Stinging, humble, forgotten. The role of Urtica dioica as a potential European Neolithic textile.

Lolas, Magdalena

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Illustration by Magdalena Lolas

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Magdalena Lolas
s3012050
Master Thesis Archaeological Science
1084VTSY
Prof.dr. A.L. van Gijn
Leiden University, Faculty of Archaeology
Kraków. 01.07.2022
Final version.

I want to express my deep gratitude to Robert Tyborski
for the constant support and help all along the way.

Structure

1. Introduction

White delicate linen cloth carefully woven on the loom is one of the two images immediately conjured in minds of most when the words Neolithic and Neolithisation are invoked.
This is by no means strange or unexpected, as the appearance of the loom-woven textiles coming from the domesticated sources are one of key components defining this period, divorcing it from the previous Mesolithic traditions.

Originally thought as one of the greatest breakthroughs in human ingenuity coming to Europe and other Mediterranean regions from the cradle of the civilisation located in the Near East (Kozłowski & Kaczanowski, 1998, p. 100, Verhoeven 2011, p. 78-79), it is currently considered a more nuanced and faceted development (Çilingiroğlu, 2005, Kozłowski, p. 1999, 133-136; Verhoeven, 2011).

Researchers are now less keen on assuming the sudden appearance of this technology, but note the presence of some forms of textile production, such as rope-making and netting starting already in the Palaeolithic (Grömer, 2016, p. 6, 42; Kozłowski, 2004, p. 671-718; Piqué et al., 2016, p. 262). There is a growing belief, that it was indeed from this traditions that the loom weaving come to be, as more evidence of Mesolithic and Neolithic practices are unearthed such as varied forms of rope-making, knotted and unknotted netting, basketry and even forms of sandal-making (Grömer, 2016, p. 347; Piqué et al., 2016, p. 262). Moreover, as the elements of the evolution in loom application and construction are observed (Chmielewski, 2009, p. 165-223), and the appearance of other tools such as distaff, weights and wetting-pots, illustrate the further changes in the practice within Neolithic and Eneolithic (Chmielewski, 2009, p. 75-150).

Another aspect of neolithic cloth-making, which became more apparent, is the non-simultaneous exploitation of plant and animal fibres and the seemingly late appearance of the latter.
This might have been due to different priorities for the animal domestication and husbandry processes emphasised by the people of that time, namely meat, or milk production (Chmielewski, 2009, p. 28-51).

However, what seems to be less examined is the prominence of flax (Linum *usitatissimum)* as the main source of plant bast fibre. The immense importance of flax is not to be denied, but as some scientists pointed out, if the weaving comes from the older traditions, it would be unwise to forget about other possible textile resources (Chmielewski, 2009, p. 165-167; Piqué et al., 2016, p. 262). One of the more often brought up materials in recent times is the tree bast fibres, given its ready availability and apparent ease at acquisition. There is evidence of the use of the inner bark of various trees, but the most commonly mentioned seems to be linden (Chmielewski, 2009, p. 27-28; Rimkuté, 2009, p. 218).

Ill. 1. Urtica dioica. The watercolour representation of stinging nettle, also called common due to its wide spread Eurasia, North Africa, North and South Americas and Polynesia. Usually growing in clusters, up to 2.5m. Lolas 2022, after Szwedlar, 1998, p. 430.

The less often considered source is stinging nettle (Urtica dioica), as it is considered harder to gather and process than tree bast (Ford, 2015, p.10). However, given the known prehistoric example, including the cases from Neolithic Europe, as well as the rich ethnographic data, this seems a little of an oversight, which this research is set to counteract, in a small degree.

The motivation for drawing the attention towards the possible application of the stinging nettle in the context of the European Neolithic is not only based on these few known examples from the period, but also on the concern that the identification of specific plant bast fibres is particularly tricky task, even in modern, or historical samples (Suomela et al., 2018; Viljanen et al. 2022), making it even more complicated in the archaeological context.

With the high chance of the misattribution and quite common assumption, that the textile presented is made out of linen, providing informations about the use and properties of Urtica dioica may be read as encouragement for the curious re-examination not only of the notion of the commonality of the flax, but also of the actual surviving fragments, hopefully with a more reliable techniques developed in the near future.

While the understanding of the complexity of the neolithic textiles and their production increased significantly in recent years, as did the amount of known artefacts, much is yet unknown. Particularly, the topic of Urtica dioica seems to be overlooked in many researches and reconstructions of the realities of the European neolithic communities. Therefore to provide an outlook into the possible employment of nettle in this sphere of human activity, this paper will look at the recovered samples, and reconstructions of collection and processing technologies from other bast fibre plants, such as linen and tree basts, as well as analogies to the applications of other Urticaceae family plants in order to provide a possible manners in which nettle could have been collected and used in the European Neolithic. It is done on the premise that given the currently available data from both historical and experimental projects, many of these procedures could be also applicable in acquisition of the Urtica fibres and their following transformation. Additionally, the inquiry into the technical properties should ground the question in the realm of materiality and material culture analysis, as it can provide an insight into the practical and physical aspect of textile choices available for the people of the period. Outlining the similarities and limitations of both the qualities and techniques in regard to nettle should shed more light on the unique place that Urtica dioica could fill and occupy in the prehistory.

1.1. The concept of Neolithic

The neolithisation originally was seen as a new technological period with intense economical changes namely the introduction of farming (Gilingiroğlu, 2005, p. 1; Kozłowski & Kaczanowski, 1998, p. 99), with later inclusion of symbolical and cultural shift (Kozłowski, 1999, p. 133-136; Verhoeven, 2011, p. 75) aligned with the common at the time concept of linear progression from simple and primitive, to complex, civilised and sophisticated[1] (Verhoeven, 2011, p. 75).

The evolving idea of the period was that somewhere around 10 000 BC, at the beginning of Holocene, in the region east of Sinai to the Upper Tigris and Euphrates, a new way of living emerged, coming with a set of tools such as domesticated forms of wheat rye and barley, as well as lentils, peas and flax, domesticated animals such as goat and sheep, together with pottery,

1 Where the understood pinnacle of evolution was the Western European colonial culture of the late XIX and early XX centuries.

polished stone tools, figurines and sedimentary habitation, including early cities (Gilingiroğlu 2005; Kozłowski, 1999, p. 133-136; Verhoeven, 2011, p. 78).

The question of the reason behind such a profound transformation was then given a response time and time again by the subsequent researchers coming with different answers such as simple technological improvement, response to ecological, or sociological pressures, fundamental shifts of human culture and ideology (Verhoeven, 2011, p. 76), to the modern hypothesis of the feedback loop, where as the time progressed, in response to cooperation and shared decision-making processes, the volume capacity of Homo sapiens brain decreased, resulting in need for more cooperation and exchange with even wider groups (DeSilva et al., 2021).

In truth, today the initially proposed image of the Neolithic is much less well defined, if only in a higher resolution. It is, for example, commonly accepted that the neolithisation as a process of shifting human activity from hunting, fishing, gathering, through gathering-collecting, to a form of sedimentary agriculture and husbandry, occurred independently in various times and in different places (Kozłowski, 1999, p. 133-134). These changes are however not understood as linear, or inevitable, as the period also includes destabilisation, depopulation and reintroduction of older practices, or clear continuation of said traditions (Verhoeven, 2011, p. 83).
Yet, there are regional changes in materials and techniques used. While it seems the speed of innovations and cultural exchange, at certain instances, seems quite high (Kruk & Milisauskas, 1999, p. 53-170), these coexist with a plethora of local variations, including these in chronology. This is important to highlight, as this paper indiscriminately uses materials from the Central, Western and South-Western, as well as Northern Europe. However, it is not to suggest the universality and unity within the continent, but only to draw attention to the possible parallels. The adduced associations may be results of various causes, such as shared climate and similar environments, or might be due to cultural affinity, however these reasons will not be examined in detail. Therefore, for the time frame of this research, the chronology of Central Europe will be used, dating the Neolithic to the period from 5600 BC to 2300 BC.

2. The taxonomy and ecology.

2.1. Urtica dioica

Urtica dioica (Ill.1.), also known as stinging nettle is a common perennial, herbaceous plant of cold and moderate regions of Eurasia, North Africa, North and South Americas and Polynesia (Michałowska, 2006, p. 296; Szwedlar, 1998, p. 430). It grows in various of spaces from meadows and fields to shadowy forest areas, in dense clusters, usually up to 1.5m in height.

The most characteristic elements of the plant are the leaves, which with intensively serrated margin are of ovoid and elongated-ovoid shape and together with the angular stem are covered in stinging needle-like hair called trichomes (Szwedlar, 1998, p. 430).
As the Latin name entails, nettle is a dioecious, where one plant produces only either male or female gametes. In the case of Urtica, the male flowers are long racemoid clusters horizontally growing, in colours from light green to yellow. They appear a little earlier than the female inflorescences and are less densely gathered, while the latter are typically growing downwards, creating a chandelier-like effect, usually in greenish shades. The blooming period for nettle is between early June to October (Ford, 2015, p. 1-3; Szwedlar, 1998, p. 430).
The root system of nettle is comprised of vertically growing parent root of a yellowish colour and white hue, horizontally oriented, and shallow growing child roots (Ford, 2015, p. 3-4).

Urtica dioica seems to prefer shady and moist environments, especially in forests, where it can reach up to 2m (Ford, 2015, p. 3-4; Gorzkowska, 2015, p. 51). This might also tie to the observation made by B. Wedel, that the alder leaves were natural fertiliser for the stinging nettle, which he advised to use for improving the harvest (Ford, 2015, p. 10), showing long and continuous interest in use of the plant.

It also grows well on rich in phosphate soils, which makes Urtica a ruderal plant and a good indicator informing of areas of human habitation (Sawyer, 2019, p. 20). The degree to which the stinging nettle tolerates the high levels of phosphates is so vast, that its cultivation is currently researched as a natural revitalisation method for over-fertilised and marginalised soils, as it is easily adaptable and requires little to none irrigation (Torano, 2011, p. 210-213). Additionally, because Urtica dioica could be an organically cultivated perennial crop, it is considered for agricultural introduction for example in the Apulia region in Italy (Torano, 2011, p. 214).

Taxonomically stinging nettle belongs to the Urtica genus, which consists of about 46 species (Bodros & Baley 2008, p. 2143). Among which the second most common one in Europe is Urtica urens easily distinguishable by its smaller height and more gathered, non-dangling flowers (Szwedlar, 1998, p. 430-431). The genus also contains two other fibrous species, first being Urtica galeopsifolia, and the second Urtica cannabina.
While within a wider context, the genus is part of the Urticaceae family which includes also, among others, Girardinia, Laportea and Boehmeria genera, all known as fibre sources (Edom, 2019, p. 4).

2.2. Urtica galeopsifolia

Ill. 2. Urtica galeopsifoli.
This subspecies of Urtica dioica is native to many parts of Eurasia is characterised by having little of trichomes causing little to none skin irritation. It has been used in textile from Must Farm in England. Lolas 2022.

Urtica galeopsifolia (Ill. 2.), also called a fen nettle, is another plant from the Urtica genus known for being harvested for fibres.
It is sometimes considered a subspecies of Urtica dioica and is likely a result of hybridization with Urtica sondenii.
Native to Asia, as well as East and Central Europe south of 60º N meridian, rare in the Western part of the continent (Geltman, 1992, p. 127-128).
It seems to prefer the damp environments in the near vicinity of the river, in the shady valleys, or woods particularly made out of Alder trees, and in the swamp areas in the company of the reed grasses of the Phragmites genus (Geltman, 1992, p. 128), the last giving the nettle its common name. In that, Urtica galeopsifolia differs from the common stinging nettle, as the latter is more found in drier places and hornbeam forests, and especially ruderal sites.

The main difference between the two species, however, lies in their leaves, which in case of fen nettle are often longer and narrower and are not or only very lightly, stinging.

2.3. Urtica cannabina

Another of the fibrous plants of the Urtica genus worth mentioning is Urtica cannabina.
This nettle with palmate-shaped leaves is native to the moderate climate zones of Asia, but grows also in the south regions of the Eastern and to lesser degree Central Europe, and from there can sporadically spread to the other parts of the continent.

The oldest known traces of textiles made with this plant is dated to 4000 BC, and was used for varied types of items, such as thick cloth, rope and other types of cordage in both Asia and Europe (Michałowska, 2016, p. 296; Flora of China Vol. 5, 2004). It was a popular material choice until the industrial introduction of cotton. Though even throughout the XIX century Urtica cannabina fibres were a preferred textile material for flour sieves and honey strainers (Michałowska, 2016, p. 296).

Contrary to Urtica dioica, U. cannabina is very often a monoecious species growing from 50-150 cm high and is very sparsely covered with trichomes. As its European cousin, it is a ruderal plant which can be also found near riverside, meadows, hill slopes as well as roads (Flora of China Vol. 5, 2004).

2.4. Boehmeria group

Lastly, there is a need to briefly mention a few of the Boehmeria genus. While not that similar to the Urtica dioica, it had a significant history of textile use and moreover until quite recently was often called nettle itself, which can be confusing when researching older papers regarding regions where both plants could be found. Additionally, its preparation is not that different from stinging nettle and therefore a description of it to it might be beneficial for understanding the wider textile production context.

First from the group, Boehmeria nivea (Ill. 3.) also known as a white ramie, is the most commonly used of the genus. Growing up to 2.5m, it prefers moist spaces, particularly along the streams, but can also be found along the roads (Flora of China Vol. 5, 2004). A perennial plant, white ramie is native to the tropical and subtropical zones of Asia, but had been spread in the prehistory as far east as to Egypt, and was then cultivated in parts of Europe, South and North America and Australia (Michałowska, 2016, p. 317).

Ramie's fibre has a long tradition of textile application and with the oldest records dated to 4000 BC coming from China, as well as India and perhaps Egypt, though the identification in the last case is uncertain (Flora of China Vol. 5; Michałowska, 2016, p. 317). Interestingly, the first attempts of cultivation were carried out in China already around the 3000 BC (Flora of China Vol. 5, 2004).

Ill. 3. Boehmeria nivea.
Belonging to the Urticaceae family, this plant is one of oldest known sources of textile fibre and has been widely used for production of luxurious, lustrous fabrics, that were quite easy to dye. Contrary to common nettle, ramie does not cause any irritation when touched making it more ready available for collection. Lolas 2022.

Boehmeria nivea is known for its natural high fibre content and the length of the individual fibres (Flora of China Vol. 5, 2004; Michałowska 2016, p. 317). It is usually monoecious, but is also varied in many aspects including in its height, as well as shape and colour of its leaves. Though, characteristically for the species, the leaves are heart-shaped or broad-ovate with serrated edges, while the underside is usually white or grey and, differentiating from the Urtica genus, they do not have any stinging needles (Flora of China Vol. 5, 2004).

Boehmeria nivea var. Tenacissima is a subspecies of Boehmeria nivea known as green ramie or rhea, most likely native to the Malay Peninsula (Flora of China Vol. 5, 2004; Michałowska, 2016, p. 317). Contrary to the white ramie, its stem is only very lightly covered on the hair, while the leaves' underside is usually green, sometimes white and nearly never grey (Flora of China Vol. 5, 2004).

The last of the group is Boehmeria japonica. It is found on the slopes of hills and mountains of Japan, Taiwan and parts of South and South East Asia at the hight of between 300m and 600m above the sea level (Flora of China Vol. 5, 2004). What seems especially curious, is that Boehmeria japonica might be one of first plants used for its fibres, as there is evidence of this occurring perhaps as early as 10 000 BC in Japan of early Jomon period (Edom, 2005, p. 15).

3. Tracing the use of Urtica dioica

The deterioration of any organic matter is quite inevitable and it requires exceptional circumstances for a material, particularly a textile, to prevail.
With the passing of time, therefore, it is becoming less and less likely to retrieve a piece of fibres, even less a cloth or a complete garment. This is the reason why attempts at reconstructing the use of textiles in Neolithic Europe is such a challenging task. The identification of nettle in this context is even more complicated resulting from the vast similarities, and only minor differences, between the fibres of all of the bast plants, that can be further distorted due to state of preservation.

3.1. Conditions of textile preservation

Luckily for the field of archaeology there are few sets of circumstances, which allow for slowing of the destructive processes affecting the organic matter significantly enough, for the remnants of the prehistoric textiles to be recovered in modern day.

One of the most essential elements of textile preservation is the pH of the environment of the material's deposition. For the plant fibres the environment needs to be alkaline, while the animal ones require the pH of 7 and below. This is the reason why the two kinds are rarely found within the same context. Although there can be exceptions to this, for example in the case of dry and very cold or warm environments, such as glaciers, or desserts. The first of them being the place where the most famous European Neolithic set of clothing was found on the slope of Fineilspitze on the Austrian-Italian border together with its wearer, though importantly none of the elements were woven. Later, a similar finding of shoes and fragments of leggings, among others, was made in Schnidejoch Switzerland (Grömer, 2017, p. 27).

As with extreme temperatures, the high concentration of salt inhibits bacterial growth, allowing all types of textiles to survive the passing of time in as good a condition as to have material's flexibility preserved, which is unlikely in any other circumstances. Usually the salt environment is that of the salt mines (Grömer, 2016, p. 24-25), however there are examples of other spaces with salt concentration, such as seabed, where the salt can contribute to the material preservation, although in those cases it is only one of the contributing factors (Hansen, 2011).

Another environment halting the microbial activity are bogs. Although depending on their composition and origins, either plant or animal fibres will be preserved. The humic acid and tannins of moss peats deteriorates the plant material, while the calcareous fen bogs negatively affect the woollen textiles (Grömer, 2016, p. 28).

Ill. 4. Fishing comb from Skjoldnæs on Ærø in Denmark. Belonging to Ertebølle culture this wooden, composite tool has been tied together with a nettle string. Lolas 2022, after Hansen, 2011.

Probably the most common environment in the European Neolithic textile recovery context are the waterlogged sides, such the as Swiss lakes' settlements (Grömer, 2016, p. 26; Grömer, 2017, p. 61), which allowed for better understanding the extent of the role of basketry and cordage in the Neolithic societies. However due to the high pH of the water reservoir, the only matter found was plant based, while the information about the use of animal products is lost (Grömer, 2016, p. 26).

Surprisingly stabilising method is charring, which carbonises the material, while shrinking it, to a degree, in a process, as well as protecting the textile against the environmental conditions (Grömer, 2016, p. 30; Sawyer, 2019, p. 8).

All the above allow for the preservation of the actual textile, however there are situations in which the information about fibres is preserved even if material itself is not. Such is the case of the pottery imprints, which creates a negative impression on a clay material. The quality of the imprints can vary, but quite often it allows for the identification of some of the textile properties such as fineness of a thread and thread count, as well as some degree of fibre identification (Grömer, 2016, p. 30-32), but it also provides an outlook into the functions of the textiles in the pottery makers lives.

While pottery imprint is a negative impression form, mineralization and the pseudomorphs provide the positive ones. In these processes, the original textile is slowly covered by the layers of metal salts, usually coming from the nearly deposed copper, bronze, or iron objects, capturing the textile's structure (Grömer, 2016 p. 23-24; Grömer, 2017, p. 58-59).

The difference between the mineralization and pseudomorph, here, is the extent to which this change happens, where in the formation of the pseudomorph the organic compounds are no longer present. These conditions are naturally not very common in the Neolithic, however there are some cases of such preservation taking place. One of them is a ritual wrapping from Brodek in Czech Republic, where the textile was covered in the iron salts as a result of deposition in the iron rich soil with a high water level (Grömer, 2017, p. 58). There are also cases of the formation of pseudomorphs from this period (Grömer, 2017, p. 59; Chmielewski, 2009, p. 24). Therefore, while unlikely and rare, there are a few known examples of Neolithic textiles from Europe classified as Urtica to describe here.

3.2. Nettle in neolithic textiles

One of such potential finds is a roll of cord from the site of La Draga in Spain. Being the only known waterlogged Neolithic site in the country, it turned out rich in organic matter, including quite a varied collection of fibres and cordage, coming particularly from the earlier habitation period dated to 5320-4980 BC. While other examples of technical textiles were categorised as tree bast or grass, the examination of the roll of cord showed the item to be a plant bast fibre. Given that neither flax nor hemp are native to the region, and no traces of flax cultivation were as of yet found, it was suggested that the most likely source should be then nettle, but the definite classification is currently impossible (Piqué et al., 2016, p. 262).

The following example of Neolithic nettle cordage was found north of Spain at the site of Sweet Track in Great Britain. Dated to 4000-3500 BC and preserved in a peat, it is a remnant of Urtica dioica fibres attached to the split hazelwood shaft of an arrowhead. The identification of the plant was made on observation of the stinging hair bases on the surface of the fibres. It seems that the nettle was used raw without much of a pretreatment, except for the fibre extraction from the stem. Interestingly, this has been experimentally tested by Ray Mears with the results showing this very simple method of twisting freshly collected fibres faring well as a reliable binding technique (Edom, 2019, p. 13-14)

A less forward trace of Urtica use comes from the Titszapolár culture in the form of a pseudomorph. The fragment was found within a burial at the Hómezővárhly-Gorzsa site (Chmielewski, 2009, p. 27).

Another sample of nettle cordage was also found at the Ertebølle culture site of Skjoldnæs on Ærø in Denmark (Chmielewski, 2009, p. 27; Hansen, 2011). It was a part of ta small, wooden fishing comb connecting hazelwood staff with the hawthorn side branches (Ill. 4.). The item was found in the seabed context, therefore more precise dating is unknown, but as of its function it is believed to be used for eel hunting (Hansen, 2011).

The youngest of the Neolithic samples of stinging nettle textile also comes from Denmark, from the Slotshøj megalith at the Funnel Beaker culture site at Stege. It is an imprint on the pottery fragment dated to 3000-2900 BC. This piece of local ceramic shows a negative of a fine woven cloth, which was determined to be made out of plant bast fibre. As in the case of La Draga site, the attribution of textile as made of the nettle was suggested due to the absences of flax in the region at that time.
In fact, the plant was introduced to Denmark no earlier than at the beginning of the Iron age (around 400 BC), though as with the pseudomorph from Hómezővárhly-Gorzsa site, no actual fibres were found (Edom, 2019, p. 14).

While the number of the known fragments of nettle textiles is by no means high, it is important to consider that Urtica dioica is thought to be more sensitive to the degenerative influence of the moisture compared to the flax (Chmielewski, 2009, p. 27).
It might be also worth noting, that most of the examples presented came from the earlier parts of the Neolithic which is particularly interesting in the context of the reappearance of nettle as a woven textile in the Bronze Age, and a rather luxurious one at that.

3.3. Bronze Age and later uses

One of the most well known examples of such clothing from the Bronze age comes from the grave from Voldtofte, Denmark. Found within the megalith tumulus of Lushøj, a tabby piece of cloth was deposited inside a bronze urn where it was holding the cremated human remains. Dated to 900-750 BC the whole burial was one of the richest discoveries of the period, and the quality of the textile reflects that, being a finely woven from 0.3-0.5mm yarn into 16 threads per cm cloth of probable high lustre.

While originally considered flax, further analyses, particularly microscopic fibrillar orientation measuring of calcium oxalate crystals, pointed to the fibres coming from nettle. Additionally, strontium analysis suggested the provenance of likely Kärnten-Steiermark, Austria (Bergjord et al., 2012, p. 664).

Another example of high quality, as well as well preserved Bronze Age textile comes from Must Farm in Cambridgeshire, England. The item was made out of Urtica galeopsifolia and the good conditions in which it was found, was a result of charring around 1000-800 BC (Sawyer, 2019, p. 8).

Last of the nettle woven cloth of this period mentioned here comes from Whitehorse Hill on Dartmoor Great Britain, from an intact burial chamber of a barrow dated to 1750-1600 BC. The good preservation of the space was likely a result of the peat environment. The textile itself was identified as a sash or a garment made out of woven nettle fabric with edges made out of calfskin piping and triangular applications (Jones, 2016, p. 20-22).

There are, however, few Bronze Age examples of technical textiles including dated to 1100-900 BC cordage made out of twisted nettle from the hoard from Beeston Hall, Norfolk which was still attached to the axes' sockets (Edom, 2019, p. 15).

The use of nettle as technical and woven textile continues further in the Viking and Mediaeval times, up to the XX century. The examples of such late practices are known particularly from Eastern Europe, in Finland, Russia and Ukraine as a part of folk culture (Edom, 2019, p. 22-26, 47-49; Michałowska, 2006, p. 296; Suomela et al., 2018, p. 412-413; Viljanen et al., p. 2645). However there were also attempts at cultivation and industrial application of nettle already in the XVIII century (Edom, 2019, p. 40-49; Ford, 2015, p. 1-10, 33-34), which aimed at both popularising the plant in its local Central and Western regions, as well as increasing the productivity of the crop in matter of height and fibre content. Unfortunately, most of those endeavours had only limited success, given that flax tools often used are not sufficient for nettle, and the devolution of Urtica dioica seeds resulting in partial regress of fibre content to the levels of the original wild progenitor (Di Virgilio et al., 2015, p.45).

3.4. Ethnographic records

Additionally, there is an impressive range of worldwide records regarding the use of nettle, and even wider when including cousin plants from the Urtica family, therefore including all of which would be beyond the scope of this research[2].
Importantly though, while differencing between the genera from the ethnographic sources is not quite problematic, the same might be hard if not impossible to accomplish with the Urtica genus, therefore it is likely that the texts available might be referring to either of the plants listed in the above section.

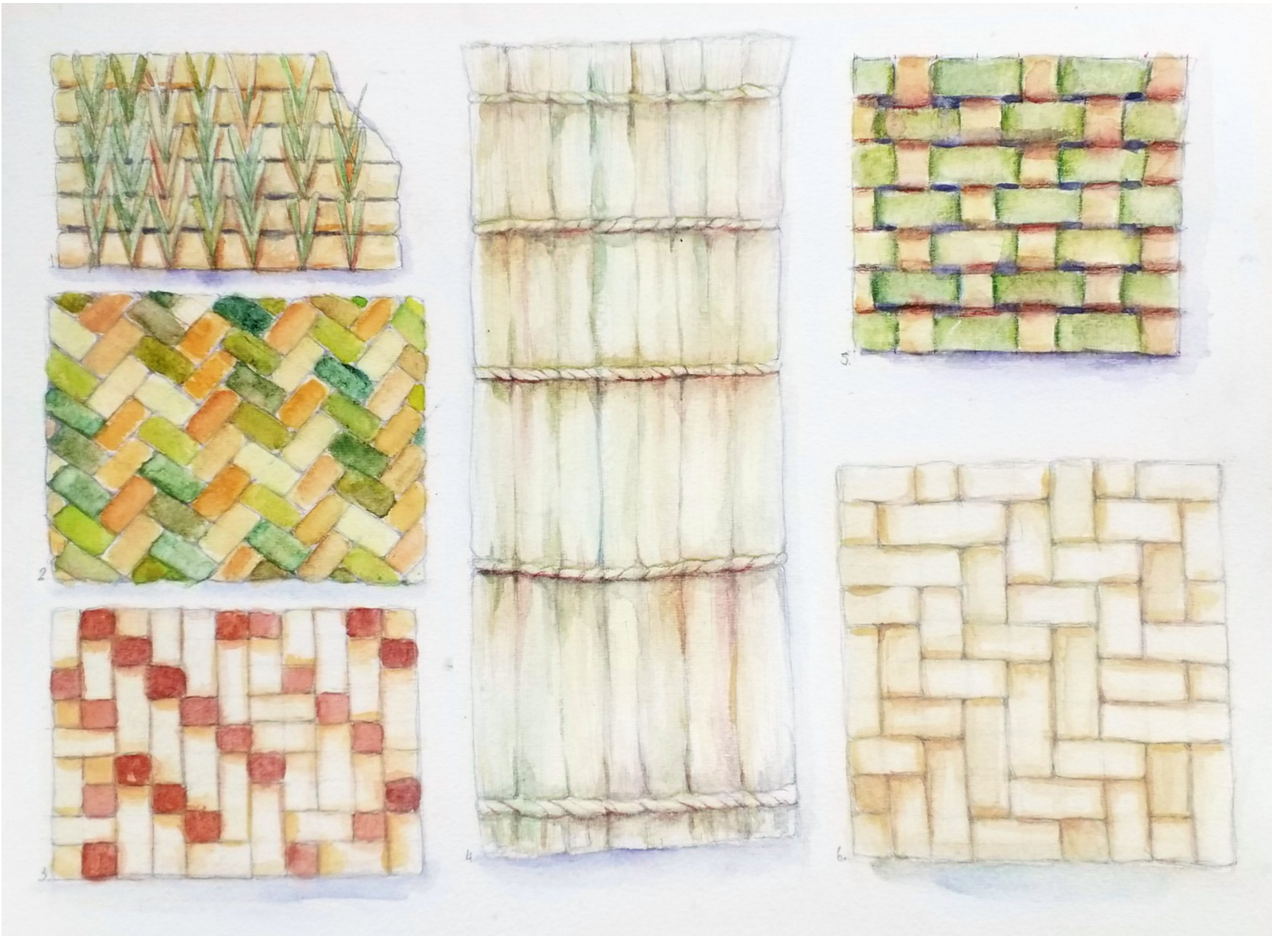
Nonetheless, the applications and preparation methods vary greatly within different regions and traditions. One of the documented uses of nettle cordage, for example, comes from the Cherokee and Californian Indian communities, where it was employed as a bowstring (Piqué et al., 2016, p. 269).

Though of course this is not the only known use of nettle cordage and netting. Particularly among the Western Siberian Mansi and Khanty people the nettle has a rich history of daily life applications, not only as the above mentioned ropes and nets, but also as a source of fibre for the characteristic for those groups garments such as, often quite elaborate, shirts (Edom, 2019, p. 23).
Their technique of collecting the surviving winter stems of the plant, that is then followed by beating and fibre extraction and cleaning by the use of knife, seems to be very similar to the tree bast use, specially as the nettle fibres are then often twisted by hands, possibly mirroring the prehistoric methods (Chmielewski, 2009, p. 56-57; Edom, 2019, p. 24).

2 There are, however, publications, such as Edom G., 2019 which can provide more detailed information on the topic.

4. Textiles in neolithic societies

The opening sentence of this paper introduced the linen woven textiles as one of the main images associated with the Neolithic. Yet, it was a little of a trick played. Based on the long held beliefs of the commonness of the woven materials from this period on, as well as the modern commodity of clothing, together with the representations from the Mediterranean civilizations, such a statement can pass without being questioned, or challenged. The parallels were drawn, as it seemed that the flax was quite swiftly popularised and cultivated in Southern and Central Europe followed by the appearance of the spinning and weaving tools.



Ill. 5. Visualisation of a few examples of Neolithic mat-making patterns.
Lolas 2022, after Buxó, 2010, p. 44; Rimkute, 2010, p. 219-220.

Yet, researchers pointed out that during the Neolithic and even in the Bronze Age weaving was quite an exclusive skill (Pipes et al., 2019, p. 64; Żychlińska, 2017). Similarly, early Neolithic European figurines show people clothed in very limited amount of clothing, with the exact nature

of the garment unknown. Though with the role of the statuettes uncertain (Grömer, 2016, p. 335-341), whether being artistic, or religious expression, or had a different role, there would be a multitude of reasons for particular choices including presented clothing, therefore there is also a possibility that they do not depict any real clothing (Grömer, 2016, p. 335-341). Nonetheless, the findings from the Alps constitute physical proof that the woven textiles were not a necessary element of everyday life at the time, and perhaps not of every person.
That seems reasonable in the context of very harsh environments, where clothing made out of cool and air-permeable material would not be a sensible choice (Harris, 2010, p. 106-107).

If the suggestion about the high social status of woven clothing, as well as the weavers themselves (Pipes et al., 2019, p. 64), is correct, due to the skills required and the labour costs of flax cultivation and processing, it is then possible, that wearing of the woven (linen or hemp) textiles would be limited to the specific socio-religious context including seasonal timing and position of the wearer.

That would certainly not be a precedent, as similar case could be made for the Meroitic period of ancient Sudan and Nubia (Yvanez, 2018). Due to the very warm and dry climate, the local agriculture of fibrous was very labour intensive, therefore the wearing of woven, as well as spinning and weaving activities were limited to the royal spaces and likely to the adults of the upper classes. Incidentally, the relief representations from the period depicted the nobility bare-chested in a similar manner to the early Neolithic European figurines.
The value of the plant fibre materials, here cotton, might also have a visual significance, as the white clothing would also stand out against the ones made out of animal sources, such as leather, or camel, goat and sheep wool (Yvanez, 2018).

Independently of the possible similarities between the Kush kingdom of the Meroitic period and the European Neolithic, it is likely that much of the technical textiles, such as cordage, were held in less regards than the loom woven textiles, the former being everyday items and tools, and the collection of these is very wide.

4.1. The types of textiles

Many of the production techniques of the technical textile used in the Neolithic were created already in Palaeolithic and the Mesolithic, and more, particularly loom weaning, were based on these developments (Kozłowski & Kaczanowski, 1998, p. 157; Chmielewski, 2009, p. 51; Grömer, 2016, p. 6, Rimkuté, 2010), that is why it would be useful to define these terms.

The main differentiation made in the paper is the woven and the technical textiles. The first one simply being all forms of materials made with the use of any type of loom. While the latter is understood as all forms of fibre-made items, which are not loom-woven, but of which some can still be worn as garments nonetheless.

The most basic element of the set is then fibre, which can be used raw as a thread. Twisting or braiding together one or multiple fibres, forms a string or a yarn. Additionally techniques like splicing, drafting and winding could also bear similar results (Chmielewski, 2009, p. 61).
The cord (or a rope) is composed of several twisted strings, while a roll, spool, or reel is a gathering of a cord, or a yarn, that is also a way of storing the matter and preventing it from tangling.
Lastly, a purposefully tangled thread, string or cord forms a knot, which can serve varied functions, such as securing the string or netting, extending the length of the object, or being part of textile making technique (Piqué et al., 2016, p. 61).
Some known neolithic examples of strings or ropes were made out of raw fibres of grass, liana, (Piqué et al., 2016). More time-consuming netting however might require some form of preparation, like storing and drying. The two main types of this technique used in Neolithic are knotted and unknotted netting, which have a wide range of uses and known examples include fishing nets, carrying bags, head adornments (Ijsveld, 2014; Harris, 2010, p. 104; Grömer, 2016, p. 335-341; Grömer et al., 2017, p. 58; Piqué et al., 2016, p. 262-263). Depending on the type and style used they will also have varied properties such as tensile strength, or elasticity.

Similarly, cordage was developed for different functions, the most interesting probably being elements of sandals, both soles, as well as lacing (Grömer, 2016, p. 344-347).
Ropework could be combined with basketry, which itself is a form of technical textiles, though it, together with wicker, often uses more rigid materials. One of best well known examples from the period are Putcher fishing traps (Ijsveld, 2014; Kozłowski & Kaczanowski, 1998, p. 157; Harris, 2010, p. 104).

Other common forms are braiding, knitting, intertwining and mat-making. The last one being very important in the Neolithic, as mats could serve as form of furniture and sleeping spaces, carrying bags, but also clothing, especially outer garments, which thanks to the technique used could protect from elements, such as wind and rain (Rimkuté, 2010). It is important to highlight that the traditions of basketry twining and braiding were very rich (Ill. 5.), unique, as often the recovered samples have very little, or no known parallels, but also far-reaching. Interesting here is the case of the textile from Schipluiden in Netherlands (Ill. 6.), as while similar material was found in the Netherlands, at site of Hoge Vaart-A27, the latter was nearly millennium older, a similar in age finding came all the way from Carrigdirty Rock in Ireland (Kooistra, 2006, p.257).
It is also likely that tablet weaving, and later loom weaving, evolved from these forms of technical textiles (Grömer, 2016, p. 6; Chmielewski, 2009, p. 159-160).

Cordage might be particularly likely progenitor of the tablet weaving, as examples of potential weaving tables were found in Šarišské Michaľany, Slovakia in Bükk culture, or in Iberian Peninsula could also work for ropework. However finds of sets from Lystvyn, or Kozarovychi in Ukraine might be more certainly weaving sets. They were made out of clay, but the objects could be also be made from organic materials such as wood, bone, or horn. In this technique threads or yarns are strung through the holes of the tablets and are woven together by the movement and twisting of said tablets. This allows for creation of strips, belts, or selvedge, often with simple geometric patterns. With time the technique evolved to include small looms, which then could develop into a stationary tool (Chmielewski, 2009, p. 161-162; Pipes et al., 2019, p. 27).
Another technique, which might influence the appearance of loom weaving and itself relate to knitting is sprang. In this method the yarn is attached to the simple loom frame and twisted while interwoven with horizontal thread from the bottom up. The use of this technique in the Neolithic is hotly debated, but it is mentioned here as the results can resemble netting (Chmielewski, 2009, p. 163-164) and while the two are quite distinguishable, it is worth mentioning for that relation.

Finally, the last type of textile to be discussed is the loom woven cloth. First developed in the Near East in early Neolithic and from there spread further to appear in Central Europe with the Linear Pottery Culture between 5500-4500 BC, only in a limited amount. The number of woven textiles increased significantly in the latter part of the Neolithic with the Funnel Beaker culture from 4300-2800 BC (Pipes et al., 2019, p. 26). Through the whole period the nearly exclusively used pattern is tabby canvas weave (Chmielewski, 2009, p. 210) sometime interwoven with its rips variation, or thread of a different thickness for creating a more varied visual effects (Chmielewski, 2009, p .233-236) and much of this type of textile was found within the funerary context (Chmielewski, 2009, p. 225-226; Pipes et al., 2019, p. 20).

Ill. 6. Reconstruction of willow twining textile from the Neolithic settlement Schipluiden in the Netherlands. Lolas 2022, after Kooistra, 2006.

4.2. The tools

Ill. 7. A reconstruction of a heckling comb from Lattrigen and two types of spindles. This form of brush reconstructed from Neolithic context has been in use well into the XX century as a tool for flax processing. The high-whorl spindle and the low- whorl spindle allowed for stronger twist of the yarn were used in a different manner. Objects are not to scale. Lolas 2022, after Chmielewski, 2009, 56.

Compared to the other textile production tools, looms were quite spacious constructions, as well as quite immobile, though they may differ between each other. Their actual size and structure probably changed through time, but the best method for approximating it is making calculations based on the lines of weights found within the domestic context, where they can be presumed to be part of a set-up loom, especially if there are visible signs of building collapse, or fire (Chmielewski, 2009, p. 196-223). With this basis, Centre for Textile Research in Copenhagen estimated the Neolithic looms to be of 1.15-1.85m in width and the fabric of 55-130cm (Chmielewski, 2009, p. 210). The two main forms which they took in this period were horizontal ground looms used in the drier Southern regions of Europe, while in the colder and more humid North the warp-weighted vertical ones were more common (Chmielewski, 2009, p. 221-223).

The mentioned loom weights are the most commonly found evidence of the loom use and constitute a very varied category of clay objects. Often grouped in several types based on particular shape, as well as weight, they might have been also chosen for specific thickness of yarn and the cloth made, as well as preferred weaving method (Chmielewski, 2009, p.161-162; Pipes et al., 2019, p. 37).

Other clay elements of the textile production kit are spindle whorls (Ill. 7.). Spindles themselves were often made out of a simple stick preferably with a hook ending. The length and overall shape were varied depending on the spinning technique used, for example if they were thigh supported or suspended (Chmielewski, 2009, p. 66-69; Grömer, 2016, p. 72-75; Pipes et al., 2019, p. 37),

but also to a degree on a personal and group preference. Similarly, the application, as well as the shape and weight of the whorls, were very diversified. The low placed weights are connected to the suspended technique, while the upper placement is related to the supported method.
While the chosen approach might result in different parameters of the yarn, the main role of spindle whorls was the same, as they were to stabilise the spin and strengthen the twist. Additionally, commonly used in the Neolithic was also the double-drafting, which could also increase the degree of twisting, while many of the known yarns were made of double spooned threads (Chmielewski, 2009, p. 70-71).

Another, mainly wooden accessory, which is not always immediately recognized in the archaeological context is distaff. It allowed for freeing the hand from holding the fibres and allowing for using it to further control the spinning process, by having the fibres arranged on the top of it. Distaff can take various forms from a spike, to a forked or spoon-shaped stick (Chmielewski, 2009, p. 144-147).

Further, possible, but much less common tools are the spinning bowls, also known as the tension pots, which allowed for moistening of the thread while spinning, as well as eneolithic Tüllengefaße, which a pot used for twisting the yarn (Chmielewski, 2009, p. 148-158), and Epinetron, that was a thigh protection (Chmielewski, 2009, p. 75-76).

There are also remnants of tools used for extracting and processing fibres, such as combs (Ill. 8.) and brushes (Grömer, 2016, p. 72-74; Chmielewski, 2009, p. 55-56), but the gross of the spinstress, wicker, or seamstress kit would consist of simpler and usually organic elements.
Objects found at sites like La Draga (Piqué et al., 2016, p. 263), among others (Grömer, 2016, p. 72-74; Chmielewski, 2009, p. 63-66), as well as reconstructions, suggest that these sets (Ill. 7.) could contain only few items, such as bone needles, awls, crochet hooks, and spinning hook, as well as stone blades (Rimkuté, 2009, p. 218-219) and a simple stone, which could be used for immobilising the collected fibre prepared or spinning, among others (Chmielewski, 2009, p. 63).

However, the most important tool in the textile maker arsenal was simply their own body.
One of oldest techniques that is known from the Neolithic that requires hands excursively is splicing. It very often can be used for raw fibres, particularly of tree bast (Gleba & Harris, 2018, p. 2329), but also nettle (Edom, 2019, p. 13-14). Two main splicing methods are continuous, where fibre is added at all time through the process, and end-to-end, where the new thread is added

as the other is ending. The technique requires yarn to be plied for twist stabilisation (Gleba & Harris, 2018, p. 2329-2333).

While the hands are also the most obvious tools in activities such as mat-making and basketry, and the thigh was used as a space for spinning, or sawing, other part of the body is less often considered, that being the mouth. There is evidence in the dental plaque and perhaps in some dental alterations (Chmielewski, 2009, p. 69-70), as well as in ethnographic data, that mouth was used while spinning. Aside from the cheek spinning method (Chmielewski, 2009, p. 62), just using the mouth for moistening the thread, allowed not only for easier handling, but in case of plant fibre might have additional benefit as the enzymes in the saliva could reactivate the peptides on the bast, which acted like a glue, immobilising and stabilising the twist afterwards (Chmielewski, 2009, p. 62; Gleba & Harris, 2019, p. 2237; Sawyer, 2019, p.17).

Perhaps it is then the richness of the simple ad hoc, but also combustible kits and employment of weavers own body, that is responsible for the perceived lack of textile production within some communities, particularly those of the early stages of the European Neolithic (Pipes et al., 2019, p. 26).

Ill. 8. Sewing tool kit.
Watercolour reconstructions of possible Neolithic set of carry-on tools used for textile making. Includes, wooden hook, bone bodkins and needles, flint blade and weight and spool of thread.
Lolas 2022, after Rimkuté, 2010, p. 219.

4.3. Sources of fibre

As with the tools and techniques the sources of textile fibre in the Neolithic were also diversified. They can be categorised in three groups, which are cultivated fibrous plants, wild plants, as well as animals, mainly domesticated ones.

4.3.1 Agriculture

The plant the most associated with the Neolithic is flax. Linum usitatissimum L. is a plant native to the regions of Syria Iran and Iraq, but very early on spread throughout the whole Mediterranean basin and into Caucasus (Chmielewski, 2009, p.16; Grömer, 2016, p. 42). Cultivated into Linum bienne in two main variants, oleaginous and fibrous, although a third hybrid form was introduced in later periods (Kilanowski, 1974, p. 13). The first traces of domestication are dated to nearly 10 000 BC in Central Levant (Chmielewski, 2009, p. 17), after which it was introduced to Europe, probably throughout continental Greece, and was cultivated in much of the Europe[3] by 5500-4500 (Chmielewski, 2009, p. 20-21; Grömer, 2016, p. 43-44).

Flax is known to be a demanding plant (Grömer, 2016, 42; Kilanowski, 1974, p. 15-18), which in the Neolithic grew to about 60-90cm. It prefers fertile soils, but can be grown in poor ones too. However, coming from a warm, dry climate, it is not well adapted to prolonged humid conditions, which makes it prone to infections, especially fungal ones (Kilanowski, 1974, p. 18-19).

What balances the high cultivation requirements and the labour-intensitivity of its agriculture and processing, is the versatility of uses the plant offers. The seeds are highly oleaginous (Chmielewski, 2009, p. 22; Grömer, 2016, p. 42; Kilanowski, 1974, p. 7-8), which might have been the initial reason for domestication of flax (Chmielewski 2009, p. 20-22; Grömer 2016, p. 47-48), stem is fibrous, while chaffs contain 34% starch and can be used as animal feed. Nearly all flax parts and its production waste can be used in a farmstead (Kilanowski, 1974, p. 5-8).

Another, yet much rarer fibrous crop, is hemp. Cannabis sativa's origins are unclear. It seems the wild form originates in Central Asia, however, at least since Mesolithic, there are evidence of the plant in the Southern Europe as well as Southern-Eastern regions of Baltic woodlands

3 With the exception of Northern Europe, where its used until its introduction in the Iron Age.

(Chmielewski, 2009, p. 24-25), which curiously coincident with the modern subdivision of fibrous hemp (Kilanowski, 1974, p. 143). Aside from the fibrous type, the other two are oleaginous and indica variant, which contrary to the two previous types, has highly psychoactive properties (Chmielewski, 2009, p. 24).

Hem is an annual, dioica plant growing up to 2-3m high (Grömer, 2016, p. 47-48), it is also thicker and more fibrous (even in the uncultivated from) than flax, but it also requires better soil (Chmielewski, 2009, p. 24-25; Kilanowski, 1974, p. 143-148). The textile produced from hemp is stiff and coarse, however bears better in humid conditions and is more abrasion resistant, so there is a long tradition of use in rigging and sails (Chmielewski, 2009, p. 24-25). Despite these differences, it is hard to distinguish from linen, especially in archaeological material, but also in ancient times, as attested by Herodotus (Grömer, 2016, p. 41).
Similarly to flax, much of the plant can have practical applications (Kilanowski, 1974, p. 143-148), however the obtained from seeds oil requires thermal processing to be safely consumed by humans (Chmielewski, 2009, p. 24-25).

4.3.2. Foraging

While agriculture is strongly linked with the changes occurring during the Neolithic, the foraging probably constitutes one of oldest human activities. Therefore, it is no wonder that it is the foraging that provides most of the technical textile sources, as these technologies were greatly developed already throughout the Mesolithic (Kozłowski & Kaczanowski, 1998, p. 671-672).
The beginning of the Neolithic coincided with the Atlantic climate phase (7460-3960 BC), which for the Central Europe meant a mild and quite humid conditions, that were very varied locally, with the majority of the region covered in thick very diversified deciduous woodlands (Kruk & Milisauskas, 1999, p. 23).
That created great circumstances for foraging in which acquisition of many of the textile materials might have been less time-consuming and labour-intensive than their cultivated counterparts.

The main fibrous sources, Urtica not including, were trees for their phloem, wood, and other parts, as well as various grasses (Chmielewski, 2009, p. 27-28; Gleba & Harris, 2019, p. 3239, 2334; Grömer, 2016, p. 6, 42, 52-54; Pique et al., 2016, p. 262-263). For the textiles commonly used were Tilia, Quercus and Ulmus, and for the groups influenced by Ertebølle culture Salix and Populus

seem to hold significance (Chmielewski, 2009, p. 28). Linden and willow generally might be the most often chosen and there are known examples of them being used for mats (Grömer, 2016, p. 42; Rimkuté, 2009, p. 217; Kooistra, 2006, p.257), roping, but also for stitching, as in the case of the alpine fur leggings (Grömer, 2016, p. 341-346).
The fibre from inner bark was likely collected in the spring, before the appearance of leaves, although it is possible to use phloem acquired at the later time, however that would require a prolonged soaking of the material. Each tree fibre came with its unique qualities, where willow is considered to be among the most elastic and of high tensile strength, poplar while quite similar in its parameters, has less abrasive resistance, and lime might have been the easiest to extract in good quantity. Quite interesting are the properties of elm fibres, which are soft, short, but also of good elasticity, resembling cotton, making it quite suitable for spinning (Chmielewski, 2009, p. 57).

Another category of wild gathered materials were undoubtedly grasses and reeds (Chmielewski, 2009, p. 57-58; Piquè et al. 2016, p. 262-263). Not only were their found in the alpine contexts (Grömer, 2016, p. 341-346), but they also seemed to constitute a rich tradition on the Iberian Peninsula, where plants such as Esparto grass (Stripa tenacissima L.) were common (Buxó, 1995; Fajardo et al., 2015) together with liana of Clematis sp (Piquè et al. 2016), as the known examples of use are dated back to 6th millenium BC and were used for making not only basketry, but also garments, sandals, and hats Buxó, 1995, p. 41; Fajardo et al., 2015, p. 370-371).

In time the vast areas of woodlands were thinned into the parkland and open space landscapes, with possible strong local ecological degradation by around 2500 BC due to the extensive human activities (Kruk & Milisauskas, 1999, p. 200), and while in some places remnants of the Mesolithic traditions were still registered (Kruk & Milisauskas, 1999, p. 123), it might have still influence further alteration to the agricultural practices, as well as those of foraging and husbandry.

4.3.3. Husbandry

While there are traces of goat hair use (Pipes et al., 2019, p. 27), within the European Neolithic the main animal source of fibre was wool. The appearance of sheep (Ovis) on the continent is dated to at least VII millennium BC, but signs of its domestication are much later, although the definite answer on the process is hard to trace. It seems that through the most of the Neolithic the sheep were rather tall and massive, suggesting either still quite wild form, or a breeding for meat, or milk.

Around 4000 BC appear first known examples of woolly sheep in the Middle East uplands and mountain regions (Chmielewski, 2009, p. 28-50), however it is unlikely that the animal was introduced in Central Europe before the beginning of third millennium BC (Grömer, 2016, p. 53; Chmielewski, 2009, p. 51). It became a particularly popular animal in the later parts of the Neolithic, especially Eneolithic, when it was definitely raised for its fleece too.
Yet, as the wool is naturally warm and windproof, as well as having high degree of insulation (Harris, 2010, p.106-107), it is likely that the hair of archaic sheep was still used and it is the unideal shortness and coarseness of the fibre that were the reasons for mixing it with the tree and plant bast fibres, as such textiles are attested (Pipes et al., 2019, p. 20; Chmielewski, 2009, p. 50).

5. Reconstructing the nettle processing

Urtica dioica was a wild crop, therefore it was only natural that there was no one universal processing method. Perhaps being a crop of an opportunity, its use was dependent on other factors, as well as available periods within the busy agricultural calendar. In fact nettle lands itself into the varied forms of exploitation, as it was present for wide window of time, and could be approached in many ways, as shown in ethnological and historical records, therefore it is with that data, as well as in comparison to information known about other bast fibre plants, that its collection, retting and processing it attempted.

5.1. Collecting the material

If the collection of the tree bast should be conducted within the weeks of early spring, then there is no such rule for bast plants especially nettle itself as many of the historical and ethnographic records attest. The assumption can be made that Urtica and its gathering followed the pattern of the cultivated crops of lax and hemp. In this scenario several stages of its maturing during which it can be harvested can be recognised, each resulting in different qualities of the fibre.
In agriculture, for flax four such phases are recognised.

Mature green is the earliest possible moment for collection, which occurs about 70 to 80 days after sowing, and around week to 9 days after blooming, when the most of the plant is still green and the only yellowing can be visible at the lowest parts. At this stage the seed bags are still green with soft and white seeds inside (Kilanowski, 1974, p. 88).
The fibre is still not of its full potential length and can be harder to process, but is also the finest and softest at that point (Lukasova & Holst, 2020 p. 219).

The second phase is the early yellow flax maturity, which usually in the moderate climate happens between 85 and 90 days. At which time the plant is completely of light yellow hue and about a third its leaves had fallen, and the seeds matured. Which makes it the more preferable for harvest as both main crops of the flax can be obtained, while the fibre quality is still very good (Kilanowski 1974, p. 89).

Following is the mature yellow stage, which is observed at around the 100 day mark. It is characterised by a yellow to dark yellow colour of the stem and seed bags, with first signs of browning. At this moment 2/3 of leaves should have fallen and the seeds should be turning brownish-yellow, while the fibre is thick and strong (Kilanowski, 1974, p. 89).

Last is the dark yellow maturity phase at about 115-150 days after sowing, when the stems turn to dark yellow with the close to ground parts turning browning and the majority of the leaves are gone. The seed bags are dark and close to opening, and seeds have taken an intense brown shade and are dry. The fibres are the longest at this point, but they can be brittle and coarse (Kilanowski, 1974, p. 90-92).
The harvest carried by hand, by pulling the small handfuls of flax by the top parts of the plant (Kilanowski, 1974, p. 92; Kiryluk & Kostecka, 2020, p. 69) would take up to 25 days of work for 1ha (Kilanowski, 1974, p. 95).

While the current prescriptive action for nettle collection is cutting close to the ground to preserve the perennial root system (Ford, 2015, p. 34; Di Virgilio et al., 2015, p. 45) ethnographic data suggests that for some groups it was a custom to pull this crop in similar manner to the flax (Edom, 2019, p. 22-29). The same sources are the premises suggesting the observance of harvest stages, with the strong preference for gathering Urtica in late August and early September, when the stems of the plant turn yellow (Edom, 2019, p. 22-29). However there is also evidence of a later collection is October even through November when the natural deterioration of pectins and gums begins (Edom, 2019, p. 23-24).
Equally there are historical trials of gathering young, green nettle, just after the blooming but before the development of the seeds, where the full potential length of the plant has not been reached yet, but the obtained fibres are said to be very fine and decortication should be an easier process (Ford, 2015, p. 31).
However, it was rather rare and the general choice was to harvest Urtica at the point at which the plant yellows and turns brown, or less often till the first ground frosts. These might have well coincided with the agricultural calendar and its greater period at the end of harvest, and before the winter, when further processing would take place, but also would see human activity turning to foraging for collecting additional stocks. A rhythm that might be attested by remains of hazelnuts, acorns, berries, as well as various grasses of Bronus family and in sites such as Bronocice (here dated to the middle of Lengyel-Polgár cultures stage) (Kruk & Milisauskas, 1999, p. 87-88). Even a later gathering is used by the author B. Ford, where nettle is not collected until well into

the winter till very early spring, when the repeated frosts break down the bonds of pectins, therefore becoming also a natural retting process, which Ford calls root retting (2015, p. 10-11).
The visible and, perhaps more importantly, tangible advantage of the approach is the falling of leaves and deterioration of the trichomes on the still standing nettles. The standing stems should still contain the fibre, but a significant sign of spoilage is the unexpected lightness of the lower parts of the plant.

On the other hand a lack of ease in an attempted breaking of the nettle indicates that the dissolving of the gum has not been enough forgone. The disadvantage of this method, other than the uncertain timing, is the loss of some of the fibre length leading to only 2/3 of the entire plant being available for use (Ford, 2015, p. 10). However the apparent ease of this approach, as well as its timing might have been naturally observed and taken advantage of. For the sake of clarity, it is however necessary to admit that the propagator of this technique does not use the fibres in their long form, but short in a manner closer to cotton than to flax.

Regarding the gathering of Urtica in an earlier time, the height of the plant, and particularly woodland clusters could be reaching even beyond 2m and as such are considerably longer then their counterpart in the form of flax, which given the dense covering in trichomes poses a significant challenge in collection, requiring full body covering including neck in a thick clothing (Ford, 2015, p. 33-34; Edom, 2005, p. 17). With this length, cutting at the ground level might be also an easier option than to pull, therefore the mentions of Asian and Northern American traditions of gathering nettle by pulling (Edom, 2019, p. 27-29) may suggest use of shorter specimens. Additionally, leaving the crop for a few hours before the collection would allow trichomes to wither and, therefore making the transport much easier (Ford, 2015, p. 34).

Best timing to carry out the harvest was considered to be a warm, dry day after the dew settled down (Ford, 2015, p. 33-34; Kilanowski, 1974, p. 95). This prescription allowed to minimise the amount of residual moisture, as the next step, following the gathering, was placing the crop in conditions where it could be initially dried. For this stage the plants needed to be grouped in by length, diameter and for flax, also by the hue and turned into small bundles, which were then stacked up sometime, on angled piles, for better air circulation, and needed to be shaken daily (Kilanowski, 1974, p. 96).
Alternatively, the harvest could be spread flat in dry and well ventilated conditions, where it was turned twice a day (Ford, 2015, p. 33-34).

Part of the remaining leaves might have fallen during this process, but for flax more important was to carry the combing, or less preferably, threshing of the heads and seeds (Kiryluk & Kostecka, 2020, p. 69). In this form the stems could be stored in dry places with good air circulation, such as the under roof spaces created in many many traditional dwellings, before it could be retted.

5.2. Retting techniques

Following the varied approaches, which could be taken in collecting the plant bast fibre, so were there several equally valid techniques for their extraction. In the case of nettle the expected fibre content is rather low of 2-5% (Ford, 2015, p. 3-4), that further differs between the years of growth (Jankauskiene & Gruzdeviene 2010, p. 176; Tavano et al., 2011, p. 218-219), particularly when compared with the fibre composition of flax at the level of 10-15%, and especially hemp, the tallest and thickest of the three and with the fibre content nearing 30% of stem's mass (Ford, 2015, p. 3-4).[4] It is also worth the attention to reiterate the already included observation that in the Neolithic not all fibres needed retting in the first place. Notably, for splicing extensive extraction and neutralisation of gum could be counter-productive, as they could disturb the natural twist tendencies of the plant and, therefore, would require, at least, reactivating the peptides by wetting the fibre beforehand (Chmielewski, 2009, p. 62; Gleba & Harris, 2019, p. 2237; Sawyer, 2019, p.17).

Nonetheless without the attempt at breaking the bonds within the stem, the fibred gathered could not be fine enough for spinning and weaving. Moreover a chosen extraction method could influence further characteristics of the material obtained (Ford, 2015, p. 33-34).

5.2.1 Root retting

As mentioned, the available for nettle technique of root retting allows for gathering the plant in already retted-like state, where the frost was the decortication agent, and it was too the basis of the quote before Khanty and Mansi people, who after the late harvest, peeled the outer epidermis, dried the crop, and after soaking it in water, buried the gather material in snow till early spring. It would be interesting to know if their approach was also an attempt at bleaching, as whitening

4. Interestingly, modern cultivation efforts allowed for nettle harvest to equal that of flax and current efforts now aim to raise that effectiveness up to 30% , as expressed by Dr. Beckhaus of NFC GmbH Nettle Fibre Company.

by snow of another plant from the Urticaceae family is a known practice. In tradition from Echigo region (modern day Niigata Prefecture) Boehmeria nivea was extracted and processed in a low temperatures, to then be left on thick snow till early in the spring, which resulted in the creation of a white, lightweight and luxurious textile, worn in summer, called echigo jōfu (Tōto, 2021, p. 16).

5.2.2. Dew retting

Possibly the most common in Central Europe historical method of fibre extraction was the dew retting. In this process the pectin deterioration was initiated by the fungal activity in moist environments with access to air and preferably in warm conditions. Usually conducted in autumn, for hemp and nettle it was also possible to be carried at different times (Kilanowski, 1974, p. 188-190). The process took on average about 50 days, however good conditions, such as temperature between 17-25ºC with plenty of rain, could lower the time necessary even by half.
The stems needed to be spread flat in the rows loose or in small bundles, and turned or shaken daily, after which they needed to be pushed down to prevent it being displaced by the wind (Kilanowski, 1974, p. 109; Ford, 2015, p. 45). If the given season was particularly dry, the artificial rinsing might be required (Ford, 2015, p. 37-39).
In flax the first sign of retting taking place was lightening of the stems' colour, which in time turned to grey, or steel-grey with darker spots (Kilanowski 1974, p. 109). At the completion of the process, the epidermis could be easily removed, while flax fibres tended to turn in a particular manner (Kilanowski 1974, p. 110). At this point, a characteristic and rather unpleasant aroma could be sensed coming from the plants, but it was ridden with a cold wash (Ford, 2015, p. 37-39).
The retted stems needed then to be moved to avoid any further contact with moisture, to a spot with sufficient air circulation where they could dry, before they were made ready for storage or further processing (Ford, 2015, p. 39; Kilanowski, 1974, p. 110; Kiryluk & Kostecka, 2020, p. 69).

5.2.3. Running water retting

In contrast to the dew retting (which in Polish is called “roszenie”), where the decortication being an effect of fungal growth, water retting (in Polish named “moczenie”) was a bacterial initiated process (Ford, 2015, p. 39-41; Dzięgielewski, 2011, p. 119), which was known to be toxic to fish and could be dangerous to animals and humans (Dzięgielewski, 2011, p. 119). For these reasons

nowadays, alongside the post-use water purifying technologies, the industrial water retting had been either heavily limited and regulated, or altogether prohibited (Tavano et al., 2011, p. 214).
Yet, curiously, in quite recent times this waste product had been used as a fertiliser for poor quality soils (Kilanowski, 1974, p. 9).

The water retting could be grouped into running and still water categories. The first of them might be harder to trace in archaeological records, and due to the temperature requirements this method was likely regionally limited to warmer, southern parts of Europe, where the running water of streams or brooks was at at least 15ºC. As below this threshold the bacterial activity could not be initiated. Therefore when appropriate torrent was available, bundles of approximately 50 to 100 stems needed to be securely submerged for the period of between 6 to 8 days, which was significantly more rapid than the dew retting. Upon the completion of the process, plants had to be thoughtfully dried in sun, preferably in addition allowing for air circulation (Ford, 2015, p. 39).

5.2.4. Still water retting

Still water methods can be differentiated by temperature needed into warm and cold water. The first one seemed to be much less likely to occur in prehistoric context, as it needed to be carried out for approximately 4 days in alkaline water of stable temperature of 25ºC-35ºC (Ford, 2015, p. 39-42), which in European context is quite rare to find. The process could be also conducted by initial heating of the batch to 85ºC and allowing the gradual cooling. Additionally, a regular water change aided in stabilising the process (Ford, 2015, p. 41-43).

Due to these prerequisites the wider application of the method might be sporadic, therefore simpler to accomplish cold water retting seems to be a more common choice. In this technique, bundles of sorted by size and height stems were placed vertically into a shallow pond or an artificial basin with water of between 15ºC to 25ºC for the period of 5 to 6 days. After which the plants needed to be taken out and given a cold wash to neutralise the bacterial growth, as well as the unpleasant smell caused by it, then dried in the sun in plenty of circulation (Ford, 2015, p. 39-42).

A probable case for the use of still water retting in Neolithic might be a particular type of v-profiled pits. Called Schlitzgruben in German and commonly referred as splits in English, are known from several European sites, like Hienheim in Germany, Branč in Slovakia and Modlica 5, Kraków in Poland. This type of objects came in a rather unified size of approximately 1.5m in depth, 2.5-4m width and up to 3m length. Interestingly, there is a ethnological data regarding use of similar constructions and, for example in Poland, records show their employment up to the XX century. They were usually built in regions with limited water supplies, in valleys, or in the plains. Likely because of the intensive and detestable odour, as well as the toxicity, they were placed outside the limits of the settlement, often lined, close to the river banks, or anywhere where the groundwater could easily fill the pits and stay at the same level for enough time. Due to the high change of spoilage as a result of stems coming in contact with soil, splits were often plastered with a layer of grey clay. As with the other still-water retted materials, sorted in bundles, were placed vertically in the pits and weighted (Dzięgielewski, 2011, p. 199-121). Requiring regular control check-ins, they too needed a treatment stopping the bacterial activity, followed by drying before storing or further processing could take place.

5.3. Processing

By the end of retting and drying processes the epidermis of the bast plants should become only lightly attached and easy to remove, therefore traditionally a first step was breaking and removing it, with a minimum damage to the fibres, often with brakes. It was done by breaking handfuls of stems starting from the roots and going upwards. After the initial removal of chaffs, the process could be furthered by the use of brushes and combs, or other tools for ginning and bashing, that would leave only the fibres (Kiryluk & Kostecka, 2020, p. 70-71).

In case of nettle a softening step might be added, as the material at this stage was rather coarse and stiff. The change was accomplished by boiling the material in alkaline water, especially one made with adding beechwood ash. Following the wash, the fibres ought to be straightened, perhaps with additional beating and drying, which if done with the sun, could also work as minor bleaching (Ford, 2015, p. 45). Once the fibre were cleaned and softened, they were sorted by the quality, which would determine their use.
Following step was brushing, which was often done with different sized brushes and combs, starting with the widest and coming to the thickest (Kiryluk & Kostecka, 2020, 70-71). The process had definitely been registered in the Neolithic with the presence of the spiked brushes (Ill. 7.) and similar tools (Chmielewski, 2009, p. 52-56). At the end of this stage the fibres would be soft and lustrous and ready for spinning and weaving (Kiryluk & Kostecka, 2020, p. 70).

However, there not always was a need for such a complex processing, not only because many technical textiles can be done with rawer forms of fibre, and in case of splicing a finely retted material would be ill-advised, but also woven textile of the Neolithic could be under-combed and supposedly still served their purpose (Chmielewski, 2009, p. 54-56).

Ill. 9. Z and S twists.
The watercolour visualisation of directional twists present in helical form on the cellular level in bast fibres, as well as in threads, yarns and ropes.
Lolas 2022.

6. Methods of fibre identification

There are several viable methods applied for fibre identification with the caveat that each of them has a particular use and limitations. One of these techniques is white light microscopic analysis, which can allow for differentiating the plant and animal fibres, as the latter have easily distinguishable scales (Hangan & Holst, 2013, p. 159), but cannot be reliably used for further determination of particular bast fibre (Lukesova & Holst, 2020, p. 216). The only exception to this might be cases of lightly processed material, where the outer elements, such as parts of epidermis or trichomes, have been preserved.

According to the research conducted by H. Lukesova and B. Holst (2020, p. 216) the limitations of the white light microscopy are also shared by the electron microscopy. It might however be enough to categorise cotton, which as a seed-plant fibre does not have well defined fibrillar angles (Hangan & Holst, 2013, p. 168).
Similarly, the otherwise very useful DNA analysis has near no use in the textile identification, as in many instances due to the processing, especially retting, the genetic material of the plant becomes highly deteriorated (Lukesova & Holst, 2020, p. 217).

6.1. Tools for bast fibre differentiation

More viable methods are micro x-ray diffraction, microchemical tests, polarisation microscopy and modified Herzog test (Lukesova & Holst, 2020, p. 217), the latter being possibly the most common. It is based on the principle of observation of cellulose-made microfibrils in the bast fibres. Helically oriented, they are also birefringent along the longitudinal axis and are located within the second cell wall. This wall, assumed the thickest, is composed of three layers, within which microfibrils can have either S or Z twist (Ill. 9.). Together with a fibrillar angle of the twist, as well as the presence of calcium oxalate crystals, they form a sequence specific to the given bast plant, as shown in the table. There are, however, differences in the angular measures found between the studies. More importantly, though, it seems as if they are widening with time, as when analysing historical and archaeological material, the recorded results are higher than those of the modern examples (Viljanen et al., 2022, p. 2645).

Bast plant	Twist sequence	Angle
Flax	s1Z s2S s3Z	6.5º/10º
Hemp	s1Z s2S s3Z	6.5º/6.2º
Ramie	s1Z s2S s3Z	6.5º/7.5º
Jute	s1Z s2Z s3Z	7.0º
Nettle	s1S s2S s3S	7.5º

Table 1. The twist sequence and angles typical for bast plants in their second cellular wall. After Hangan & Holst 2013 and Bogard et al. 2021

The modified Herzog test is then a red-plate test, that uses white polarised light with the sample oriented at extinction with the 530 full wave compensator, which results in either of two colour patterns. The Z twist is recognised when the sample appears yellow when it is parallel to the polariser, or blue when parallel to the analyser, and the S twist, being the opposite, is identified when the blue colour is visible as the material is aligned with the polariser and yellow if parallel to the analyser.

The method is modelled by using Jones Matrix formalism, where the individual cell is assumed to be a linear reader. It is also related to the wood fibre analysis.

The important detail, which can be also seen as a setback of the test, is the inconsistency of the colour insensitivity, which can differ between sections of the same fibre, and that can be less or more pronounced in various samples (Hangan & Holst, 2013, p. 168), therefore using it in combination with another method is suggested (Lukesova & Holst, 2020, p. 216; Suomela et al., 2017, p. 415).

One of such supportive methods in use is cross section (Suomela et al., 2017), however data suggests considerable differentiation occurring within just one species (Lukesova & Holst, 2020, p. 217). Therefore its use is unlikely to be definite, as the changes in the shape of stem can not only be a result of a plant's growing conditions, but also its post-collection treatment, particularly retting, which is even more compounded in the archaeological samples (Lukesova & Holst, 2020, p. 218).

Another, often applied technique is calcium oxalate analysis. This organic compound is known to various forms of crystals, including druses, which are the clusters of said in some of the plants, one of them being nettle.

Therefore, attesting the presence of this substance within a fibre can be used to determine it as Urtica, as neither flax, nor hemp have calcium oxalate in their cellular build. The task is accomplished by the use of a polarised light microscopy (PLM), or scanning electron microscopy (SEM), under which the crystals are well visible. Additionally, the use of X-ray diffraction (XRD), or wide-angle X-ray scattering (WAXS) allows investigating the nanostructures and dimensions of the noted compounds (Viljanen et al., 2022, p. 2647).

There is therefore a need for further evaluating the probability and effectiveness of any potential new methods, as well as improving and modifying already available ones, to establish the most reliable and efficient set of tests for identification of prehistoric textile sources. One such new technique recently proposed is for example wide-angle X-ray scattering measurement and analysis of the cellular microfibrils, in which the fibrillar angle and twist, as well as the cellulose crystalline structure, fraction and width are recorded, processed and compared with known samples and against other known methods (Viljanen et al., 2022).

In these circumstances, the initiative of keeping the nomenclature of the recovered samples as plant bast fibre (Piqué et al, 2016, p. 262), if further specification is impossible, instead of assuming it to be flax due to the Neolithic context, seems very reasonable, as it avoids potential misattribution (Lukesova & Holst, 2020, p. 216; Piqué et al., 2016, p. 263; Sawyer, 2019, p. 8; Viljanen et al., 2022, p. 2645). Although it would be still useful to include the intuited classification based on the context of the finding, as with the nettle associations in regions without attested presence of cultivated fibrous plants (Piquè et al. 2016, p. 262-263; Edom, 2019, p. 10-13) as a background information attached to the main item's record.

7. Comparison of fibre and textile properties

The well known characteristic of bast fibres is their variability depending on the type of soil, exposure to sun and amount of rain among other factors. Whether the observation was made and exploited already by the prehistoric communities might be impossible to verify with the limited data available, nonetheless the diverse group of fibres used in the Neolithic allowed for a wide range of textiles to be produced, suited for different, specific tasks. Therefore a brief description of these properties as well as an approximated comparison might be necessary.

7.1. Technical classifications

Standard textile handbook lists well about two dozen possible textile properties (Białobrzeski et al., 1978), however for the purpose of this work, a limited list of common and general characteristics will be included.
The two most primary variables would be the fibre length and diameter as well as individual cell length, as these refer to the raw material itself, which influence other properties, such as fineness which is mass per unit of length (g/cm).

One of most commonly tested and quite crucial data is tensile strength which is the force applied just before reaching the point of material's breaking and it is expressed in megapascals (MPa). Related to this is elastic recovery, which is the amount of force applied to cause material stretch before reaching the irreversible textile damage and is also presented in megapascals (MPa), while elongation is the additional physical length the fabric gains, usually temporarily, as a results of reaching the elastic recovery threshold described in percentage (%).

Another parameter is toughness, which represents the resistance to material fatigue. There are different elements that can be encompassed by and tested for toughness, but for simplicity, the characteristics like abrasion resistance, and other forms of energy absorption are also considered toughness, assuming they can be expressed in g/m^3.

One of more important qualities is water absorption, which describes the ability and speed, in which the fabric takes in the water, a quality that can be described in percentage (%) of mass gained. Opposite to it is water repellency and water proof. The latter is expressed with the value of the water column pressure which causes the appearance of water droplets on the other side of the textile (120) While the earlier refers to the amount of water absorbed before the material is soaked, counted as a mass gain (Białobrzeski et al., 1978 , p.121; Harris, 2009, p.105).

By association, windproof quality is then related to the amount of air permeability through the textile in a given amount of time and under defined pressure (Białobrzeski et al., 1978, p. 122). This quality is often improved by additional coating of materials with oils, or waxes including lanolin (Harris, 2010, p. 105).
It can be also related to the thickness of weave, and the yarn count, as well as the threads' mobility, which is counted by the size of in-material clearance (Białobrzeski et al., 1978, p. 119).

Following characteristic is thermal insulation, which is the amount of the warmth carried through and out the textile in a given amount of time, which as waterproof quality can be related to the weave chosen (Białobrzeski et al., 1978, p. 124), as well as the type of fibre used.
Whereas flammability is the quality related to the fabric's behaviour when exposed to fire, including the point of ignition and as well as the form and type of burning (Harris, 2010, p. 105).

A more subjective parameter is the handle, which the sensation registered via touching the textile, that can be categorised as smooth, rough, or tickle, which is the level of hairiness of the material. Another of the less formalised qualities is lustre, which relates to the degree of light reflectiveness and sheen of the fabric, which is often considered when describing plant bast fibre textiles.
Final characteristic worth mentioning is drape, that is a manner in which the cloth lays over a surface (Harris, 2010, p.105), including body and in which it, as while perhaps not always is easy to reconstruct and furthermore interpret the value, it nonetheless had a likely role in informing some of the material choices in the past.

7.2. Comparison to other bast fibres

The cultivated plants had been made to evolve and deviate significantly from their wild forms, and since their current qualities might not reflect their state in the past, a certain amount of research and approximation is necessary, with the caveat that the modern comparisons are estimates. Nonetheless it has been established that the height of the Neolithic flax was no taller than 90cm

(Grömer, 2016, p. 42) and while nettle probably grew to the equal heights as today, the known historical advice on its harvest suggest for it not to be shorter than 80cm (Ford, 2015, p. 33-34). Whether the coinciding measurement is the result of harvest advantages, such as pulling rather than cutting (Edom, 2019, p. 22-25), or is it a minimal practical length for processing, it is likely that both of the crops might be gathered at similar height.

Assuming the fibre density of today plants can be ascribed to the prehistoric ones, then flax would be characterised by the highest one of around $1.55 g/cm^3$, while nettle would have a smaller value of $1.45 g/cm^3$ and hemp, however unlikely to be found in European Neolithic context, hemp would be the least dense, with the results of $1.35 g/cm^3$ (Bogard et al., 2021, p.10).

While all of these bast plants are characterised by a quite high tensile strength, Urtica presents the highest potential in the group with resistance of about 1600MPa with Cannabis sativa being close second reaching up to 1500MPa and Linum's strength being established to be at 800MPa (Bogard et al., 2021, p. 10). Nettle had also the highest elasticity rates of 87GPa, followed by flax with 70GPa, while the hemp was classified significantly lower, compared to the two previous, with the result of 45GPa.

The tactile properties of linen, hemp and nettle textiles can vary greatly depending on the quality of the fibres, with finer loner and more processed ones giving softer and more lustrous fabrics, while shorter ones usually produce more coarser and thicker ones (Harris, 2010, p. 105). However, Cannabis is generally stiffer and more rough compared to the two others no matter the level of processing.
The variation in characteristics depending on the level of retting and beating might be significantly higher for nettle than for flax, as archaeological and historical records account for the textiles made out of it suggests appearance of fabrics either thick and coarse, used, for example, as protective garments in some demanding jobs (Edom, 2005, p.15) as well as very lustrous, delicate, luxurious, and silk-like (Bergfjord et al., 2012).

Plant bast fibres are also generally very flammable, which might add to the limited state of preservation and there are records of using Urticaceae textiles as burning fuel after an intensive wear (Edom, 2005, p. 15). They are, though, resistant to abrasion, as well as relatively good water absorption. It is, however, the drying rate that is of particular interest and use, as it is high among all of the group. The quality is especially high in nettle, then in hemp, as the both had been historically used as rigging, as well as for sails as when tested they dried completely within hours, that is also connected with the good rates of thermal exchange (Di Virgilio et al., 2015, p. 42).

Worth mentioning are the characteristics of other Neolithic fibres. Tree bast fibres, another one of more commonly used, are known for their low water absorption, quick drying, and lightweight, but also significantly lower tensile strength than that of the above mentioned plants (Harris et al., 2016, p. 105-106).

Contrary to bast fibres, wool is a strongly insulating material, which is also quite fire resistant, however not very strong. It has high levels of water absorption, higher than the flax, however dries slowly and has a tendency to felt when wet, loosing its original size. The degree of softness of coarseness depends on the quality of fibre, as well as on preparation method. Wool is also excellent energy as well as shock absorbent and in opposition to the bast plants, it is a warm textile which can be easily dyed (Harris et al., 2016, p. 106-107), bringing another set of qualities available in the Neolithic textiles.

8. Discussion

Ill. 10. Watercolour representation of several Neolithic figurines, depicting a varied range of elements of garments. From the left: Sondershausen, Germany, Ostheim, Germany, Sé, Hungary (2 figurines: "female" and "male"), Vinča, Serbia (2 figurines: "male" and "female"), stella from France (2 figurines: "female" and "male" in the back row), Arco, Italy, Ljubljana Bog, Slovenia. Lolas 2022, after Grömer, 2016, p. 340.

The invention of the concept of the staple crops was often projected back onto the Neolithic, as it was the first moment of wide spread of plant and animal. However, as with the unified and linear nature of this period was questioned, if not disproved (Çilingiroğlu, 2005; Kozłowski, p. 1999, 133-136; Verhoeven, 2011), so seems the reliance on very small selection of materials is a modern idea retroactively assigned, due to bias of the known.

Even within Europe many of the preferences and choices varied both in space, and even more significantly, in time, with some traditions having long, Mesolithic continuations. Others came, or were adapted from the Southern influences, other being imitations made with local resources, some existing for short amount of time, others lasting well into following era.

The sentiment seems also to be true in regards to textiles. Both garments, as suggested by the changes in visual representations of them in known examples of figurines (Ill. 10.) and pottery (Grömer, 2016, p. 335-341), as well as the technical ones, as some types of netting found, do not seem to have later continuation (Harris, 2010, p.108).

These fabrics were certainly were accompanied by the products of the hunting, or animal slaughter, such as leathers and furs, as well as from husbandry, such as wool, all of which added important qualities to available garments and tools, as they offered good thermal insulation and level of waterproofing (Grömer, 2016, p. 344-347; Harris, 2010, p.106-107).

The above examples constitute a quite wide range of resources with varied applications, illustrating the human creativity and the problem solving skills, as well as a dose of opportunism. In this context, the use of nettle places itself naturally into the set of explored materials. Growing almost in all areas of Europe and neighbouring regions (Ford, 2015, p. 3-4, Gorzkowska, 2015, p. 51; Michałowska, 2006, p. 296; Szwedlar, 1998, p. 430), it is a wild crop which can be easily found and recognised by local people as well as migrating groups. Therefore a continuation of traditional applications, assuming such were present, would be easy to secure.

Additionally, since nettle is the only bast plant in Europe, which can be also treated in the same manner, therefore it is probable that it could have been used as a substitute material, in conditions, where flax was unavailable for cultivation, or import. A similar state of matter had been attested in the historical and ethnological data from both Western regions of Siberia, as well as Northern, and to a lesser degree Eastern Europe, where even after the introduction of Linum, and till propagation of cotton, Urtica was collected and processed in small, household productions, where it was turned into various garments and other items such as table and bed linens[5] (Edom, 2019, p. 40-49; Michałowska, 2006, p. 296; Suomela, 2017, p. 412-413; Viljanen et al., 2022, p. 2648).

It seems that at some point loom woven textiles became sought after products, so while it is of high possibility that, at least initially, their application was limited by the volume, if it was considered of high prestige, as it is sometimes proposed, or was filling a very particular need, it is also probable that a degree of mimicry of the gaining popularity techniques and fabrics could be attempted. The counter argument could be made that the successful replication of the new trends might have

5 This term was pointed to the often obscure nature of actual fibres used. This seems also the case for the Finnish textiles, where the tradition of using Urtica was long lived, yet the same term could historically refer to both flax and nettle (Suomela, 2017).

been stamped by the seemingly limited amount of skilled spinsters and weavers, that have been estimated by the number of tools found in the period. It has been proposed that, in fact, spinning and especially weaving were guarded trades, close to hermetic knowledge[6], which could inform the high status of the crafteress (Pipes et al., 2019, p. 64; Iancu, 2018, p. 71; Yvanez, 2018; Żychlińska, 2017). This was also suggested to be the reason for the disproportion between the spinsters and weavers (Pipes et al. 2019, p. 64), although the latter could possibly be connected to the production structure and volume, as well as to underestimation of the needs and applications of yarns not related to the loom weaving.

Nonetheless, this could also have been the case, where the interest was put not into the process, but it was the semblance of the results, that sought after, with the use of the loom precursors, or other weaving or braiding techniques. In such scenarios, of the spread of the trends, both nettle and tree bast fibres could be used as alternatives to flax.

Unfortunately, given the data about the Neolithic conflict, we cannot exclude it being a factor contributing to the wider skill transmission. A potential example could perhaps be the case of a mass burial from Schöneck-Kilianstädten, in Germany, where among the victims of violence, the group of teen girls was not at all represented, suggesting the abduction (Meyer et al., 2015). While the main reason for this form of aggression was unlikely due to desire for gaining the access to the skilled spinstresses and weavers, it could still be the consequence.
Regardless, most recorded signs of mass murder do not seem to be accompanied by the kidnapping, some do not have clear motifs or culprits (Kurt et al., 2020), while in other cases, such as the grave from the Globular Amphora culture in Koszyce, Poland, the idea of outer-group conflict is questioned altogether (Krzemińska, 2022, p. 67-71).
It is, however, more sound to assume that the weaving technology was spread through natural dispersion related to intermarriages and cultural exchange, rather than due to purposeful capturing and enslavement of highly skilled individuals, to a degree that the phenomenon might have occurred in ancient Eastern Mediterranean (Iancu, 2018).

Additionally, nettle as a material for weaving could be used by the communities with the knowledge of flax cultivation in instances of crop failure, or insufficient amount of other fibres, as while garment production might not be a priority in the circumstances of a crisis, the other known applications of various textiles were related to pottery production, as well as for sieves

6 A practice that was also attributed to smiths.

and cheese-making tools, which would be more crucial and practical to have. While the craft could be perceived as time-consuming, it is important to take into the consideration that in the very busy agricultural calendar, there were also plenty of periods of inactivity, either related to the bad weather, or lack of available light. These moments were traditionally used for twining, braiding and weaving, often in a communal form (Fajardo et al., 2015, p. 372), and it is not unreasonable to assume similar practices were carried in the Neolithic.

It could be even argued, that due to the specific mechanical properties, such as better tensile and elongation properties, as well as higher drying rates, when compared to flax (Bogard et al., 2021, p. 10), Urtica would have been a better choice for food production items. Worth remembering here is the fact that nettle can be harvested both before and after the agricultural crops, offering a window of opportunity to supplement the gathered stocks and subsidise potential shortages of fibres, but also of animal forage.

These same qualities could also factor in using nettle fibres in technical textiles, either for cordage, or for netting, but especially for fishing equipment (Ill. 11.). Even though Urtica has lower resistance to deterioration in damp environments, when compared to Linum (Chmielewski, 2009, p. 26), it is still higher than that of tree basts (Harris, 2010, p. 107-108), and both are known to be used in these conditions as fishing nets, traps and fishing combs (Ijsveld, 2014).

The fact that nettle fibres were then made into a whole spool of yarn at the site of La Draga in Spain (Piqué et al., 2016, p. 266), could signify it was everyday material which was used in enough quantities, that called for a larger collection into reels. It is therefore an unfortunate shortcoming of this paper, that the discussion regarding rope-work and its applications is so limited.
Due to the mundane and assumed nature of this dying craft, the documentation and research related to it is often overlooked and incomplete, even though it encompasses a wide spectrum of human activity and history.
The full extent of potential uses is not always considered in the reconstructions of the past, therefore a closer analysis of the Neolithic through the lenses of this art and its recorded uses would be necessary for better placement of the value of various found examples of cordage as well as their probable application.

Such research would be particularly useful for contextualising both types of wild bast fibres, as it seems that their metaphorical roots lie in the rope-making practices.
Moreover, physical testing of tree and nettle fibre cordage, including the use-wear patterns could shed more light on the activities recorded, as well as these assumed to present.
Additionally, as these types of materials can be acquired from the uncultivated sources, the accuracy of the results would be higher, nonetheless the variation in techniques applied for the reconstructions, than when compared to the similar attempts with the flax, or hemp, given the constant changes introduced in agricultural development of the latter.

9. Conclusions

It was once said that an archaeologist is a person, who from the drop of bronze on a marble can reconstruct the events of the fire. In the case of Neolithic textiles it might sometimes appear as if it is only the drop of a sea of possible materials which have been preserved.
Yet, it is the garments and tools, that make humans stand up so distinctively even among our closest primate cousins. Therefore, it is also the branch, and its development, which ought to be understood to truly comprehend the changes in the cultures, beliefs and societal ideals.

The Neolithic is from this perspective a very significant period, as among domesticated crops and animals came materials, which were for the first woven on the looms, creating wide strips of fabrics well suited for creation of garments, as well as for tools, mainly for food production, including diary processing, an activity which even more profoundly changed the shape of the populations, literally influencing their genetic make-up. This level of interconnectivity demonstrates the importance of studying these elements, which at first instance might seem of a lesser value. Such an important and overlooked field was for a long time the textile production, but moreover, the statement is also very apt in regards to nettle.

Belonging to the Urticaceae family, common nettle is but one of related plants, which for thousands of years were used globally for the making of both technical and woven textiles. While not the easiest to harvest, unless gathered during the winter and early spring, due to the presence of irritant trichomes, as well as of lower natural fibre content, of around 5%, when compared to flax and particularly hemp, Urtica dioica has however the advantage of growing nearly anywhere, in woodlands, meadows, sides of the roads, and even on poor, phosphates polluted soils, while reaching height of even up to 2.5m (Ford, 2015, p. 3-10).

Often becoming choice of opportunity it was possibly the first bast plant used in Europe, before the introduction of flax (). Within the known samples of the use of the plant from the Neolithic, examples of both raw and processed fibres had been attested, which could be explained by the unique qualities each form possessed. The unprocessed fibres could be extracted at site, once the need arose, while the freshly obtained materials would contain high amount of pectins which acted as an additional binding agent increasing the strength of the attachment formed with the simple thread (Chmielewski, 2009, p. 62; Gleba & Harris, 2019, p. 2237; Sawyer, 2019, p.17), as in the case of the arrowheads from Sweet Track site in Great Britain (Edom, 2019, p.13-14). While this variant provided extra bonding, it was also more rigid and the naturally formed bundles could not be separated into finer, individual fibres (Ford, 2015, p. 10). However, if the plant was treated in a manner accustomed to that of flax or hemp, so retted in one of few available methods, after which it was to be beaten and hackled, it would too come into possession of similar qualities and at which point it would be soft and lustrous, quite fine and suitable for spinning.

Whether coarser or smoother, nettle, as other fibres, served a multitude of purposes in the Neolithic. The known samples from the era revealed an abundant world of human activities and endeavours, as manufacturing of the most associated with the period items such as pottery, on which the fabric and cordage imprints are relatively common occurrences, or such as food production, where tools such as sieves are known to be in use (Grömer, 2016, p. 347).

Such association and the fact that most of the remaining examples of European textiles of the era came from the funerary context[7] (Chmielewski, 2009, p. 225-226) also link these materials to the spiritual and symbolic realms, making them objects connected to the sources of personal and communal identities, as well as to the individual and social expression of emotions. That intrinsic relation of the very tangible material such as fabric with the world of ideas and feelings provides an insight into the ritual and ritualised needs of the living mourners, as well as the perceived ones of those who passed away from the community. It might be that textiles were brought due to simple practicality, yet at the same time deepening the sense of care given to the deceased, decreed by the tradition, but also coming from the sense of grief and loss. The materiality of these choices, therefore, or despite of, is now a prompt demonstrating the universality of emotions, grounding the prehistoric people, as humans, in modern minds, granting them more attention and rights to complexity.

Yet, the tools of personification aside, the physical applications of the Neolithic textiles were even more abundant and multifaceted. It might be argued that in the early stages of the period, the role of the loom woven fabrics was quite limited in its scope (Pipes et al., 2019, p. 62), therefore, as such, not being a main everyday choice for most of the European people of the time. It does not, however, mean that no other forms of textiles were present and used, as it stands to reason, that for example most of the garments worn were sawn, which, basing on the known examples, was done

7 This state of the matter could be mainly a result of preferable conditions provided by the grave forms of deposition (Chmielewski, Grömer).

with the tree, or plant fibres (Grömer, 2016, p. 344-347). It is also likely that various netted, knitted, braided and plaited materials were used, in addition to any leather or fur outfits.
Moreover, traces of embroidery, and rich tradition sewn on appliqués were attested (Grömer 2016, p. 335-336, 370-372, Pipes et al., 2019, p. 27), as well as elements suggesting practices of cloth staining and wool dying (Chmielewski, 2009, p. 238).
From reconstructions of grave goods, it seemed that forms of hair, or head, nets with exuberant beading were worn, alongside probable knee-length tunics finished with remaining of detailed hem adorned with appliqués, aside from known from other sites fur leggings (Grömer, 2016, p. 334-337).

Plant fibres of the Neolithic were not enough processed to be dyed, which might have been caused by the still lingering presence of the resins on the bast plants fibres, as some of the known samples do seem to still carry it on (Chmielewski, 2009, p. 237) as well as their structure (Mairet, 1916, p. 18). As it was also said that nettle presents even more of a challenge in regards to gum elimination (Ford, 2015, p. 10-11). Plant textiles, especially bast plants, were considered tough to dye in a manner that would be steadfast, and the procedures to accomplish that were multisteped. This consisted of boiling in concentrated sorrel (Rumex acetosa), acid, or in caustic concentration of potash for a few hours, which was followed by bleaching, which was carried by alternating soda and soap boiling baths and grass bleaching, taking up to 3 weeks. Afterwards the galling was carried, this was a day-long bath in beaten and boiled gall apples, or in tannic acid.
Lastly the processes of aluming or mordanting had to be done and finished with final wash (Mairet, 1916, p. 18-22). As the procedure is quite complex and requires uses of strong irritants, it is rather likely that attempts at dyeing would produce results closer to staining.
Yet, given the ethnological parallels it is still of good probability, that many of the garments were still decorated with staining or painting on their surface, the form of which could be differentiated between the various groups and communities. Appearing later in the period woollen clothing, on the other hand, could have been easily dyed at various stages of the production, allowing for further development of patterned outfits, trends and preferences as well as a symbolic meaning of these choices (Chmielewski, 2009, p. 226; Harris, 2010, p. 104). The presence of weaving tablets and sprang loom frames might indicate the possibility of the creation of decorative strips either to be attached to the garments, worn as a belt, or used for other forms of adornment.
Similarly, braided items could have had an aesthetic value aside from the inherent practical functions.

However, though the visual significance of textiles was certainly crucial in some areas, as it correlates with the natural human need to stand out as an individual on one hand, and to express belonging to a group on the other, the application of plant fibres may also have wider, more universal layers. The items such as mats, could have been used as protective garments, carrying bags, sleeping spaces, portable sheltering, and forms of interior furniture and decoration (Harris et al., 2010 p. 105-110; Rimkuté, 2010, p. 220). Similarly, braided and twined items had multiple uses, from forms of apparel and footwear, but also as carrying items, for either small everyday objects, to communally transported massive and extremely heavy ones, such as parts of megalithic structures, as well as in construction of said places, and of private dwellings. They were also applied in food collection, in forms of fishing traps, but might have also been used in elements such as bow strings and arrowhead binding, both known from ethnological and archaeological materials to be sometimes made out of nettle fibres (Ijsveld, 2014; Grömer, 2016, p. 347).

This wide range of applications is the result of collecting varied scope of materials and processing them in different manners increasing the available choices. Most of the bast fibres, but especially the plant sources are characterised by high tensile strength and toughness, of which nettle seems to present the best qualities. They are also, in contrast to wool, not highly windproof, allowing for air circulation, as well as for quick water evaporation, making them especially sought after in warmer climates, or seasons, as well as in appliances, which ought to be kept dry. Tree basts naturally lend themselves to creation of thick strips, which can be used for mat-making and braiding, while plant basts, particularly when well retted, could be turned into very fine fibre, which could have been spun and woven into delicate yarn and fabric. They are also, in general, more resistant to biological infestation than wool (Harris, 2010, p. 106-107).

However, the numerous likenesses between the plant bast fibres are also reflected in the similarities between their cellular structures. Their build, when observed under light microscopy, is not significantly characteristic to allow even familial identification. For this reason other analytical methods needed to be established and applied to present any opportunity to differentiate the bast plants from each other. A more common one of these techniques, still in use, is modified Herzog test, in which birefringent microfibrils of the second cellular wall are observed under the white polarised light microscope, and the combination of their twist direction as well as angle is compared against the standard for each of the plants. For nettle this is s1Ss2Ss3s sequence with fibral angle of 7.5º, while flax has been attributed the combination of s1Zs2Ss3Z twists directions and 6.5º according to Haugan & Holst (2013, p. 159), or 10º as reported by Bogard et al. (2021, p. 8-9).

The method was often combined with cross-section analysis, of which the premise was that each species had a distinctive shape of their stem, characteristic only to them, which can be observed under a microscope. This hypothesis was however recently heavily criticised, as some research, such as one conducted by Lukesova and Holst (2020), showed the presence of all the possible variations within just one plant. The quality, that could be further compounded by the growth conditions, as well as post-collection treatment and processing.
Therefore, other techniques are suggested as a part of fibre identification combination, mainly calcium oxalate crystals analysis (Lukesova & Holst, 2020, p. 216; Suomela et al., 2017, p. 415). The latter is an investigation into the presence of crystallographic structures visible within the nettle, done with a polarised light microscopy, or scanning electron microscopy (Viljanen et al., 2022, p. 2647).

Even with this data, however, it has been said that identification of particular kind of bast plants is often highly challenging and prone to misattribution (Lukesova & Holst, 2020, p. 216; Piqué et al., 2016, p. 263; Sawyer, 2019, p. 8; Viljanen et al., 2022, p. 2645), as the margin of error is unfortunately small even in perfect conditions, and can be even slimmer in historical samples as a result of genetic, environmental and processing factors.

Due to all these elements, as well as the deterioration caused by prolonged deposition in the not ideal conditions, the above mentioned problems are even more pronounced in the archaeological records, where the adage of the internal biases resulting from the limited data and based on it held beliefs can weight in, leading to misidentification of the material analysed. In this situation, the turn in the nomenclature being made, where all of the bast plant fibres are identified only as such, without attribution to particular genus. This is a very sound and necessary step, but it ought to be and more widely is followed by drawing the attention to the full spectrum of available botanical resources with their ecological and technical contextualisation. It seems especially important to challenge the previously unquestioned hegemony of the role of Linum in Neolithic Europe, as without it, even with the adjustment to naming convention, the subconscious impulse might have still been to associate the given textile as being made out of flax.

For this reason, further and ongoing research into the topic of the variety of the used species and the methods of identification, whether in the field of physical microscopy, or as with the recent advance in the detection of wool and silk by chemical trace analyses (Liu et al., 2015) is crucial. Additionally, establishing the universal recognition protocol focused on the archaeological textile samples, as a combination of several independent techniques is also a worthy endeavour.

There is yet still a high necessity for physical and chemical testing, and retesting, of the available in the prehistory fibres, as well as accompanying them processing methods and produced textile. This refers to both analyses of known archaeological data, to confront particularly older attributions with the modern insight, but also to the field of experimental material sciences. The later being still a quite vital sphere to investigate, as while technical analyses of many of the materials are available, they are mostly centred on highly specific, newly developed, subspecies of cultivated plants, as well as mechanically collected and processed materials, which, as it had been pointed out, do not necessarily correlate well with their ancient counterparts. These misalignments might not even be in favour of the current techniques, as there are some instances of Bronze Age fabrics, which seem to surpass the factory produced linens in fines and lustre (Bergjord et al., 2012, p. 664). Just for these circumstances, well-designed analyses of non-industrially grown and gathered fibres, especially of the wild and reconstructed genomes of plants, would be essential for more accurate estimates of the properties and qualities of the prehistoric materials.

Moreover, this observation also signals a need for closer study of period-accurate methods of harvest, drying, retting and extraction, as well as yarn and textile production techniques from the perspective of long term experimental archaeology projects supported by ethnological and, if possible, practising specialist input. The latter also requires more consideration, as many of the perceived limitations believed about the textile, in techniques such as slicing and spinning seem to come as a result of a limited exposure and training of people trying to recreate and evaluate said methods. However, this seems to stand in the opposition to the observations made when interviewing practitioners of dying crafts, which pointed to these skills needing to be honed for years if not decades (Chmielewski, 2009, p. 238).

Therefore, if the efficiency of these technologies is hindered by the short span of practice, such quickly learned attempts might be producing false data, obscuring the realities of this still understudied field. Consequently then, relearning these approaches within the necessary time frame, in long term projects, especially under the tutelage of still practising craftswomen might be the method providing the most accurate understanding of these techniques, not only from the efficiency perspective, but also from the social one. These efforts made would also allow for having a better point of reference for placing the textile production in the cultural and symbolic context of human behaviour and interactions.

Such actions and approaches would be especially beneficial for placing the common nettle in the Neolithic, but also just past, reality. Unfortunately, by this moment many of the traditional nettle spinning and weaving are perhaps nearly completely vanished, therefore if the research is not carried swiftly, these specialised skills might have to be reinvented from the very scattered ethnographic and historical records. Which would also most likely extend the process significantly.

However, there are also new people drawn to the field of nettle collection and fibre processing, forming small communities around sharing, learning and teaching these skills to each other, mainly on the internet, which seems like an opportunity for citizen science being employed in the research of hand crafted textiles in manners alike to those applied in the prehistory. In fact, with the aim of revaluation of Neolithic textile sources, it might be a necessary approach to take.

While the topic of garments, textiles, and especially cordage, had been undervalued for a long time, currently there have been numerous attempts in improving the state of the matter using very varied techniques and interpretation angles. Additionally, changes and acceleration of the available excavation and analytical practices allowed for discovery and preservation of many of the now known samples. All that needs to be weighed when accessing not only the field of textiles, but also foraging, which turned out to require a different approach than the cultivated plants.
This is the core of the reason why more focus shed on the subject of use of undomesticated resources is so important, as placed in a wider perspective, the understanding of the role of wild plants exploration puts people of that time in the immediate relation with their surroundings and nature as a whole, rather than as an abstract element alone and alienated from the living world around.

Therefore nettle constitutes a very valuable medium for the more holistic, multifaceted perception and approach. As a wild crop, which grows equally readily in the ruderal context, and appears in plenty whether surrounded by forests, fields, or meadow scope (Sawyer, 2019, p. 20; Szwedlar, 1998, p. 430). Since its presence is also not at risk in a situation of human expansion, it naturally lends itself towards being a substitute source of fibre, if not being a primary one.

Drawing a coherent picture of Urtica dioica presence in the life of the Neolithic people from the perspective of wide range textile production and application is an elusive task, particularly as nettle is frequently overlooked. The reasons for its omission are likely quite varied. Perhaps while being a perennial wild plant, which occupies many of the environments, it also does not stand out to the same extent as a tree, or field of cultivated crops would, in both the landscape, as well as, the imagination and recollection. Further, covered completely in painful to touch trichomes, it might not be the most approachable. These combines with the lack of large scale industrial interest, as well as near extinct and forgotten practices and homestead production. The limited information regarding its harvest and preparation further makes the researchers less inclined to include it in their projects alongside for example willow, or linden fibres.

To remedy that state of the matter, more attention should be placed on the processing techniques. As presented here, nettle could have been collected, retted, had its fibres extracted and used in several different manners. That varied approach was less a technological matter, in many cases, and more cultural and practical one, connected to the rhythm of the life of the community, as well as to their physical, social and spiritual needs. Available for harvest since the early summer till the early spring, sets Urtica as an unique bast plant, which could be fit into the agrarian and farming year.

Moreover the limited data on mechanical properties also provides examples of not only very good technical qualities, comparable, if not exceeding those of flax, but also some that could have been sought after.

It is therefore a hopeful wish that this short research into this forgotten, humble, stinging plant may inspire more further inquiries into other overlooked materials, which are perhaps only rarely preserved in the archaeological context, but which could hold significance in the everyday life of the prehistoric people, and to be an invitation into further, comprehensive studies, as it also sheds light on the creativity and problem solving approaches of the Neolithic communities.

While the understanding on the field is ever expanding thanks to the careful work of many specialists, as shown within these pages, the amount of unanswered questions regarding Urtica, wild fibres and the multiple roles of the woven and technical textiles is still vast. There is, however, no doubt, that if the interest in the topic continues, the significance of nettle is yet to be truly established, as the more detailed picture of the textiles, their production regional differences, the symbolism and the mundane practicality of the Neolithic and prehistoric communities emerges.

Ill. 11. Watercolour impression of Neolithic netting in use. Lolas 2022.

10. Abstract

Stinging nettle (Urtica dioica) is one of the most common perennial plants on the European continent. Growing equally well in forests, ditches and ruderal spaces up to 2.5m tall, it is easy to find and identify due to its stem and characteristic oval, serrated leaves being lavishly covered in irritant-filled trichomes, a hair-like organs (Szwedlar, 1998, p. 430). Having plenty of nutritional and medical applications, it is however often overlooked as a source of textile fibres.
The issue perhaps being a result of dying traditions of nettle uses, as well as being associated with war time crop, due to the increased attempts at industrialisation during the both World Wars in Europe (Edom, 2005, p. 16). Yet, it had a much more profound role, not only in historical times. It used to be known as distinctive, luxurious, soft, fine and full of lustre fabric of Bronze Age elites, as it was identified as a priced grave gift in one of the richest and most splendid burials of the period from the mound Lushøj n Denmark (Bergjord et al., 2012, p. 664). It was also known and valued in mediaeval times as both sign of status, but also as tough, fast drying and resistant fibre preferred for rigging (Edom, 2019, p. 18-20).

Urtica dioica seems often neglected in the research of Neolithic textiles. The aim of this paper therefore is to propose it as an alternative material to the main source of fibre of the age, that was newly domesticated and introduced to the small continent flax, as well as more and more acknowledged, and utilised since at least Mesolithic, tree basts (Grömer, 2016, p. 5-6).
It is necessary to draw attention towards nettle, as there is a small, yet growing set of samples identified as this plant. The best known examples coming from spheres where the introduction of flax came at a later period, as the waterlogged site of La Draga, Spain (Piqué et al., 2016) where a whole ball of yarn has been found, or a thread on the fishing luster from seabed near Skjoldnæs on Ærø in Denmark (Chmielewski, 2009, p. 26; Hansen, 2011).
To contextualise these finds, a wider look at the Urticaceae family is included, especially as Japanese cousins of the common nettle is one of the oldest known textile dated to 10 000 BC early Jomon period (Edom, 2005, p. 5), while well documented processing methods of Boehmeria nivea might be also applied for Urtica.

Similarly, ethnological, historical and experimental data allows for expanding the understanding of nettle fibre applications, but also, based on records and in comparison to flax and hemp, for reconstruction of the collection, retting and spinning techniques, which might have been used by European Neolithic communities.

Further, the identification methods, such as modified Herzog test, calcium oxalate crystals observation and cross section, are briefly discussed to illustrate the complexity and limitations of bast plants attribution (Lukesova & Holst, 2021). Additionally, the information about technical properties allows to demonstrate the value of Urtica as a source of fibre, as tensile strength, toughness and drying rate presented results as good, or better than those of flax. These, combined with possibly greater length and longer collection period, could constitute an important input of advantages of Urtica and its presence in the Neolithic.

Abstrakt

Pokrzywa zwyczajna (Urtica dioica) jest wieloletnią rośliną powszechnie występującą na terenie całej Europy. Rozwija się równie dobrze na terenach leśnych, łąkowych oraz ruderalnych osiągając wysokość do 2,5m. Jest stosunkowo łatwa do zidentyfikowania dzięki łodydze i charakterystycznym owalnym, ząbkowanym liściom, obficie pokrytymi gruczołowatymi, parzącymi włoskami, powodującymi, w kontakcie ze skórą, bolesną reakcję zapalną (Szwedlar, 1998, p. 430). Pomimo, iż jej zastosowania w obrębie medycyny i żywienia są dobrze znane, wykorzystanie pokrzywy do produkcji tekstylnej wydaje się być zapomniane lub zupełnie pomijane. Jej użycie w tej dziedzinie jest zwykle jedynie wspominane w kontekście braków wojennych, szczególnie prób industrializacji jej uprawy w czasie II wojny światowej (Edom, 2005, p. 16). Jednak w okresie prehistorycznym, a nawet historycznym, rola pokrzywy i jej znacznie były o wiele większe, do tego stopnia, że starannie utkana w cienką, delikatną, miękką, wysoce połyskliwą tkaninę, jest obecnie czasem określana jako obiekt charakteryzujący epokę brązu. Taki, luksusowy, materiał był odnajdowany w darach pogrzebowych w pochówkach elit tego okresu, m. in. z niezwykle bogato wyposażonego kopca Lushøj w Danii (Bergjord et al., 2012, p. 664). Jeszcze w okresie średniowiecza wykonana z pokrzywy lekka tkanina była symbolem statusu, zaś jej mniej obrobione, sztywniejsze i szorstkie włókna wykorzystywano do produkcji sznurów i olinowania (Edom, 2019, p. 18-20).

Jednakże Urtica dioica wydaje się być pomijana w badaniach nad szeroko rozumianymi tekstyliami okresu neolitu, dlatego celem tej pracy jest przybliżenie jej zastosowań i właściwości oraz, poprzez analogie form pozyskania i przetwórstwa, zaproponowanie pokrzywy jako alternatywy dla głównych źródeł włókienniczych tej epoki, za które przyjmuje się nowo udomowiony i dopiero wprowadzany do uprawy na terenie Europy len, oraz coraz częściej rozpoznawane, a będące w użyciu przynajmniej od mezolitu, łyka drzew (Grömer, 2016, p. 5-6).

Jest to szczególnie uzasadnione ze względu na rosnącą grupę zabytków identyfikowanych jako tekstylia pokrzywowe, pochodzące często z regionów i kultur, w których uprawa lnu nie była praktykowana, takich jak podmokłe stanowisko w La Draga, w Hiszpanii (Piqué et al., 2016), na którym odkryto wytworzony z włókien pokrzywy motek sznurka, lub z dna morskiego w pobliżu Skjoldnæs on Ærø, w Danii, skąd pochodzi trójzębna ość rybacka połączona ze sobą pokrzywową nicią (Chmielewski, 2009, p. 26; Hansen, 2011).

Aby umiejscowić pokrzywę zwyczajną w temacie produkcji tekstylnej, należy przyjrzeć się jej w szerszym kontekście taksonomicznym rodziny Urticaceae, jako że należące do niej rośliny mają długą i obszerną historię zastosowań w tej dziedzinie, a których techniki obróbki mogą być z powodzeniem przełożone na Urticę dioicę. Najlepiej znany jest tu Szczymiel biały (Boehmeria nivea) zwany również Ramią, zaś spokrewniona z nim Boehmeria japonica jest prawdopodobnie jedną z najdawniej wykorzystywanych roślin tkackich, o czym świadczy wykonany z niej fragment materiału z wczesnego okresu Jomon (Japonia), datowany na około 10 tys. lat BC (Edom. 2005, p.5).

Podobnie, etnologiczne, historyczne i eksperymentalne badania pozwalają na poszerzenie wiedzy o wykorzystaniu pokrzywy zwyczajnej w produkcji tekstylnej, zwłaszcza poprzez porównanie tej rośliny, oraz metod jej pozyskania i obróbki, z tymi znanymi dla lnu i konopi włóknistych.
W pracy dodatkowo przedstawiono metody identyfikacji wykorzystywane w badaniach tekstyliów archeologicznych, takie jak modyfikowany test Herzoga, analiza obecności kryształów szczawianu wapnia oraz kształtu przekroju łodygi, aby pokazać ich możliwości, ale także ich ograniczenia dotyczące prawdopodobieństwa rozpoznania poszczególnych roślin włóknistych (Lukesova & Holst, 2021), ponieważ istnieje podejrzenie błędnej atrybucji wielu prehistorycznych tkanin (Suomela et al., 2018; Viljanen et al., 2022).

Z tego powodu informacje o technicznych własnościach wyrobów tekstylnych wykonanych z dostępnych w neolicie roślin włóknistych stanowią tutaj konieczne uzupełnienie.
Z nielicznych przeprowadzonych badań wynika bowiem, że Urtica dioca ma właściwości podobne, jeśli nie lepsze, do lnu, konopi włóknistych, czy łyka drzew, szczególnie w zakresie wytrzymałości materiału. Razem ze znacznie dłuższym dostępnym okresem zbioru, te cechy sprawiają, iż pokrzywa zwyczajna mogła być atrakcyjnym źródłem włókien dla neolitycznych społeczności europejskich i w tym kontekście powinna być częściej uwzględniana w pracach i badaniach dotyczących tej epoki.

Illustrations

Ill. 1. Urtica dioica. The watercolour representation of stinging nettle, also called common due to its wide spread Eurasia, North Africa, North and South Americas and Polynesia. Usually growing in clusters, up to 2.5m. Lolas 2022, after Szwedlar, 1998, p. 430.

Ill. 2. Urtica galeopsifoli. This subspecies of Urtica dioica is native to many parts of Eurasia is characterised by having little of trichomes causing little to none skin irritation. It has been used in textile from Must Farm in England. Lolas 2022.

Ill. 3. Boehmeria nivea. Belonging to the Urticaceae family, this plant is one of oldest known sources of textile fibre and has been widely used for production of luxurious, lustrous fabrics, that were quite easy to dye. Contrary to common nettle, ramie does not cause any irritation when touched making it more ready available for collection. Lolas 2022.

Ill. 4. Watercolour representation of fishing comb from Skjoldnæs on Ærø in Denmark. Belonging to Ertebølle culture this wooden, composite tool has been tied together with a nettle string. Lolas 2022, after Hansen, 2011.

Ill. 5. Visualisation of a few examples of Neolithic mat-making patterns. Lolas 2022, after Buxó, 2010, p.44; Rimkute, 2010, p. 219-220.

Ill. 6. Reconstruction of willow twining textile from the Neolithic settlement Schipluiden in the Netherlands. Lolas 2022, after Kooistra, 2006.

Ill. 7. A reconstruction of a heckling comb from Lattrigen and two types of spindles. This form of brush reconstructed from Neolithic context has been in use well into the XX century as a tool for flax processing. The high-whorl spindle and the low- whorl spindle allowed for stronger twist of the yarn were used in a different manner. Objects are not to scale. Lolas 2022, after Chmielewski, 2009, 56.

Ill. 8. Sewing tool kit. Watercolour reconstructions of possible Neolithic set of carry-on tools used for textile making. Includes, wooden hook, bone bodkins and needles, flint blade and weight and spool of thread. Lolas 2022, after Rimkuté, 2010, p. 219.

Ill. 9. Z and S twists. The watercolour visualisation of directional twists present in helical form on the cellular level in bast fibres, as well as in threads, yarns and ropes. Lolas 2022.

Ill. 10. Watercolour representation of several Neolithic figurines, depicting a varied range of elements of garments. From the left: Sondershausen, Germany, Ostheim, Germany, Sé, Hungary (2 figurines: “female” and “male”), Vinča, Serbia (2 figurines: “male” and “female”), stella from France (2 figurines: “female” and “male” in the back row), Arco, Italy, Ljubljana Bog, Slovenia. Lolas 2022, after Grömer, 2016, p. 340.

Ill. 11. Watercolour impression of Neolithic netting in use. Lolas 2022.

Tables

Table.1. The twist sequence and angles typical for bast plants in their second cellular wall.
After Hangan & Holst 2013 and Bogard et al. 2021

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