^3 samples of soil, one from each sample. Knowing the precise amount of soil used allowed for assumptions to be made about the density of finds in larger sample amounts.

The procedures described above follow standard archaeobotanical methodologies for the recovery, processing, and analysis of plant macrofossils (Pearsall, 2015).

3.2 Sample preparation

The measured samples were placed in separate buckets, and water and soap were added to each bucket. A large amount of water was also added to soften the soil, allowing the macrofossils trapped inside to be released. Soap was added to discourage bacterial and fungal growth in the water, as the buckets would be stored at room temperature. Both buckets were labelled and stored in the botany lab for a few days to allow the water to soften the soil.

After the samples had been soaking for at least two to three days, they were checked to ensure there was no fungal presence. During the next step they were gently stirred to break up the remaining soil and loosen it. This procedure was repeated every three to four days for the next two weeks until the soil samples were soft enough to proceed to the next step.

3.3 Sieving

After the soil was determined to be sufficiently soft the process of sieving begun. This process involved emptying the buckets with the samples through a set of sieves with decreasing mesh sizes to try to remove the soil from the plant fossils.

The sieves used were stacked one above the other and had mesh sizes of 1mm, 500um, 250um and 150um. After the soil and water from the bucket were passed through the sieves, the samples were washed of any soap remains using a moderate jet of water, strong enough to dislodge the soil and push it through the sieve mesh.

Once each sieve was cleaned of soap, they were stacked again from largest to smallest mesh size and the jet of water was used again to thoroughly but gently push soil and finds to their correct mesh size. During this step large clumps of soil, mostly found in the first or second sieve, were gently broken up to dislodge further any macrofossils still found inside.

This process was performed on one sample at a time, upon completion the sample was returned to its bucket along with new water and soap and left to soak for a longer period. The sieves were then cleaned, and the whole process was repeated for the second sample. Once both samples were stored again, the sieves were cleaned again with water and soap and returned to their place in the lab.

The sieving process was repeated for multiple weeks until no large clumps of soil were found in either sample. At this point the sieving process was repeated, and the samples were cleaned of any soap. Instead of being returned to the bucket, the sieves were now emptied one by one into beakers labelled according to the sieve mesh size. Four beakers per sample, one for each size fraction, were then collected, placed back into the buckets for storage and then placed into a refrigerated storage ready for the next step.

3.4 Collection

The next step of the investigation was collection. Using a light microscope, the sieved samples were observed one size fraction at a time. A small amount of the sieved material was placed in a petri dish and observed under the microscope. From the sieved material, any possible plant macrofossils were separated. They were placed in a separate labelled petri dish that was prepared by placing a round filter paper soaked with a glycerol and water solution to prevent the fossils from drying out and possibly breaking or decomposing. This process was repeated for all the sieved material from both samples.

At this point of the investigation due to a scarcity of well-preserved macrofossils, Dr Field advised to acquire extra samples that had already been sieved on site. This was done to acquire additional information about the plant species variety at the site.

3.5 Identification

After all macrofossils were separated into petri dishes according to the size fraction in which they were found, the identification process begun. This process involves identifying the remains by comparing them to pictures, descriptions, and pre-collected reference fossils. This process was particularly challenging, as many of the macrofossils found in the samples exhibited varying degrees of preservation and did not often resemble those depicted in the pictorial sources or reference collection. The collected macrofossils were identified to genus level as a base and to species level when their conservation allowed it. After a botanical specimen was identified to the highest degree possible, it was counted and recorded in a spreadsheet as seen in table 1.

3.6 Extra samples

As previously stated, a set of extra samples form layer 13II-3 have been used. Macrofossils from these samples would be identified like the ones from the original samples to create a better reconstruction, as more species known from the site were identified. These macrofossils would not be counted as they were sieved on site, larger amounts of soil was used respect the samples used for my analysis, so they would skew the final count results affecting the final results.

4 Results

This chapter shows the results obtained during the investigation of the plant remains collected from Samples 691 and 692 taken from the site of Schöningen, as well as the supplementary samples from layer 13II-3.

Plants identified	Macrofossil count sample 691	Macrofossil count sample 692
Carex sp. 3 sided	30	36
Carex sp. 2 sided	40	26
Zanichellia palustris	1	6
Sphagnum Moss	13	0
Potamogeton sp	2	0
Rumex palustris	0	9
Rosaceae sp	0	20
Ranunculus sp	0	16
Ranaculaceae sp	0	13
Poaceae sp	0	12

Table 1: Table of plants identified at genus and species level found and counted in samples 691 and 692

The most abundant plant species found in the investigation was Carex Sp. As previously stated, these remains were not identified to species level due to poor preservation of the fossils, allowing only for identification to the genus level to be done. The remains were split between two sided and three sided seeds as a way to further distinguish between the plant fossils (Table 1).

The supplementary samples were also examined due to the low quantity and resolution of plant fossils found in the investigated samples. The extra samples were already sieved on site from much larger soil quantities than the samples analysed in the lab. As such they would have a much larger amount of plant macrofossils therefore, macrofossils from these samples were not counted, instead, they were identified to include more unique plant species to increase the quality of the environmental reconstruction. The plant species found can be seen in Table 2.

Plants identified from layer 13II-3 extra samples	
Betula	*Potamogeton filiformis*
Carex Sp. 2 sided	*Potamogeton pectinatus*
Carex Sp. 3 sided	*Potamogeton sp*
Cenococcum geophilum	*Ranaculaceae sp*
Ceratophyllum demersum	*Rannunculus Batrachium*
Groenlandia densa	*Rannunculus Ranunculus*
Hippuris vulgaris	*Ranunculus* sp
Myriophyllum spicatum	*Rosaceae* sp
Nuphar C.F. lutea	*Rubus fruticosus*
Nuphar sp.	*Rumex sp palustris*
Poacea sp	Spagnum Moss
Polygonum sp.	*Sparganium erectum*
Potamogeton C.F. *Pusillus*	*Sparganium Xanthosparganium*
Zanichellia palustris	

Table 2: Plants identified in the extra samples analysed.

5 Discussion and interpretation

5.1 Vegetation and environmental reconstruction

From a taxonomic and techonomic point of view using carpology as a way to reconstruct the environment is a great tool as using taxonomy species can often be identified to a high level taphonomy as macrofossils tend to not disperse far, knowing this we can create a detailed and local reconstruction.

Based on the observed macrofossils, we can outline an early environmental reconstruction of the layer from the samples taken. The main part of this reconstruction is the presence of the paleolake; this is shown by the depositional information of the layers but also confirmed by the presence of many aquatic and semi-aquatic plants (Urban & Bigga, 2015 p.58).
The presence of Nuphar sp. (water lilies) and *Potamogeton pectinatus*, which both can live in water levels up to 5–6 meters, demonstrates that the samples came from the shores of the lake. Further, the presence of *Potamogeton filiformis* and *Zanichellia palustris*, both plants that prefer shallower water, shows that the samples came from the shallower shores of the lake.

The majority of the plants found also prefer soft substrates, mostly sand or mud, and slow moving water, and although plants like *Potamogeton pectinatus* can survive eutrophic waters the presence of less tolerant plants like *Potamogeton filiformis* points to the waters being oligotrophic, along these plants in the shallower areas of the shore there were plants like *Hippuris vulgaris* and *Rannunculus Batrachium*, this shows that this paleolake was very rich in plant material.

Moving away from the lake but remaining in a wet environment Carex sp, were found. Unfortunately, due to the low definition of the fossil identification It was not possible to discern which species of Carex were present at the site. These fossils were incredibly abundant as seen by their overrepresentation in the samples investigated making up 58.9% of all fossils identified, with a total of 132 Carex fossils being counted.

Some outliers in the samples, such as Betula and Poaceae also gives information on how the surrounding area away from the water's edge was like. The presence of birch trees and grasses, as well as *Rubus fruticosus,* the European blackberry, suggest the presence of a woodland with maybe some open spaces where grasses can grow.

In summary the findings show us that the environment at Schöningen 13II-3 was mostly wet. It can be assumed the sample came from a slow-moving bank were there was both a shallower and a deeper area in close proximity, with water probably of a neutral Ph. A wetland or damp area around the lake allowed for sedges to grow in abundance, followed then by some wooded areas where birch and blackberries could be found along with patches of open grasslands nearby.

5.2 Plant usage by early hominids at Schöningen

Many aspects of the site were highlighted throughout this thesis in order to create a comprehensive picture that could help understand what life was like for hominids at the site. Using the information gathered, a link between the environment of Schöningen and hominids presence at the site was attempted to explore how they may have interacted with their surroundings with particular focus on the plant resources around the paleolake.

Plant usage by early hominids is a debated topic in archaeology. While there is clear evidence for plant usage in later periods of time in prehistory, the consumption of plants for food and other means remains scarcely documented during the Pleistocene period in comparison to later periods of time (Hardy, 2018 p. 394)
Despite the lack of direct evidence, we can assume that early hominid species, such as those that would have inhabited Schöningen at the time of layer 13II-3, would have been able to make use of certain plants for various uses (Hardy, 2018, pp. 394–400). Using the data gathered during this study, some assumptions on botanical use at the site during the period investigated can be made.

5.2.1 Diet

Diet is the most straightforward answer to plant use during the Pleistocene. Evidence for calorically dense plants is rare in the samples analysed, but as stated by Bigga et al. (2015, p. 100), “nearly every plant that is not poisonous can be eaten, and even the poisonous plants can usually be eaten in small quantities”. Despite the exceptional preservation conditions at Schöningen, there is currently no direct and unambiguous evidence for the use of plants in the diet of the hominins (Conard et al., 2015, p. 12; Bigga et al., 2015, p. 101). However, the environment would have provided a wide variety of flora that almost certainly contributed to subsistence (Conard et al., 2015, p. 12; Bigga et al., 2015, p. 101).

Plants such as *Rubus fruticosus* are easily linked to diet because they are still eaten raw today. Therefore, it is not difficult to associate them with the diet of early hominins. In contrast, other plant taxa are harder to link directly. In their paper, Bigga et al. (2015, p. 102) provide evidence that underground storage organs (USOs) were likely present at the site of Schöningen along the shore of the lake and would have been a good source of nutrition for early hominins. These organs are rarely preserved in the archaeological record, but plants within the Potamogetonaceae family do produce such structures. USOs, including the rhizomes of cattail (Typha sp.) and various sedge species (Carex sp.), were particularly important sources of carbohydrates (Conard et al., 2015, p. 12; Bigga et al., 2015, p. 101). These plants are best harvested from autumn to early spring when starch content is highest (Bigga et al., 2015, p. 101). Their consumption is plausible, especially given that closely related primates, such as chimpanzees, use tools to harvest underground storage organs (Hernandez-Aguilar et al., 2007, as cited in Conard et al., 2015, p. 12).

Evidence for the consumption of aquatic plants by humans is scarce in the Lower Palaeolithic record, but the consumption of seaweed and other aquatic plants, including members of the Potamogetonaceae, is well documented later in prehistory (Buckley et al., 2023). Although differences in time period and hominin species must be considered, it is not unreasonable to suggest that earlier hominins at Schöningen could also have consumed aquatic plants. Species such as fennel-leaved pondweed (*Potamogeton pectinatus*) have edible leaves, stems, and roots (Bigga et al., 2015, Table 1). The concentration of these macro-remains in the lakeshore environment further reinforces the idea that hominins could have easily utilized them (Bigga et al., 2015, p. 101). Recent biomolecular analyses of dental calculus from the Mesolithic to the Early Middle Ages provide direct evidence for the widespread consumption of submerged aquatic plants across Europe, including *Potamogeton pectinatus* (Buckley et al., 2023).

Alongside these calorically dense plant foods, other species found in the same archaeological layers could have provided important nutrients to early hominins. For example, birch (*Betula*) bark is a good source of vitamin C, an important nutrient for preventing scurvy.

5.2.2 Tools

While Schöningen 13II-4 is famous for the wooden tools discovered, it is not an impossibility that hominids earlier on in time at this site would also have had access to tools made of plant materials as well (Hardy, 2018 p. 394).

Considering that sticks and leaves are used by modern day primates as primitive forms of tools (Koops, 2022, p. 1038), an ancient hominid, either *Heidelbergensis* or *Neanderthalensis*, would probably have been able to use wood or other plant materials as tools in one way or another (Hardy, 2018 pp. 394–400).

At Schöningen 13II-3 traces of plant materials were found on lithic artefacts; these plant residues, especially wood residue, show that hominids at this site were at least processing plant materials. Venditti studied 57 small and micro flint artefacts found in close proximity with the straight-tusked elephant skeleton from the study layer; fifteen of these microliths had microwear traces of soft wood on them such as pine, birch and spruce, this indicates that hominids at the site, at least, processed soft wood either on site or elsewhere (Venditti et al., 2022 p. 2).

This evidence of plant use on lithic tools shows us that, even though, lacking in the archaeological record, tools made of wood or other botanical materials could have been a central part of the lives of the hominids at Schöningen.

5.2.3 Medicine

Medicine is difficult to investigate in prehistory. Nowadays a lot is known about medicinal plants and related practices making it is easy to assume that plants with medicinal uses were used as medicine. As said in Conrad et al, (2015) however, likely the use of such plants may have been claims for the use of medicinal plants, while plausible, remain speculative.

This caution is also supported by broader research on the origins of medicinal behaviour, Hardy (2021) notes that although many Pleistocene environments contained plants with antimicrobial, anti-inflammatory, or analgesic properties, identifying intentional medicinal use by early hominins is extremely challenging due to the rarity of diagnostic archaeological signatures (p. 1). Evidence from other species demonstrates that self-medication has deep evolutionary roots, being widespread among primates and many other animals (Hardy, 2021, pp. 8–9) yet direct proof among early Middle Pleistocene hominins remains scarce.

This uncertainty applies at Schöningen as well. For example, although bark and other plant materials with potential medicinal properties were present in the environment, nothing indicates that they were used in a medicinal way, especially due to the lack of hominid remains found at the site. Even the best-attested examples of medicinal plant use, such as the consumption of plants with antibacterial and anti-inflammatory compounds by Neanderthals at El Sidrón (Hardy, 2021, p. 3), occur tens of thousands of years later and cannot be automatically projected backwards to the hominins at Schöningen. The absence of direct evidence, and the physiological and behavioural differences between hominid species, mean that they might not have been able to make use of these plants in a medicinal way.

But it is important to note that the hominids at this layer were capable of complex thought and processes, such as flint knapping, butchering, and possibly tool making, so they could have very well been able to identify and make use of medicinal plants such as birch at the site. Hardy (2021) argues that even simple forms of medicinal behaviour, such as chewing raw plant materials to relieve discomfort, lie well within the range of behaviours observed across many mammals, including non-human primates (pp. 8–9). Therefore, while no evidence confirms medicinal plant use at Schöningen, it remains plausible that hominins possessed at least a basic understanding of certain plant properties, even if this cannot yet be demonstrated archaeologically.

6 Conclusion

The results show us a clear image of a slow-moving lake with its waters hosting a multitude of freshwater plants and its banks covered in sedges, further away from the lake temperate forests of birch and pine alongside with open grassy areas were probably present (Serangeli et al., 2015).

In this Thesis, it was highlighted that there were multiple botanical resources available to the hominids at the site, including edible plants such as blackberries as well as Underground Storage Organs like the rhizomes of cattails and sedges and even birch bark could have very well have been a staple of the hominid diet at Schöningen (Bigga et al., 2015).

Looking further, there is evidence that these hominids already processed plants, the most obvious being the Schöningen spear found in layer 13II 4 but specifically in layer 13II -3 botanical residue was found on flint artefacts further proving botanical processing by hominids at the site. There is also real possibility that these early hominids used these plants as medicine, even though there is no evidence for it (Venditti et al., 2022).

The site of Schöningen provided substantial resources to early hominids, and that the plants at the site might have played a more significant role in their lives during Pleistocene than is often assumed (Hardy, 2018). Even considering all of these factors there is still a lack of evidence for pereniall occupation pointing to the shores of the Paleolake at Schöningen being more of a transitional site with any base camps or areas of longer occcupation being located on dry ground in nearby uplands (Conard et al., 2015, p. 2).

The findings of this thesis support the hypothesis brought fowardy by reaserachers such as Conard, Serangeli and Hardy pointing to Schöningen being a rich and appealing site for hunting and foraging. Of course, there are shortcomings in this research. Time and sample size have been discussed in this thesis as being limiting factors: future studies would require larger sample sizes and a longer research timeframe to produce a more detailed concise and robust environmental reconstruction.

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