Understanding the environmental context of potential plant exploitation by a central European Hominin population in Schöningen

Vasiliki Xiromeriti

Description of cover image: The archaeological site of Schöningen in Lower Saxony Germany.
Photographer: Vasiliki Xiromeriti   Date: 19/08/2024

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Final

ABSTRACT:

The German Palaeolithic site of Schöningen located in Lower Saxony, which features a palaeo-lacustrine environment, is renowned for its exceptional preservation of artefacts, zoological and botanical remains and more specifically for the nine wooden spears. These spears were attributed to a hominin population which is referred to by most scholars, despite the absence of hominin remains, as *Homo heidelbergensis*. Most research has been focused on the Spear horizon(13II-4), the hunting patterns and zoological records, with few publications dealing with the plant exploitation and environment. The utilization of plant materials is very often overlooked causing for a skewed perspective on early hominin lives and missing out on valuable information that can be inferred from the local flora and environment. In order to attempt to understand the potential plant exploitation patters of early hominins the environmental context is crucial. Therefore, this thesis aims, firstly, to reconstruct the palaeoenvironment of Schöningen layer 13II-3; a layer below the famous spear horizon; and secondly, through that environmental context understand the potential subsistent strategies and activities revolving around plant exploitation. Samples from Schöningen layer 13II-3 were collected in August of 2024 and were further divided into subsamples (ID 690,691 and 692). The sample analysed in this study is the oldest bottom layer 960. It was processed in Leiden University's botany lab in the faculty of Archaeology and was analysed using low power binocular microscopes. The result suggests a biodiverse lacustrine environment characterized by ample sun light, fresh, lentic, calcareous and alkaline waters surrounded by a riparian woodland ecosystem. The majority of the plant taxa recognised have nutritional value and/or healing properties also known today or utilised in traditional remedies. Further, the use of plant materials for tool manufacturing is also highly suggested given the existence of a suspected digging stick in layer 13II-3 and the wooden spears one layer above. Therefore, it could be inferred that '*Homo heidelbergensis'* potentially exploited several of these taxa for consumption, medicinal effects but also their structural properties for tool manufacturing. Which breaks the stereotype of palaeolithic hominins diets as strictly wild game with the occasional gathering of plants highlighting plant exploitation and its diverse usage potential.

KEYWORDS:

Palaeolithic, Plant exploitation, Schöningen, Palaeoenvironment, Hominin subsistence strategies

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CHAPTER 1: INTRODUCTION AND CONTEXT

Understanding the past environment (flora, fauna, climate) through reconstruction attempts is essential in studying the past activities and subsistence strategies of hominins but will also give us a general idea of the floral and faunal diversity of the time period researched. This thesis focuses on the Middle Pleistocene archaeological site of Schöningen, a small German town located in in the foothills of the Harz mountains in Lower Saxony (Serangeli, et al., 2018, p. 140), with a focus on botanical macrofossils of horizon 13II-3.

The site in Schöningen was originally an open-cast lignite mine rich in archaeological finds due to its impressive preservation of artefacts, especially organic materials (Peters & van Kolfschoten, 2020, p. 1). This high level of preservation stems from the site's geography and geology. The old open cast mine is near the edge of a palaeolake. This palaeolake is responsible for the waterlogging of the sediments (Starkovich & Conard, 2015, p. 154) and thus the preservation of organics such as wood, plants and seeds. Furthermore, the high concentrations of calcium carbonate present in the ground water of the town of Schöningen also plays a key role in the preservation of these types of materials (Peters & van Kolfschoten, 2020, p. 1). The stratigraphy of the site is characterized by its numerous horizons. These were formed through repeated depositions of sediments transported by the actions of several overwriting ice advances, and are a key part of the archaeological investigation of the site. Moreover, Schöningen is of high significance since it's well-preserved finds are a major contribution to our understanding of early hominin (*H. heidelbergensis)* behaviour and daily activities, bringing to the light information that often challenge already established notions on the incipient stages of humankind (Conard et al., 2015, p. 1).

Figure 1: The Position of Schöningen in the map of Germany and an overview of the area around the site including the Northern mining area and the southern mining area in which the excavation site is located but also the location of the town.

Source: Vasiliki Xiromeriti

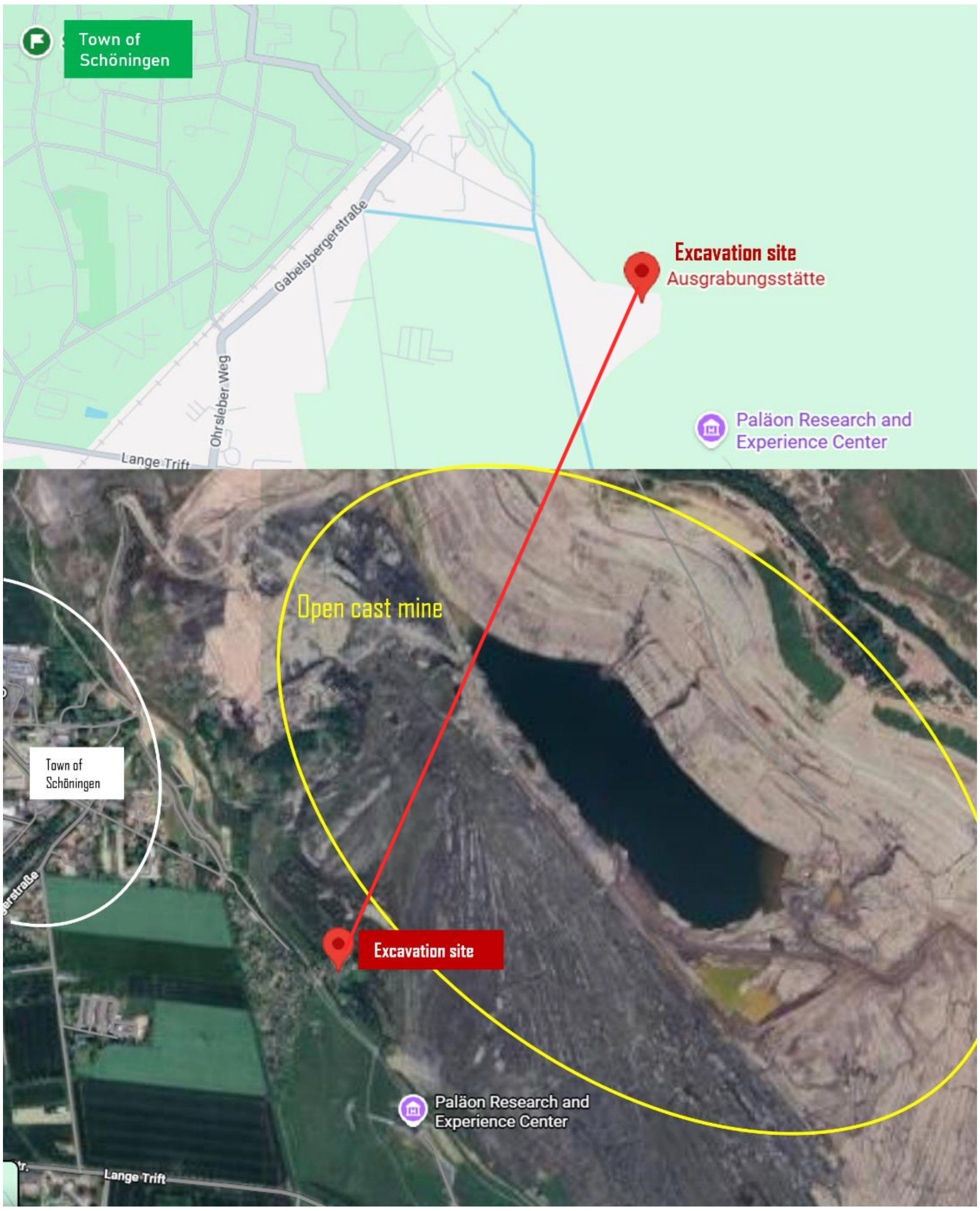

Figure 2: Location of Schöningen in modern day Germany and the exact position of the archaeological site—red dots— with a close-up satellite view of the open cast mine(yellow), and the position of the excavation site in relation to the town of Schöningen(white). The Paläon research centre where a lot of the archaeological materials and the famous wooden speers are housed is also shown. Source: Vasiliki Xiromeriti

Central Europe and Schöningen in the Middle Pleistocene

Stratigraphical context and palaeoclimate in Central Europe and Schöningen:

The Central European Lower Palaeolithic approximately extends over a period from 3 to 0.3 Ma (million years) ago. It includes the late part of Early Pleistocene (about 1 – 0.78 Ma ago), early Middle Pleistocene (about 0.78–0.45 Ma ago) as well as middle part of the Middle Pleistocene (about 0.45–0.3 Ma ago). Between 1 to 0.6 Ma ago intense climatic cyclicity occurred (glacials and interglacials) which caused oscillations of the ice sheet from Scandinavia and directly influenced the environment and faunal populations. This made vegetation levels unstable and resulted in important changes in mammalian fauna communities all over Europe (Szymanek & Julien, 2018, p. 56). During the early Middle Pleistocene, the late Early Pleistocene taxa typically found in open habitats with xeric conditions were displaced over time by taxa of a cooler and more humid environments which predominately were large and mega-herbivores (Szymanek & Julien, 2018, p. 56). The influx of herbivorous game could potentially have attracted hominin populations as well, expanding their territory.

Schöningen 13II which is the overarching layer researched in this paper, is situated at the south side of the open cast mine and is associated with MIS 9 (Reinsdorf Interglacial) which although initially disputed has been confirmed by thermoluminescence dating of flint derived from layer 13II-1 (Tucci et al., 2021, p.3). Schöningen 13II provides some of the best terrestrial palaeoecological data for MIS 9 through the ample palaeobotanical, palaeozoological and archaeological indicators extracted from its several Palaeolake deposits (Szymanek & Julien, 2018, p. 64) that were developed on top of a glacial tunnel valley of the Elsterian ice sheet (Chauhan et al., 2017, p. 32).

The vegetation of a part of the warm interglacial phase of Schöningen Channel II has been characterised by typical species of the interglacial climatic optimum such as *Carpinus*(hornbeam), *Alnus* (alder), *Corylus*(hazel), *Tilia maximum*(linden) and mixed forest vegetation including *Picea* (spruce).However, there was a gradual shift during the concluding phases of the interglacial, initially to forests characterised predominately by *Alnus* (alder), *Abies* (fir), *Carpinus* (hornbeam), and *Picea* (spruce) which were slowly displaced by mainly *Pinus* (pine), and *Betula* (birch) forests with intermixed *Alnus* trees. There was a shift again by the end of the interglacial, giving away to more open ecosystems dominated by grasses and herbs. After the end of the interglacial the environmental succession sequence was characterised by the cyclicity of stadials (cold periods) with open landscapes and interstadials (warmer periods) with boreal steppe- forests (Szymanek & Julien, 2018, p. 64).

Palynological insights into the Palaeo-vegetation:

Palynological analyses can also offer valuable insights into the past vegetational patterns of Schöningen. Tucci et al., 2021 study of pollen from the Reinsdorf sequence in Schöningen shows in almost all 17 samples a majority of non- arboreal pollen taxa (NAP), so grasses and herbs. These include species in the families, Asteraceae, Cichoriaceae, Chenopodiaceae with a predominance of Poaceae and in the genera *Artemisia* and *Helianthemum*. Despite the prevalence of non- arboreal pollen there is also pollen from arboreal (woody plant) taxa present in the study, of which, 20% is *Betula*, 15%-5% is *Alnus* and 10% is *Pinus*. Other than the former native woody taxa, the study also indicates the presence of *Juniperus*, *Myrica* and *Salix*

(Tucci et al., 2021, p. 7). These findings suggest the presence of a grassland or steppe-like cold and dry environment in the area with some woody plants and shrubs present but not dominant in the ecosystem.

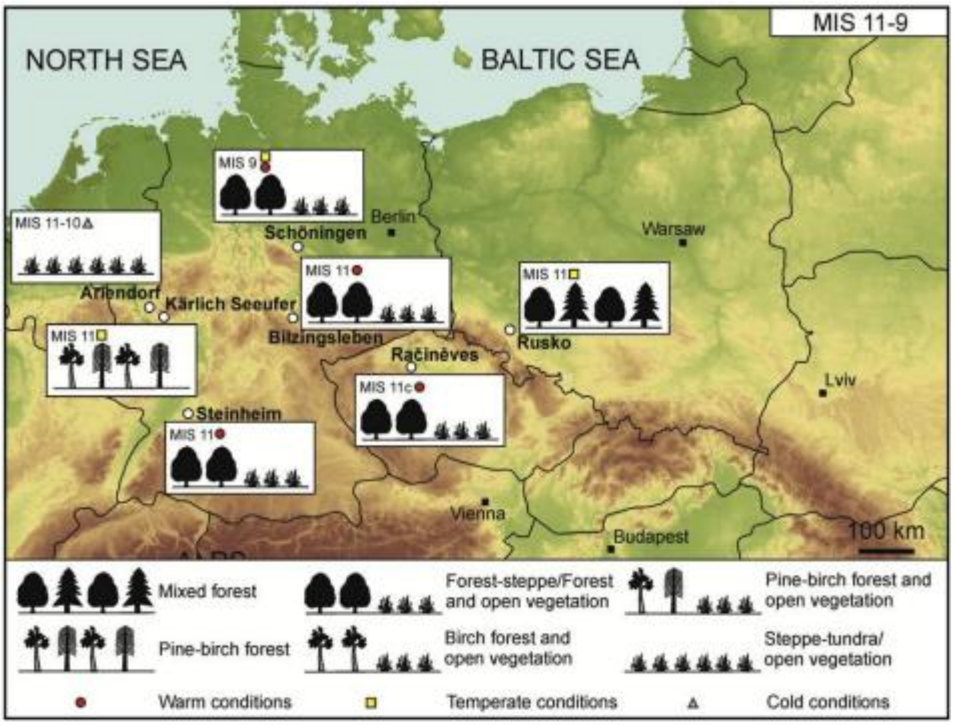

Figure 3: Map of different sites with palaeoenvironmental records from across Central Europe attributed to MIS 11-9. The locality of Schöningen is depicted with a Forest-steppe or Forest with open vegetation.
Source: *Szymanek, M., & Julien, M. (2018). Early and middle Pleistocene climate-environment conditions in Central Europe and the hominin settlement record. Quaternary Science Reviews, 198, 56-75. https://doi.org/10.1016/j.quascirev.2018.08.021*

Hominin migration in Europe and specifically for Central Europe:

Current research indicates the arrival of hominins in Europe in the Early Pleistocene. However, the exact timing is still in debate, because the different dating methods used (physical dating techniques and comparative fossil analyses) each have their own advantages and limitations, and thus don't suggest comparable results. Nevertheless, Muttoni et al. (2018) propose that the first Hominins migration to Europe is attributed to the late Early Pleistocene, potentially during the Early Pleistocene transition (EPT) where significant climatic changes occurred specifically in the course of the final part of the MIS 22 glacial and the transition to MIS 21 interglacial about 0.9 Ma (p.23). During that timeframe the landscapes of Europe were predominated by grasslands instead of woody forests facilitating the expansion of mixed browser grazer megaherbivores such as *Elephantidae*, which subsequently conveyed hominins (Muttoni et al., 2018, p. 23).

Evidence for hominin occupancy of Central Europe during the Lower Palaeolithic is quite scares due to inadequate stone tool examples and lack of somewhat discernible handaxes which in turn complicates the identification of Lower Palaeolithic artefacts in the region, when compared to the rest of Europe or Africa. Factors contributing to the obscurity of Lower Palaeolithic hominin occupation in C.E. include insufficient geopolitical, geological and research records as well as the complexity of accurately dating hominin remains and artefacts from known contexts (Szymanek & Julien, 2018, p. 64). Despite the overall obscurity, the first recorded appearance of hominins around Central Europe corresponds to approximately 0.95 Ma. Hominin presence remained only on the periphery up until roughly 0.7–0.6 Ma when evidence shows their distribution across C. Europe. This occupation starts to become prolonged and more widespread in the mid-Middle Pleistocene specifically during 0.4 and 0.3 million years ago (Szymanek & Julien, 2018, p. 57). It is evident Through recent DNA and anthropological data that during the Middle Pleistocene there was a variability of hominin species active in Europe with the increasing appearance of Neanderthal characteristics. Specifically in Central Europe evidence from hominin remains is attributed to *Homo heidelbergensis*, pre-neanderthals or an archaic type of *Homo sapiens* (Szymanek & Julien, 2018, p. 57). In terms of interactions with their environment, hominins of the Lower Palaeolithic exploited a variety of resources. Evidence from multiple sedimentary deposits across diverse palaeoecological contexts show that they utilised stones, bones and wood for tool making (Szymanek & Julien, 2018, p. 57).

Excavation and the Famous spear horizon 13II-4

There are over 20 excavated sites in the open cast mine of Schöningen locality dating to the Lower Palaeolithic (Szymanek & Julien, 2018, p. 68). The main archaeological layers of Schöningen (Schöningen II) which include the renowned spear horizon (13II-4), are attributed to the Reinsdorf Interglacial deposits. (Chauhan et al., 2017, p.32). The first excavation on the site commenced in 1983 and have been continuing ever since (Berkholst, 2011, p. 8). The most famous excavated horizon in Schöningen is 13 II-4, nicknamed 'the spear horizon' due to the uncovering of nine approximately 400.000-year-old wooden spears in the late 1990s (Berkholst, 2011, p. 8) boasting excellent preservation (H. Thieme,1999, p. 461-462). These spears are attested to being the oldest examples in the world. The spears were excavated between 1994 and 1999 and they were found in an assemblage which included remains of roughly 35 butchered horses. This was a breakthrough in the understanding of early hominin hunting activities and intellect since evidence of large-scale hunting of herbivorous prey with spears was never previously proven (Schoch et al., 2015, p. 214). Furthermore, the analysis of the manufacturing process of the spears through its meticulous manufacturing stages suggested experienced wood working skills regarding weapons and tools. In addition, the hominins used pine and spruce (soft woods) in the making of the spears which is rather surprising regarding similar artefacts from other archaeological sites such as Clacton-on-Sea in England and other sites from later periods use *Taxus* (Yew) wood for wooden tools and weapons due to the woods hard and elastic nature. The possible reason for this material choice in Schöningen 13II-4 layer is potentially the absence of *Taxus* species. Despite evidence of *Taxus baccata* in older Schöningen layers, the environment during the Late Interglacial which is attributed to layer 13II-4 favoured more open woodland ecosystem species such as *Betula*(birch) and *Pinus* (pine) (Schoch et al., 2015, p. 222). Specifically, almost all the spears but one (spear IV) which was made out of pine, used spruce *(Picea)* as raw materials. The exploitation of Spruce is suggested to have been standardised for the production of these spears (Schoch et al., 2015, p. 220). The spears when firstly excavated were found mainly in their original position with only some minor displacement cause by depositional processes and water flow, and majority were fragmented but complete however significant fragments of three of the spears are missing (Schoch et al., 2015, p. 218-220).

Hominin or Homo heidelbergensis?

It is important to note that as of today there are no hominin bone-remains in the site of Schöningen, making the identification of the exact hominin species difficult. Furthermore, the lithic artefacts of the site are ambiguous in terms of specific manufacture technique but also human association. So why would the researchers assume *Homo heidelbergensis* as the creator of the famous spears and not simply name them as hominin. In order to attest a specific hominin species for the site of Schöningen, researchers used different proxy data, specifically from sites with similar chronology. However, sites of the time period almost never produce whole skeletal remains leading to a couple of features that could identify or differentiate a hominin being undocumented. Moreover, genetic variability of each individual is always expected making standardized assumptions difficult. So far research has briefly considered the following. Artifact bearing layers of Bilzingsleben II in Sömmerda locality which chronologically similar to Schöningen II, roughly 10,000 years apart with the former being older, contained skull fragments attributed to three individuals characterized as *Homo erectus* or *Homo erectus bilzingslebenensis.* There are different scholarly interpretations (Bigga, 2018, p. 8-9). For instance, D. Mania and H. Thieme (2007), as referenced in Bigga (2018), suggest that the hominin variant found in Bilzingsleben II could be the same in Schöningen. On the other hand, Jöris and M. Baales (2003) also as referenced in Bigga (2018) instead propose a type of Neanderthal variant to be active in the Schöningen locality. In context, *Homo heidelbergensis* is considered the *Homo erectus* variant of Europe, named after a mandible remain near the city of Heidelberg. Others suggest that they could be a type of predecessor to Neanderthals. Officially the hominins of Bilzingsleben are recognised as *Homo heidelbergensis but exhibit some Neanderthal-typicall characteristics.* In similar fashion, in the site Sima de los Huesos in Spain, where roughly 30 individuals, dating to 530,000 BP or possibly earlier have been discovered. These individuals exhibit clear Neanderthal features and are categorised either as early Neanderthals or *Homo heidelbergensis* (Bigga, 2018, p. 9). *Another proxy data that can be used to answer the Schöningen hominin variant question is dating. The earliest reliable hominin remains found in the north and centre of Europe are attributed to the warm period of Oxygen Isotope Stage (OIS) 13 with a date older than 500,000 years.* Happisburgh site (Norfolk, England) has shown evidence of the earliest hominin settlements of northern Europe dating to about 700,000 years, despite the lack of hominin bone remains. On the contrary, Boxgrove another site in, England (West Sussex), contained three *Homo heidelbergensis* fossils, specifically a tibia and two incisors. Schöningen 13 II-4 chronologically lies at approximately 320,000 years therefore both *Homo heidelbergensis* and early Neanderthals could be assumed as the makers of the famous spears. Overall, the dominant consensus among scholars is the use of the *Homo heidelbergensis* variant for middle Pleistocene hominins in Europe due to their morphological divergence from *Homo erectus* remains. In addition, specifically for Schöningen there are no Neanderthal typical tools found, rather the tools found are typical late Lower Palaeolithic technologies showing a gradual transition to Middle Palaeolithic techniques, notably the Levallois method (Bigga, 2018, p. 9-10). For sites where bone remains are present, their attribution to a specific hominin variant is quite straightforward. For the case of *Homo heidelbergensis,* actual remains have been found apart from Mauer site (near Heidelberg) in various regions around Europe namely England (Boxgrove, Swanscombe), France (Arago cave near Tautavel), Greece (Petralona cave in central Makedonia region), Germany (Bilzingsleben, Weimar-Ehringsdorf), Hungary (Vértesszőlős), Serbia (Mala-Balanica), Spain (Sima de los Huesos) and Italy (Altamura). Conversely, the Middle Palaeolithic sites which have no hominin remains such as Torralba, Ambrona and Aridos in Spain, Kärlich lake shore in Germany and indeed Schöningen are attributed to *Homo heidelbergensis though analysis of tool technologies and chronology* (Bigga, 2018, p. 9-10).

Research aims and goals:

The research questions of this study are:

1) How was the Palaeoenvironment on Schöningen horizon 13II-3?

2) What impact does that environment have on Hominin subsistence strategies and activities regarding plants in Palaeolithic Schöningen?

Therefore, this study attempts to understand the impact environmental influences have on hominin plant exploitation subsistence strategies and activities in Palaeolithic Schöningen though Palaeoenvironmental reconstruction with a quantitative approach. Botanical macrofossil samples from the 13II-3 horizon, which is also referred to as the aurox layer due to the corresponding finds, will be analysed. Horizon 13II-3 contained finds of large mammals (such as from aurox), some flint as well as wooden artefacts including a suspected digging stick (Serangeli et al., 2015, p.29), presenting a clear picture of hominin, animal and environment connection. The presence of the wooden remains and the suspected digging stick could align with the findings of the spear horizon suggesting the usage of plant materials as tools by early hominins, in this case for potentially digging activities. In context, the Importance and utility of plants as food and tool resources for early hominins in the Middle Pleistocene have been greatly underestimated by Scholars. Specifically for the site of Schöningen on the forefront of publications have mainly been the bones remains, butchering sites and hominin artifacts reinforcing the narrative of the Palaeolithic large game hunter thriving near the palaeolake without considering alternative lower risk subsistence strategies and uses that plant exploitation provides. Therefore, this study attempts to bring the environment and plant exploitation and utility to the forefront and attempt to complete the bigger picture of hominin subsistence strategies in the middle Pleistocene. To be more specific for this study botanical remains of the aurox horizon(13II-3) have not been previously analysed highlighting the study's contribution in the knowledge concerning the environmental conditions of Middle Pleistocene Schöningen and subsequent impacts on Hominin behaviour.

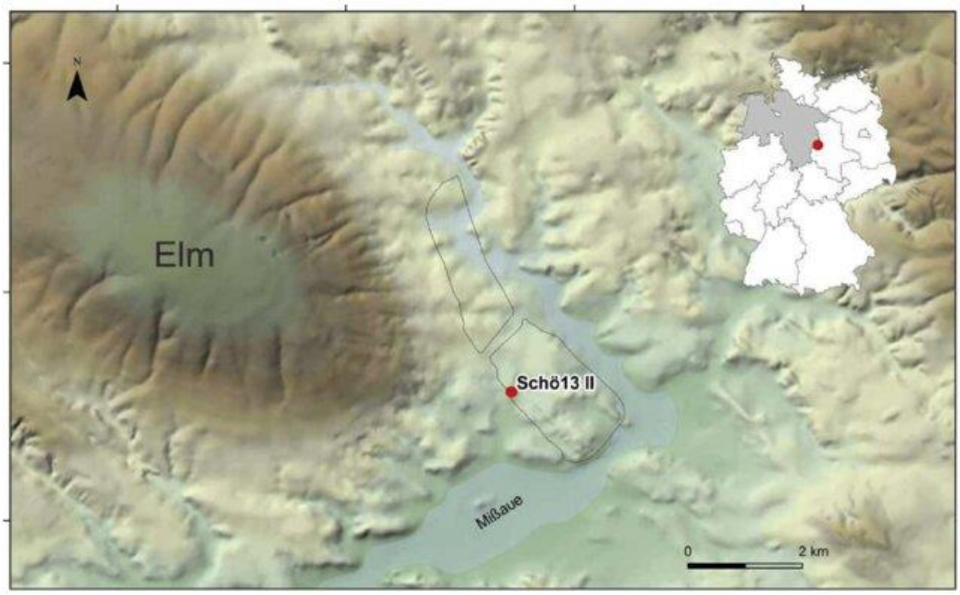

Figure 4:: This figure shows a close up of the exact topography around the site of Schöningen. Overall, the landscape is relatively mountainous. On the west of the site is the ridge of the elm forest and on the east are the archaeological site and the former open cast-mines. The modern city of Schöningen is located in the middle of the elm ridge and the open cast-mine. The red dot clearly shows the location of the overarching layer analysed in this paper.

Graphic: Utz Böhner, DEM Dirk Fabian.

Source: Serangeli, J., Böhner, U., Van Kolfschoten, T., & Conard, N. J. (2015). Overview and new results from large-scale excavations in Schöningen. Journal of Human Evolution*, 89, 27-45.* [*https://doi.org/10.1016/j.jhevol.2015.09.013*](https://doi.org/10.1016/j.jhevol.2015.09.013)

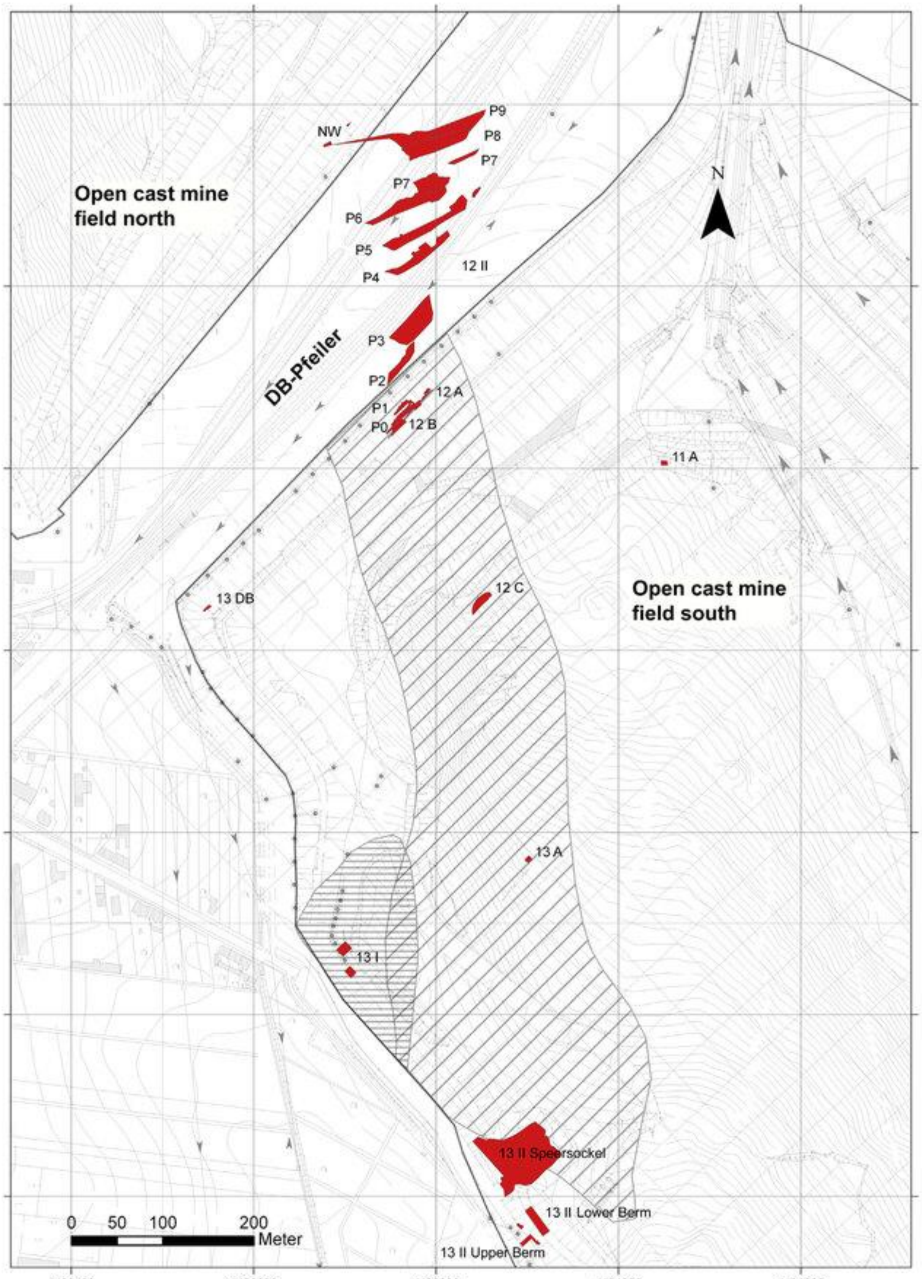

Figure 5: Map of the open cast-mine of Schöningen, indicating the different archaeological horizons. With a focus on horizon 13II.
Drawing: Utz Böhner.
Source: Serangeli, J., Böhner, U., Van Kolfschoten, T., & Conard, N. J. (2015). Overview and new results from large-scale excavations in Schöningen. Journal of Human Evolution, 89*, 27-45.* [https://doi.org/10. 1016/j.jhevol. 201 5.09.013](https://doi.org/10.1016/j.jhevol.2015.09.013)

CHAPTER 2: SAMPLES AND METHODS

The Schöningen Horizon 13II-3 sample was acquired in the field in August of 2024. The top part of the layer as well as the middle and bottom were sampled to maximize results and have an overall analysis of the horizon. Therefore, there are three sub samples, with ID 690,691 and 692. The samples analysed in this paper is of ID 690, the bottom (oldest layer the horizon). When preparations were done the samples were transported in the Leiden University botany lab of the Archaeology faculty.

The volume of the sample analysed is 100cm^3. The samples were very compact thus treatment with dish soap was essential to loosen the sediment grains minimizing macrofossil damage. ID690 was put in a bucket with ample dish soap for three consecutive days. Following the sample underwent sieving in order to break the clumps even further and separate macrofossils and sediment. The sediment was filtered through four different mesh seizes. The mesh seizes of the sieves were 1mm, 500µm^2, 250 µm^2 and 150 µm^2 from biggest to smallest. The water pressure during the sieving process was roughly medium to low intensity in order not to damage any of the macrofossils. For this reason, as well as the compactness of the sample, the sieving process lasted a little longer than expected. The procedure was repeated for about five days with dish soap been used again after every but the last sieve to assist in the de-clumping process. Bigger pieces of sediment were also gently pressed by hand for maximizing efficiency. During the last sieving the dish soap was carefully washed out from the sample and each of the different mesh seizes were transferred to cleaned beakers which were marked with information about the sample and their mesh seizes and filled with clean water. At this stage the sample preparation has been completed and the samples can proceed to be analysed.

The process through which the samples were examined is water picking with the use of low power binocular microscopes. The goal of the picking process is to collect concentration data of the macrofossils presents but also some other biological indicators such as shells, insects, bones or smaller organisms order to have the broader environmental picture as well. After discussing the results of the picking process, it was decided that a quick examination of samples from the residue sediment extracted from horizon 13II-3 was necessary in order to possibly expand the concentration of the existing macrofossils collected. This would also allow for a possible acquisition of good preservation specimens for displaying in this study. After the collecting process was completed, the next step was the identification and quantification process.

Regarding the identification, botanical macrofossil atlases were used along with reference collection material to achieve the best possible identification results. Furthermore, all taxonomic identifications were independently reviewed to maximise accuracy. Each macrofossil group was quantified and was processed into graphs in Excel in order to visualize the concentration patterns. Furthermore, the species were divided into four categories, waterside and damp ground taxa, obligate aquatic, unclassified taxa and non-botanical/ other fossils. The resulting graphs were carefully studied and interpreted to estimate the palaeoenvironment in the Schöningen layer 13II-3 and answer the research question of this study. Specifically, the sums (Σ) of the macrofossil taxa were calculated and further converted into percentages (%) in order to assist on the interpretation of the collective picture of the fossil assemblage. These calculations exclude the non-botanical (other fossils) specimens. It is important to note that the moss leaves and stems present in the assemblage were excluded from the calculations due to their really high numbers.

Figure 6: Sieves used for the sieving of the 13II-3 concentration samples. Photographer: Vasiliki Xiromeriti, Date:11/02/2025

Figure 7: Image of the Concentration sample collecting process.
Photographer: Vasiliki Xiromeriti, Date:18/02/2025

CHAPTER 3: RESULTS AND ANALYSIS

On the following table the results from the concentration data quantitative analysis of Schöningen layer 13II-3 are presented and categorized into three distinct habitat categories namely, Waterside and damp ground, Obligate aquatic and Unclassified which includes species that are found in other types of environments.

Schöningen 13II-3 Concentration data results Volume			100cm^3
	Taxon	**Plant part**	**Actual number**
Waterside & damp ground	*Bidens sp.(fragment)*	Achene	1
	Hippuris vulgaris	fruit	3
	Rumex sp.	Achene	1
Obligate aquatic	*Characeae sp.*	Oosporangium	69
	Myriophyllum spicatum	Fruit	10
	Potamogeton pectinatus	Endocarp	2
	Potamogeton sp. (fragments)	Endocarp	Present
	Ranunculus subgenus batrachium	Achene	12
	Typha sp.	Capsule	25
	Zannichellia palustris	Fruit	18
Unclassified	*Atriplex sp.*	Fruit	1
	Betula sp.	Samara	1
	Cenococcum geophilum	Spore	17
	Carex sp.	Biconvex nutlet	160
	Carex sp.	Trigonous nutlet	65
	Carex sp.	Utricle	3
	Polygonum sp.	Nutlet	1
	Poaceae sp.	Caryopsis	10
Non-botanical/Other macrofossils	**Macrofossil**	**Type**	**Number**
	Animal	Parts/Fragments	Present
	Animal	eggs	Present
	Bug	Parts/Fragments	Present
	Bone (unclassified)	Fragments	Present
	Fish	Bone fragments	Present
	Leaf	Buds	Present
	Moss	leaves and stems	Present
	Shell	fragments	Present
	Wood	Branches/bark fragments	Present

Table 1: Results of the concentration sample 13II-3 with exact numbers collected.

Following the results of the supplementary samples of the residue sediments from Schöningen layer 13II-3 will be analysed also being categorised into three distinct habitat categories; Waterside and damp ground, Obligate aquatic and Unclassified.

The numbers are indicated only as present since the documenting the exact number of the taxa wasn't the goal for the residue samples but only the presence of the taxon itself. There are two species included in the following table which are contaminants these include *Taraxacum officinale* and *c.f. Carduus.* Both of these species are present in the modern site of Schöningen and thus could have ended up in the soil samples during excavation. The contaminants will be naturally excluded from any interpretation.

Schöningen 13II-3 Residue sample data results			
Waterside & damp ground	**Taxon**	**Plant part**	**Actual number**
	Sparganium erectum	fruit stone	Present
	Sparganium subgenus sparganium	Fruit stone	Present
	Hippuris vulgaris	Fruit	Present
	Thalictrum flavum	Achene	Present
Obligate aquatic	*Ceratophylum demersum*	Nutlet	Present
	Groenlandia densa	Nutlet	Present
	Myriophyllum spicatum	Fruit	Present
	Nuphar sp.	Aggregate berry	Present
	Nuphar c.f. lutea	Aggregate berry	Present
	Potamogeton pectinatus	Endocarp	Present
	Potamogeton c.f. pusillus	Endocarp	Present
	Potamogeton sp.	Endocarp	Present
	Zannichellia palustris	Fruit	Present
Unclassified	*Carex sp.*	Biconvex nutlet	Present
	Carex sp.	Trigonous nutlet	Present
	Cenococcum geophilum	Sclerotia	Present
	Contamination (c.f. Carduus sp.)	Achene	Present
	Contamination (Taraxacum officinale)	Achene	Present
	Polygonum sp.	Nutlet	Present
	Rubus fructicosus	Aggregate drupe	Present
Non-botanical/Other macrofossils	**Macrofossil**	**Type**	**Number**
	Leaf	scars	Present
	Moss	Leaves and stems	Present
	Rodent	Tooth	Present

Table 2: Results of residue samples from the surrounding sediment collected from 13II-3 layer.

Furthermore, the sums (Σ) of all the fossils and taxa from the concentration samples for each habitat category are presented below with the total sum (Σ) included. The sums were also plotted in a Graph to further assist visualisation of the study's results.

Calculated sum (Σ) of Schöningen 13 II-3 Concentration sample	100cm³ Volume	
	Fossils	**Taxa**
Waterside and damp ground	5	3
Obligate aquatic	136	7
Unclassified	558	7
TOTAL SUM (Σ)	699	17

Table 3: The results of the Quantification process from the concentration sample and the sum (Σ) of all the fossils taxa present.

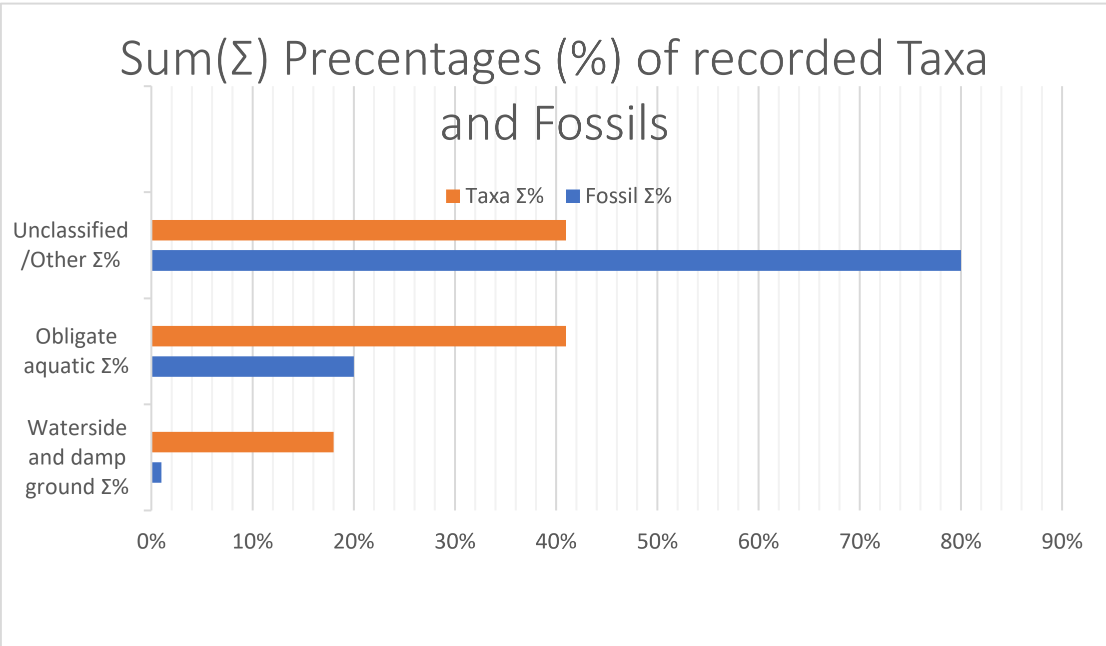

Table 4: The Percentages (%) of Sum (Σ) of the taxa and macrofossils from the 13II-3 concentration sample data.

Overall, the results of the concentration data have clearly shown an overrepresentation of obligate aquatic taxa and unclassified taxa. Likewise, the residue sample results show the majority of macrofossils to belong to the obligate aquatic group followed closely by the unclassified category. That is very consistent with the existence of the Palaeolake in the Schöningen locality researched in this paper. Overall, the taxa identified suggest clear ecological determinants allowing for a reconstruction of the middle Pleistocene environment in Schöningen. It is important to note that some taxa produce more seeds per plant than other taxa. Also, some seeds might preserve better or were deposited in an environment better suited for preservation than others. These factors should be considered since they could allow for skewed representation numbers in an assemblage. Nevertheless, in palaeoenvironmental reconstruction attempts the information provided by the taxa identified such as ecological tolerances and dispersal strategies contributes a lot, allowing for potential taphonomical concerns or phenotypical differences without hindering much of the researchers understanding and success rate at the reconstruction attempt. Following, concerning the non-botanical and other macrofossils section, a great number of moss leaves and stems is calculated in both concentration and residue samples. Furthermore, there is evidence of a biodiverse ecosystem by the presence of small animal, shellfish, insect, and fish bones and other remains.

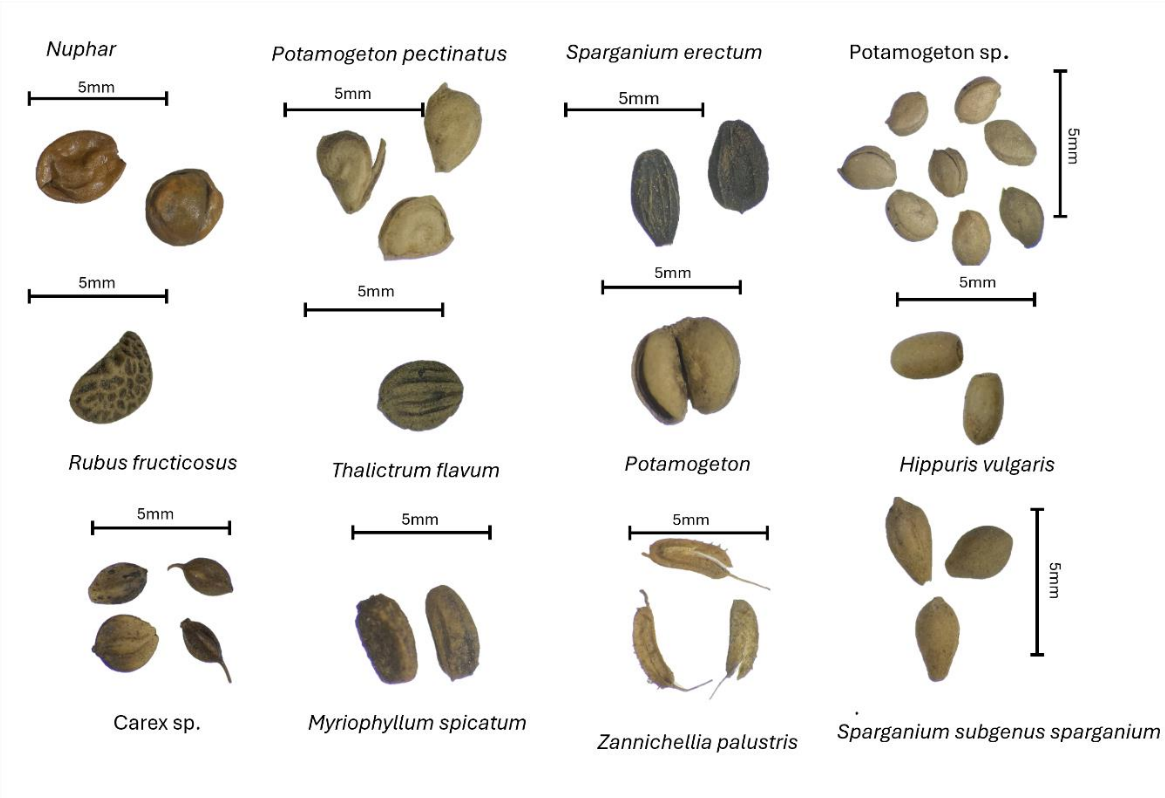

Figure 8: Close-up photographs of some of the taxa from the sub-samples that are really well preserved. The images show their size in mm and their scientific names.   Photographer: Vasiliki Xiromeriti

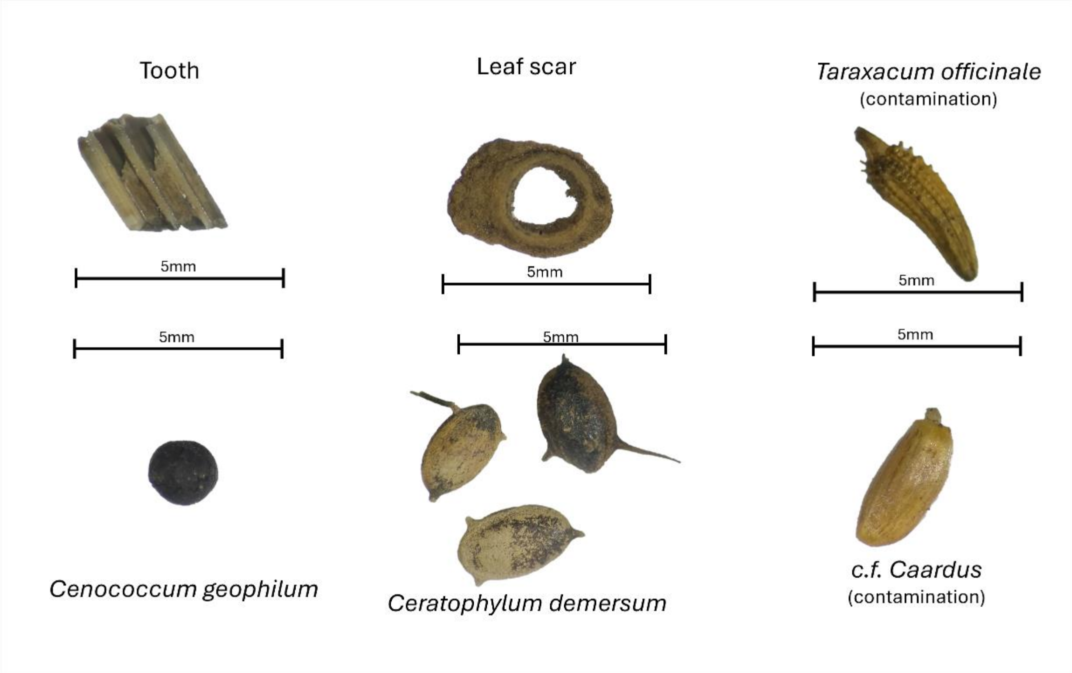

Figure 9: Close-up photographs of some more taxa from the sub-samples that are really well preserved but also two modern contaminants and some non-plant specimens. The images show their size in mm and their scientific names. Photographer: Vasiliki Xiromeriti

CHAPTER 4: DISCUSSION

Taphonomy of the Taxa and fossils identified in the concentration samples:

In every assemblage you can have different representation (number of fossils present) due to different taphonomical processes such as water flow, deposition, bioturbation (animal disturbances), natural disasters and even anthropogenic factors such as ploughing. Taxa typically have either low representation (small numeric value) or High representation (high numeric value). These should always be addressed in an analysis of a macrofossil assemblage in order to understand patterns and plant populations.

Taxa with high representation in the Schöningen 13II-3 Assemblage:

Taxa with high populations indicate the abundance of the specific taxon in a specific ecosystem. This perception however could be skewed; both in terms of underrepresentation and overrepresentation; influenced by the different dispersal strategies of each plant species. For instance, if a specific taxon is a high producer of seeds, or its seeds are very well preserved. Another factor is distribution (how far does the dispersal of the seeds reach) there are differences in case it is predominately locally or wind dispersed. Specifically for the Schöningen 13II-3 assemblage the following taxa have high population numbers.

In the concentration data results Carex *sp.* especially the biconvex but also the trigonous type has the highest representation number. The Carex *sp*. specimens in the assemblage were overall really well preserved therefore, a possible taphonomical bias could be the reason for their high numbers. Not much can be said about their reproductive strategies as they greatly differ among *Carex* species (Hulík & Douda, 2017, p. 2), however, studies of European swamp forests and other wetlands show *Carex sp*. dominating the ecosystem's vegetation (Hulík & Douda, 2017, p. 1-2). This could be another possible explanation of their overrepresentation or most likely it could be a combination of these two and other factors. Following, the second highest population macrofossil in the assemblage is *Chara sp*. oosporangia. It is important to note that *Characeae* are generally really high producers therefore they are most likely underrepresented in this assemblage with the possible reasons being taphonomy but also deterioration since several of the specimens were not in good condition. Following, another species that is prevalent in the concertation sample assemblage is *Typha*. A lot can be said about their reproductive strategy. *Typha* species are very high seed producers with roughly 20,000- 700,000 seeds being produced per plant alone. Furthermore, these seeds are light enough in order to be wind dispersed aiding to the fast and wide dispersal of the species (Species Profile - *Typha Angustifolia*, n.d., p. 1). Taking this into consideration the *Typha* species are very likely underrepresented in the assemblage since there are only 25 specimens present. One reason for this could be taphonomy or poor preservation of the *Typha sp*. seeds. However, since they are wind dispersed the seeds deposited might have traveller from nearby thereby explaining their underrepresentation. Continuing, *Zannichellia palustris* is also present in relative abundance in the assemblage. *Zannichellia* often self-pollinate due to their pollen grains being heavier than water leading them to sink (van Vierssen,1982, p. 124) therefore making wide dispersal difficult. For this reason, *Zannichellia palustris* presence in the palaeolake ecosystem itself is highly suggested.

Diverging a bit from plant taxa, *Cenococcum geophilum* is also found in relatively high amount in the concentration samples but also in the residue samples. Typically, the sclerotia of *Cenococcum geophilum* are transported through running water and deposited into waterbodies, suggesting a possible way these specimens could have ended up in this assemblage. Returning to the plant macrofossils *Myriophyllum spicatum* is very successful and rapid at its dispersal making it easily wide spread in an ecosystem sometimes even displacing other macrophyte taxa, this implies its potential underrepresentation possibly attributed to taphonomical processes or degradation of the seeds over time. Continuing, the last taxon with high representation in the sample is *Poaceae* (grass seed). Taxa of the Poaceae family are globally the most widespread angiosperms since they can thrive in a great variety of habitats. They have dominated many types of ecosystems (Linder et al., 2017, p.). This is attributed to them being really high seed producers sometimes being able to produce more than 5000 seeds per plant (Hani et al., 2017, p. 4-5). For this reason, their underrepresentation in this study is highly suggested. Taphonomical processes might be the reason for their underrepresentation but also preservation issues.

Taxa with low representation in the Schöningen 13II-3 Assemblage:

Having a taxon with a small representation, at first glance indicates the minimal presence of the plant in an environment however this could in many cases be a false observation caused by different taphonomical activities and qualities or a specific seed such as if it is encased in a hard shell slowing down decomposition or be deposited in a sediment that favours preservation.

To be more specific for this assemblage the plants which are found in low numbers are the following. Starting with *Hippuris vulgaris,* this plant has a small population in the concentration sample assemblage but is also present in the residue samples. Furthermore, it is wind dispersed, therefore a high producer. For this reason, *Hippuris vulgaris* could very likely be underrepresented here due to the same factors as *Poaceae* (taphonomy or preservation issues). Likewise, another taxon with low representation is *Potamogeton pectinatus*. There were several *Potamogeton sp*. fragments in the assemblage therefore there is a very high probability that *P. pectinatus* and *Potamogeton* species in general are underrepresented here as well. In addition, *P. pectinatus* and other Potamogetonaceae, specifically *Potamogeton c.f. pusillus* and *Groenlandia densa* are highly prevalent in the residue sample assemblage, further suggesting the underrepresentation of *Potamogeton sp.* in the concentration sample. Following, *Bidens,* which also has limited presence in the assemblage, is an edible plant foraged by a variety of local fauna including bees (Koch, 1975, p.1) and thus could have been transported in the deposits via them. However, it is important to note that the specimen in the assemblage was a fragment suggesting it could be underrepresented, potentially due to more rapid decay of its seeds. Moreover, *Rumex sp.* has a very low representation in this assemblage. This could be an indication that it had been transported by wind from nearby, since its seeds are usually wind dispersed Taphonomical processes could also play a part on their underrepresentation. Lastly regarding *Polygonum* species, they are present in both the concertation and residue sample data but with only a handful of specimens. That could possibly be due to poor preservation.

Ecological tolerances of the Taxa and fossils identified:

The ecological tolerances and preferences as well as dispersal strategies are crucial information in understanding the palaeoenvironment. In the following paragraphs these aspects will be analysed for each taxon present in the assemblage with a greater focus on the concentration data which will be supplemented by the residue samples that were not quantified.

Waterside and damp ground taxa occupying the lake margins:

There are not many taxa belonging to the waterside and damp ground group in this assemblage. Despite that their analysis can give valuable insights into the environment in the lake body and or the immediate vicinity. Firstly, Hippuris vulgaris, which grows along the edges of lakes, ponds and rivers (Yu Y, et al., 2022, p. 2), from stout rootstocks that are submerged (Encyclopaedia Britannica, n.d.), is typically found in well-lit ecosystems and grows in soils with neutral or slightly basic pH (Misson et al., 2016, p. 211). Another taxon typically found in the surrounding lake margins or river banks is Bidens. Several valuable information can be extracted from Bidens sp. namely that they prefer well-lit environments and can tolerate all types of pH levels (Greenhouse Management, 2022, p. n.d.).

Last but not least, there are three species of the water side and damp ground group that are only present in the residue samples. These taxa are, *Thalictrum flavum*, *Sparganium erectum* and *Sparganium subgenus sparganium.* To begin with, *Thalictrum flavum* can contribute a lot to the understanding of the palaeoenvironment researched. In general, *Thalictrum* species have a significant population all around the globe, predominately in temperate to cold regions of both the Northern and Southern hemisphere. Specifically, *Thalictrum flavum* is found along the edges of ditches, marshes, tall grass meadows and other water bodies such as lakes (Ropivia et al., 2010, p. 6477). The waters where it grows are typically calcareous, of neutral pH and mesotrophic or eutrophic (Botanical Society of Britain & Ireland, n.d.). Following, there are a lot of information that can be extracted from *Sparganium species* aswell*.* Typically, members of the genus *Sparganium* are perennial emergent plants inhabiting aquatic or semi-terrestrial ecosystems (Blamey & Grey-Wilson, 1989, p. 472). *S. erectum* is very prevalent in the residue samples, consequently offering compelling evidence for its abundance in the environment even though it isn't present in the concentration sample. More specifically, *Sparganium erectum* occurs in marshlands and along the margins of a water body (Blamey & Grey-Wilson, 1989, p. 472), that has slow-flowing eutrophic waters. It generally prefers sun lit environments and inhabits temperate and boreal regions. In addition, its fruits can preserve well so they can get easily transported from place to place via water flow. They are also spread by birds (Shah & Jan, 2024, p. 4-6).

Obligate aquatic taxa in the lake itself:

Since the Obligate species identified in this study are numerous, they can give very valuable insights into the immediate lacustrine environment, meaning the lake itself. Their ecological indicators and preferences will be discoursed below.

Beginning with Chara sp., they are aquatic algae with lime encrusted stems (The BRAHMS Project, University of Oxford, Department of Plant Sciences, 2014) They can be found in underwater meadows of a slow moving or still, fresh or brackish water body where there is typically but not limited to high pH but always high alkalinity (SANZ et al., 2023, p. 1-2), meaning that the water is very resistant to pH fluctuations. Furthermore, the underwater meadows that Characeae are found have very clear waters due to low phytoplankton levels (SANZ et al., 2023, p. 1). Following, *Zannichellia palustris* can also give important clues about the palaeoenvironment Specifically, *Zannichellia palustris* is found in brackish but also freshwater environments (van Vierssen,1982, p. 385) with lentic waters (WTU Herbarium, Burke Museum, University of Washington, n.d.). Another aquatic plant present is *Ranunculus subgenus batrachium.* Typically, Ranunculaceae are predominately found in stagnant or slow-moving waters that are clear and have ample access to light (Englmaier, 2016, p. 98). Following, a submerged aquatic angiosperm, *Myriophyllum spicatum* is solely found in fresh waters that are calcium rich providing valuable information for the palaeoenvironmental reconstruction. Likewise, *Potamogeton* species give valuable information about the environment. They are generally found in lacustrine or riverine environments with calcareous and lentic waters. (Blamey & Grey-Wilson, 1989, p. 448-449) Specifically, *P. pectinatus* can be found in a plethora of environments such as basic clear as well as brackish waters with stagnant or running motion (Van Wijk, 1988, p. 212).It is the only of the *Potamogeton* species that can tolerate high alkalinity and salinity but is not fond of acidic and oligotrophic waters(Kantrud, H. A. ,1990, p. 1). In similar fashion *P. pusillus* grows in fresh and relatively brackish stagnant or slow flowing waters (Maryland Department of Natural Resources, n.d.). Lastly *Groenlandia densa* is found in freshwater environments ranging from ponds to fast paced streams. It generally prefers calcareous waters (Blamey & Grey-Wilson, 1989, p. 449). Continuing, *Typha* also an obligate aquatic plant, can further expand the environmental indications for the palaeolake since it grows in the margins of a water body in shallow or deeper waters up to 2-3(*Species Profile - Typha Angustifolia*, n.d.).

Regarding the obligate aquatic category, there are a couple genera that are only present in the residue samples. Specifically, *Ceratophylum demersum, Nuphar sp.* and *Nuphar C.F. lutea*. along with *Groenlandia densa* which has been analysed along with the other Potamogetonaceae above. For the remaining three taxa, several ecological indicators can be inferred. Notably Ceratophyllaceae species which are aquatic perennials, are submerged in the water body which typically has fresh and lentic waters (Blamey & Grey-Wilson, 1989, p. 104). Specifically, for *Ceratophylum* *demersum*, it is predominately found in lacustrine or slow moving riverine fresh water environments. Occasionally it can tolerate brackish waters. (Blamey & Grey-Wilson, 1989, p. 104). Correspondingly, *Nuphar sp.*, also an aquatic perennial, is found in still or slow flow fresh water as well. Precisely, *Nuphar lutea* prefers slow moving riverine and lacustrine environments with nutrient rich waters (Blamey & Grey-Wilson, 1989, p. 104).

Ecological tolerances of taxa of the unclassified category:

There are several taxa in the assemblage which habitats are extremely variable and therefore were categorised as unclassified. A couple of taxa in this category could be attributed to an ecosystem on the surrounding area of the palaeolake whilst others due to their substantial habitat and species variability were not able to significantly contribute in the palaeoenvironmental reconstruction. The former will be discussed in the following paragraph whereas the latter will be analysed below.

Firstly, *Carex, which is very prevalent in the assemblage overall,* predominately occurs in a variety of wetlands (Hulík & Douda, 2017, p. 1) and in flooded environments which are wet or dry (Grzelak et al., 2019, p. 181). More specific information about the conditions of the environment in question cannot be inferred since the identification of the exact species of *Carex* was not achieved. Likewise, for *Polygonum,* which can survive in diverse ecological conditions and habitats (Sultan et al., 1998, p. 364), the specimens in this study's assemblage are not of the greatest preservation quality—with some being completely or partly fossilized—and thus cannot be identified to the species level. Therefore, not much information about the environmental conditions of this middle Pleistocene lacustrine environment can be extracted from them. In similar fashion, Atriplex sp. due to its broad environmental tolerances cannot have a significant contribution to the palaeoenvironmental reconstruction attempt either.

Ecological tolerances of taxa potentially from a surrounding area:

Analysis of the surrounding environment of an ecosystem studied is also significant since it can give broader contexts to our understanding of the palaeoenvironment and the habitats and interaction of local flora and fauna including hominins.

One of those taxa that can possibly give insights into the surrounding area of the palaeolake is *Betula*. Betula sp. are frequently found in damp grounds near swamps lakes or rivers (Gardenia.net, n.d.). *Betula* is a deciduous tree with approximately 40 distinct species. In addition, the seeds of the Betula sp. are wind dispersed (Blamey & Grey-Wilson, 1989, p. 54). This as well as the fact that they are commonly found near waterbodies could indicate that the Betula sp. macrofossil present in this assemblage might have come from the surrounding area of the palaeolake. This suggests the presence of a Birch tree (Betula sp.) woodland environment nearby. Another species that could have been in the same area as *Betula is Cenococcum geophilum*. *Cenococcum geophilum* is an ectomycorrhizal fungus meaning it forms a symbiotic relationship with other plants, predominately trees. It is specifically found on woody plants roots and forest soils in high-latitude, temperate, and subtropical environments (Obase et al., 2017, p. 299-302). Furthermore, their presence in this assemblage also suggests that the vegetation around the lake margins was possibly quite sparsely planted allowing for their deposition. Following, *Rumex* species just like *Betula,* are wind dispersed since their triangular seeds are often winged. This wide range of dispersal could indicate that the seeds came from a nearby ecosystem, such as the proposed birch woodland, into the palaeolake. Nevertheless, *Rumex* are found in a variety of habitats ranging from mountain meadows and damp grasslands to river, lake margins and marshes. Sometimes they can be found in open woodland too. Another taxon that could have been transported from surrounding area of the palaeolake is *Rubus fructicosus*. *Rubus fructicosus* (blackberry) inhabits a variety of environments such as woodland or waste grounds (Blamey & Grey-Wilson, 1989, p. 176) and its seeds are often consumed by animals and other mammals and thus get transported into a much wider area. They can also be transported by flowing water. (Department of Energy, Environment and Climate Action, 2025). *R. fructicosus* was only identified in the residue sample consequently there is possibility of its transportation via fauna or flowing water into the palaeolake coming from a nearby environment.

Question 1:

The Palaeoenvironment in Schöningen 13II-3 layer:

Through the analysis of the botanical macrofossil assemblage of both the concentration and residue samples consistent environmental patterns are observed gradually piecing together the palaeoenvironment of Middle Pleistocene Schöningen. For the Palaeoenvironmental reconstruction based on the Schöningen layer 13 II-3 the following environmental conditions are proposed. The great majority of all the taxa present occupy lacustrine environments therefore the presence of the palaeolake is reinforced and aligns with the views of relevant literature about Schöningen.

Analysis of the water qualities in Schöningen 13II-3 layer:

Regarding the waters of the palaeolake, it is highly endorsed that they were fresh—low salinity content— despite the existence of some plants that can tolerate both fresh and brackish waters such as *P. pectinatus*, *Z. palustris* and *Characeae*, the predominance of taxa strictly occupy fresh water ecosystems. Furthermore, the flow of the water is strongly supported to be slow moving or stagnant given that the overwhelming majority of taxa prefer such conditions. However, since one taxon namely *Sparganium erectum* typically occurs exclusively in slow moving waters, the evidence may slightly favor the existence of slow flowing conditions in the palaeolake. Moreover, the ecological preferences of the plants specifically, *H. vulgaris*, *P. pectinatus* and *Characeae* suggest the presence of alkaline (pH > 7) waters. In addition, the occurrence of *Characeae*, which have calcium carbonate ($CaCO_3$) encrusted stems as well as *Myriophyllum spicatum*, *Potamogeton pectinatus, Potamogeton pusillus, Thalictrum flavum* and *Groenlandia densa* indicate calcareous conditions in the waterbody. Another characteristic of the water is inferred to have been clarity. Several of the taxa particularly *Characeae*, since they typically grow in low phytoplankton waters, but also *Ranunculus subgenus batrachium* and *Potamogeton pectinatus* point towards clear water conditions. Lastly, the waters of the palaeolake but also the surrounding soils were likely nutrient rich, since taxa like *Nuphar lutea, Thalictrum flavum* and *Sparganium erectum* grow in these types of environments.

Comprehensive view of the ecosystem in Schöningen 13II-3 layer:

Concerning the lacustrine ecosystem overall, a significant percentage of the plants occupy shallow waters and lake margins indicating a biodiverse littoral zone. Specifically, the plants that are inferred to grow along the edges of the palaeolake are, *Typha sp.*, *Hippuris vulgaris*, *Bidens sp.*, *Thalictrum flavum* and *Sparganium erectum.* However, due to the deposition of several *Cenococcum geophilum* sclerotia in the water body the notion that the vegetation in the littoral zone must have been relatively sparse is supported. This notion is consistent with the observation that many of the above taxa occupy well-lit environments. Furthermore, though limited, there are also some indicators about the climate in Schöningen during the Middle Pleistocene. Precisely, through species like *Sparganium erectum* and *Cenococcum geophilum*, temperate climatic conditions are inferred. Additionally, the presence of *Cenococcum geophilum* in an assemblage is often associated with cooler temperatures (Zheng et al., 2023, p.9).

Palaeoenvironment of the surrounding area and other indicators:

Other than the palaeolake ecosystem itself, the surrounding area could also potentially be reconstructed. There are several taxa in the assemblage that have potential to be distributed over extensive areas via wind or other processes such as runoff and consumption by other organisms, namely *Betula sp.*, *Rubus fructicosus*, *Cenococcum geophilum* and *Rumex* species. *Betula* species are dispersed via wind and typically occur in riparian woodland environments. *Rumex* species are also wind dispersed and don't have very strict environmental boundaries. On the other hand, *C. geophilum,* which is generally transported via runoff*,* typically inhabits forest soils and forms symbiotic relationships with primarily woody plants. Thereby the mutualistic association between this ectomycorrhizal fungus and *Betula sp.* trees is strongly supported further implying the presence of these two taxa within the same ecosystem. Moreover, *Rubus fructicosus* which is commonly consumed by animals aiding to its long-distance dispersal, is typically associated with woodlands ecosystems. Overall, the taxa above suggest the presence of a riparian woodland (wet woodland) ecosystem functioning in the vicinity of the palaeolake of Schöningen. Finally, other than the plant macrofossils, the faunal/ other remains are instrumental in the understanding of the palaeoenvironment. Fossils from both the concentration and residue sample assemblage indicate a biodiverse lacustrine ecosystem, with fish, bugs such as beetles, shell fish, small mammals such as rodents, potentially water fowl, and other small aquatic creatures all coexisting in the palaeolake.

QUESTION 2:

Homo heidelbergensis plant exploitation in Schöningen 13II-3:

Having a clear picture of the supposed environment in the locality of Schöningen during the Middle Pleistocene can give valuable insights into the use and consumption of plant foods by the early Hominins in Schöningen, which leads to the second research goal of this study; what impact had the environment on Hominin subsistence strategies and activities regarding plants. In order to try to examine which plants *Homo heidelbergensis* could have exploited in the middle Pleistocene Schöningen it is essential to contextualize their cognitive abilities and nutritional needs. Specifically for Schöningen layer 13II-3, the assemblage of finds includes aurox bones, a suspected digging stick but also flint artefacts making the presence of a Hominin population in the studied environment, very likely.

Relevant literature insights on Homo heidelbergensis cognition and Neanderthal subsistence patterns:

In general, *Homo heidelbergensis* is the first of the genus *Homo* to see an increase in brain volume, with a brain size as large as modern *Homo sapiens* (Bigga, 2018, p.10). In context, the presence of the wooden speers in Schöningen is sufficient evidence of the intellectual capacity of *Homo heidelbergensis*, further insinuating the existence of skills to utilize and modify their surrounding environment. The production of these spears requires planning ahead and purpose driven activities since they are made out of hard wood not local to the immediate vicinity of the lake ecosystem. If *Homo heidelbergensis* is presented to have this intellectual ability then the processing of plants, cooking and preservation methods are highly possible, based on the assumption that the so-called spears are indeed weapons for hunting and used as tools (Bigga, 2018, p. 12).

Furthermore, through modern genetic studies it has been deducted that *Homo heidelbergensis* need to acquire vitamin C via their diets since their body cannot synthesise the vitamin itself. The same requirement applies to modern humans as well (Bigga, 2018, p. 13), therefore we can assume similar nutritional needs between the two species. Moreover, Henry et al. in their 2011 study on Neanderthal calculus from Shanidar Cave in Iraq and Spy Cave in Belgium show evidence of plant processing and consumption of a variety plant starches by Neanderthals possibly since the Middle Pleistocene (p. 486).

Particularly, the study corroborates the idea of the consumption of cooked plant foods by Neanderthals through evidence of “boiling” induced gelatinization in Triticeae staches present in the calculus samples (Henry et al., 2011, p. 487), as well as the moderate to high intensity processing of plant foods in order to maximize their nutritional value. The specific taxa identified in the calculus and phytoliths of *Homo neanderthalensis* in the Spy cave which is more adjacent with the geographic location of Northern Germany (Schöningen), are a variety of starches with most not been able to be identified due to preservation issues except some starches from water lily. However, this water lily starch was not linked to any of the common native water lily species, *Nuphar lutea* and *Nymphaea alba* (Henry et al., 2011, p. 488). The results of this study are instrumental on the understanding of the utilization of plants in Schöningen from *Homo heidelbergensis* since *H. heidelbergensis* is thought to, by many scholars, be the predecessors or in some way related to the subsequent *Homo neanderthalensis* (Stringer, 2012, p. 101-102). Therefore, through the plant foraging, consumption and preparation process of the Neanderthals we can gather valuable insights in order to understand the subsequent activities of *Homo Heidelbergensis* in Schöningen.

Specific taxa used potentially by Homo heidelbergensis in Schöningen 13II-3:

In general, the environment of Schöningen deduced from the palaeoenvironmental reconstruction attempt was ecologically diverse with plentiful resources suggesting great attractiveness for hominin groups. The area would have possibly offered them hunting opportunities including waterfowl, fish, small mammals, shellfish and other aquatic creatures. Furthermore, larger game could have been drawn to the area for similar reasons or to access water. However, the plant resources themselves could have been the focus of Hominins as their importance has been highlighted by the studies discussed above. The plants in the assemblage could have been consumed, used for medicinal purposes but also crafts and raw materials. Through careful examination of the properties of the taxa from Schöningen a list of potential plants *Homo heidelbergensis* could have utilized will be presented and discussed.

In the concentration and residue sample assemblage there are several taxa that have the potential to have been exploited by Hominins in Schöningen. Specifically, these include *Ceratophylum demersum*, *Myriophyllum spicatum*, *Potamogeton pectinatus, Hippuris vulgaris, Sparganium subgenus sparganium, sparganium erectum, Betula, Rubus fructicosus, Typha, Poaceae* and *Nuphar lutea.* Each of these taxa are edible, have medicinal properties and effects utilised in folk medicine and indigenous populations till today and some can be used in the manufacturing of tools.

Edibility, Medicinal qualities and tool resource potential of the Schöningen 13II-3 assemblage Taxa:

Some of the taxa in the 13II-3 assemblage of this study are documented to be edible and nutritious but also have some medicinal qualities often used in folk remedies and by native populations. Furthermore, some plants due to their structural qualities could be used as tools. In the following paragraphs the plant taxa with nutritional value, medicinal qualities and manufacturing resource potential will be discussed respectively.

<u>*Taxa with nutritional value:*</u>

Beginning with *Hippuris vulgaris, its* leaves and shoots of can be consumed raw or cooked, often used to make soups. It could have potentially supplemented the diets of the early hominins of Schöningen (Plants for a Future, n.d.). Likewise, *Potamogeton pectinatus* roots, leaves and stems are edible. The roots can be eaten raw and have a nut-like taste however they do require some preparation since the outer rind must be removed (Plants for a Future, n.d.). It is very likely that *H. Heidelbergensis* did process plants in order to increase their edibility, therefore *P. pectinatus* could have been also consumed by them. Another taxon that could potentially be part of the foraging repertoire of early hominins in Schöningen is *Myriophyllum spicatum.* The roots of the plant are edible and can be consumed raw or cooked, they are crunchy and have a high sugar content. Traditionally they are a highly valued food source among the North American native tribes suggesting a long-time knowledge of *Myriophyllum spicatum* as a food source.

Furthermore, Sparganium *sp.* are edible and typically provide shelter and food for several waterfowl and mammals, such as cattle. They are also consumed by humans today further suggesting the potential consumption by the early hominins of the site. Specifically, for *Sparganium erectum*, its roots and stems are edible. The root is mildly sweet and can be consumed raw, on the other hand the stem needs to be cooked (Plants for a Future, n.d.). Following, *Nuphar lutea* is plausible to have been utilized by *Homo heidelbergensis*, as it starchy roots possibly provide a nutrient dense foraging food. In addition to the roots, the seeds and leaves can be consumed and are widely considered as edible today (Plants for a Future, n.d.). All the edible parts of *Nuphar lutea* have to be processed before consumption (Plants for a Future, n.d.), which is a highly plausible skillset that *Homo Heidelbergensis* possessed. In addition, another plant possibly foraged by early hominins in Schöningen is *Rubus fructicosus*, the common blackberry. It is widely consumed today with the fruit, its leaves and stems all been utilised in different ways.

Moreover, *Typha* species are typically known as edible. For example, the rhizomes of *Typha latifolia* (common cattail) have a high starch content and are widely consumed by waterfowl (Typha latifolia, n.d.). Furthermore, the flowers, pollen, roots and seeds can be eaten in various ways (Typha latifolia, n.d.). The same applies for *Typha angustifolia (National Parks Board, n.d.)*. In addition, the root of *T. latifolia* has a high starch content with roughly 8% protein content. They can be eaten raw but preferably cooked (Typha latifolia, n.d.). Based on these information, Typha sp. are suggested to be highly nutritious. Following, as is suggested by Henry et al. (2011) study on Neanderthal calculus remains, *Poaceae* which have a high starch content, were consumed by Neanderthals (p. 486-487). Based on this information, the consumption of *Poaceae* seeds by *H. heidelbergensis* in Schöningen could be inferred. However, it is important to note that Poaceae sp. in the assemblage have not been identified to species level therefore their edibility and potential consumption is but a speculation. Finally, *Betula.* could potentially have been utilised in several occasions. Generally, many of the *Betula* species are edible, and birch was typically used in cases of famine since its bark can be ground into flour and its young leaves, which contain vitamin C, and twigs can be consumed (Harford & Harford, 2025). In addition, birch sap is traditionally consumed in many cultures and has a pleasant mildly sweet and aromatic flavour with several health benefits (Silver birch, n.d.). It can be consumed as is, fermented into alcohol and vinegar or condensed into syrup (Harford & Harford, 2025). Due to its sweet taste birch sap could very likely have been consumed by the early hominins of Schöningen.

<u>*Taxa with medicinal qualities:*</u>

A lot of the plants in the assemblage that are edible also have medicinal qualities and could have been consumed in the first place because of these healing effects.

In more detail, beginning with *Ceratophylum demersum* its leaves are edible but not particularly palatable, nevertheless it has medicinal effects including treating indigestion and soothing scorpion strings. It also has cooling antiperiodic properties (Plants for a Future, n.d.). Likewise, *Thalictrum flavum* is not edible at all due to its contents of several toxic compounds (Botanical Society of Britain & Ireland, n.d.). Despite their inedibility, Ropivia et al. (2010) study suggest that the roots and other parts of several *Thalictrum* species show medicinal qualities, namely antiparasitic effects due to a couple types of bisbenzylisoquinolines (plant alkaloid substances commonly exploited in traditional medicine) present in these plant parts (p.6477). Furthermore, *T. flavum* has been used in traditional medicine to sooth fevers and is widely researched in current medicinal studies due to its high amounts and variety of toxins with medicinal potential (Botanical Society of Britain & Ireland, n.d.). This could suggest *Thalictrum flavum* could have been one of the plants collected by the early hominins in Schöningen for its medicinal effects.

Furthermore, *Hippuris vulgaris*, could have also been used to treat wounds— since it has those properties—through external application or consumption (Plants for a Future, n.d.). Following, *Myriophyllum spicatum* in addition to its pleasant taste, also exhibits some medicinal effects. These include narcotic and antipyretic properties (Plants for a Future, n.d.). Moreover, Sparganium sp. have been used in folk medicine to enhance blood circulation (Sulman et al., 2013, p. n.d.). Specifically, for *Sparganium erectum*, based on its based on the medicinal properties it can be inferred that the plant was used in a mixed infusion to provide an anti-chill effect (Plants for a Future, n.d.).

Another taxon with medicinal potential is *Nuphar*. Specifically, *Nuphar lutea*. This waterlily species has several medicinal properties including sedative, astringent, and cardiotonic effects. Furthermore, it has been used in folk medicine to treat reproductive issues, infertility, blood diseases and inflammation (Plants for a Future, n.d.). Following, beyond its edibility, *Rubus fructicosus* also has several medicinal uses, it can be used to treat wounds, as a diuretic and tonic and has strong astringent, depurative properties. It is also useful against sore throats and gum inflammations (Plants for a Future, n.d.) which further increase the possibility that it was utilised by the *Homo heidelbergensis* in Schöningen. Following, *T. latifolia* fibers around the seeds have medicinal properties, healing burned or irritated skin (Typha latifolia, n.d., p. n.d.), further highlighting its potential usage by early hominins. Last but not least, Betula can be used for medicinal purposes due to the several health benefits of its plant parts traditionally used to treat bladder kidneys and considered as a general tonic (Harford & Harford, 2025).

<u>Plants with tool manufacturing resource potential:</u>

Along with a medicinal and a nutritional value, plants could have been exploited by the Hominins of Schöningen for manufacturing tools or other items for foraging, butchering, clothing and transport. The Schöningen spears confirm this notion and the find layer of the Spears is 13II-4 which is very close to the layer analysed in this thesis,13II-3. Furthermore, the suspected digging or rummaging stick found in 13II-3 could potentially be an early example or a sort of "prototype tool" of the spears in 13II-4 horizon. However, this is only a speculation and cannot be confirmed. Further aiding to this obscurity is the fact that remains from plant tools and other items due to the nature of the material do not preserve well if not in the right conditions so information is very likely fragmentary. Nevertheless, what can be inferred with relative confidence is the fact that the Homo heidelbergensis of Schöningen did exploit plant materials for the manufacturing of tools.

In the assemblage of this study only two taxa were presented to have some manufacturing resource potential, which are *Thalictrum flavum* and *Betula*. Starting with *Thalictrum flavum*, its resource potential cannot be inferred with confidence however there are some suggestions that its roots were sometimes used to dye cloth, these is not concrete evidence for these suggestions however (Botanical Society of Britain & Ireland, n.d.). On the contrary the resource potential of *Betula* can be assumed with much greater confidence. Specifically, Birch bark is water-repellent and flammable due to its high oil content; therefore, it is traditionally used to make several crafts such as baskets or canoes (Forest School Association, n.d.). Its wood which is soft and pliable as is commonly used for traditional crafts (Harford & Harford, 2025), could also be utilised in a variety of tools and constructions. These information indicate that Betula species may have been a highly valued resource for the early Hominins in Schöningen.

Summary of edibility, medicinal qualities and tool resource potential:

Through the analysis of the plants, present in the fossil concentration and residue sample assemblage of Schöningen layer 13II-3, it can be inferred that *Homo heidelbergensis* could have been attracted to the said environment due to the diverse edible and of medicinal interest flora along with hunting opportunities and access to water.

CHAPTER 5: CONCLUSION

The aim of this paper is to attempt at an environmental reconstruction of Schöningen layer 13II-3 and to understand through the environment the potential plant usage by *Homo heidelbergensis* around the Palaeolake. The results of the study show a biodiverse sunlit lacustrine environment with fresh, lentic, calcareous and alkaline waters surrounded by a riparian woodland ecosystem, in which *Homo heidelbergensis* potentially exploited several taxa for their nutritional value, medicinal effects but also structural properties in the manufacturing of tools and other objects. The exploitation of plants for the construction of tools and other items for hunting and everyday activities can be suggested with greater confidence since the site of Schöningen is famous for the nine wooden spears found in layer 13II-4 which is one layer above(younger) than the layer researched in this study (layer 13II-3). Furthermore, in layer 13II-3 a stick was found which is suspected to have been used for digging further reenforcing the preceding notion. Overall, by reconstructing the palaeoenvironment this paper provides new perspectives and reenforces already known narratives on the subsistence strategies and activities of early hominins in the site of Schöningen and also specifically layer 13II-3, bringing to the fore front plant exploitation which potentially supplemented hominin diets but also provided potential health benefits, medicinal effects and resources for tool manufacturing. In general, knowledge about the everyday life of early hominins such as *Homo heidelbergensis* is heavily limited due to insufficient data and evidence left behind. Taking this into consideration the significance of this study is highlighted, contributing to the collective picture of the Middle Pleistocene environment and the hominin activities that commenced in the archaeological site of Schöningen, and subsequently to the discipline of Middle Pleistocene archaeology as a whole.

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