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'The Color of the Grave is Green' – Moss and Juniper in Early Medieval Graves at Toppolanmäki, Finland

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ABSTRACT

Two graves, initially discovered in the 1930s, were reopened and examined in 2017 and 2018 at the Early Medieval cemetery of Toppolanmäki, Finland. Soil samples taken from the graves were sampled for macrofossils, pollen and microfauna. Pollen and spore analysis provided possible evidence for the use of mosses and juniper branches in the graves. Also, moss-indicating microfauna (*Euglypha* spp.) was detected. At Toppolanmäki, mosses were used in both coffins and earth burials. The clubmoss found in the latter could even indicate the presence of a woven carpet or mattress in the grave pit. The use of juniper, on the other hand, could indicate ritual continuation from the Iron Age as it is a common find in older cemeteries. It is also possible that the early medieval environment around the site was characterised by dry meadows and juniper bushes at the time of the burial, and even that one of the burials took place in early summer. The study highlights the research potential of graves that have been excavated decades ago and presents a new biological indicator of the use of moss in burials: the testate amoeba *Euglypha*.

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Introduction

The presence of plant material in graves may reveal a considerable amount of information on social and cultural relationships between humans and plants in the past. The use of plants in graves varies from practical to symbolic. They may control odours, inform us about the environment around the cemetery at the time of the burial and serve as evidence of cultivation or exploitation of wild food resources. Plants may also function as ritual items or expressions of beliefs. (e.g. Hansson and Bergström 2002; Goody 1994; Lempiäinen-Avci 2019; Lempiäinen-Avci, Laakso, and Alenius 2017; Miller 1995; Tranberg 2015).

While the plant macrofossil, pollen and spore analysis have an established position in Finnish archaeology, microscopic fauna have received much less attention, even though they have frequently been detected from archaeological sites worldwide (e.g. Bouchet et al. 2003; Dittmar and Teegen 2003; Fugassa et al. 2008; Hald et al. 2018). Studies of graves have demonstrated that microfaunal remains, such as parasites and insects, can be preserved in graves and may provide additional information about human culture and traditions, health, lifestyles and the environment.

Archaeobotanical material can be found from graves in, e.g. soil or organic concretions (e.g. Hansson and Bergström 2002, 44; Lempiäinen-Avci 2019, 28, 31). However, plant material may be difficult or even impossible to study if the excavations were conducted decades ago, especially if soil samples were never collected. This is also the case with the early medieval (twelfth century AD) cemetery at Toppolanmäki, Valkeakoski, Finland. The cemetery was mainly excavated in the 1930s (Leppäaho 1938; Pälsi 1937), but the early excavations produced only minimal material for further research beyond artefacts. The cemetery dates to the period when the inhabitants of the region were slowly adopting Christianity, so the early research questions focused on the presence of objects and the orientation of the graves, which were seen as possible indicators of the Christianisation process (e.g. Cleve 1948; Kivikoski 1955). Since soil samples were never collected, the environmental evidence on the burial contexts and the site at Toppolanmäki has been lacking for decades.

In some cases, the bones found at Toppolanmäki were left *in situ* after documentation (Pälsi 1937). In 2017 and 2018, two of these graves were reopened and examined with an aim to find out what kind of information could be obtained with the help of modern methods (Moilanen 2018b, 2019, 2021, 42). Soil samples were taken for macrofossil, microfauna and

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pollen analyses to shed light on the plant use in the graves and the possible presence of parasites. This article presents the results of these analyses and discusses how they contribute to the growing evidence of plant use and environmental conditions in early medieval Finland.

Plants and Microfauna in Finnish Inhumation Graves

In Finland, the acidic soil leads to a fast decomposition of osseous material (e.g. Taavitsainen 1997, 53), although the preservation varies even within sites (Moilanen 2021, 32). Regarding plant remains, only charred macrofossils are usually preserved at open-air archaeological sites. Uncharred macrofossils can be found close to metal artefacts, for example, in inhumation graves (Lempiäinen-Avci, Laakso, and Alenius 2017; Vanhanen 2019, 30). On the other hand, pollen preserves well in acidic soils but can be destroyed by oxidation (Dimbleby 1957; Havinga 1967; Twiddle and Bunting 2010).

Despite the preservation issues, the soil samples taken from Late Iron Age and Medieval (c. 10th–15th centuries AD) inhumation graves in Finland have revealed varied use of plant material in graves. Remains from cultivated and wild plants, such as barley, rye, hops, hemp and juniper, have been discovered in inhumation graves (Lempiäinen 2002). Graves from the Medieval and Early Modern Periods (c. 16th–19th centuries) have contained mineralised raspberry seeds that may have been the remains of the last meal consumed by the individual (Lempiäinen-Avci, Laakso, and Alenius 2017). It also seems likely that corpses were sometimes intentionally placed on soft surfaces since there is evidence of softening the coffin floor with mosses and grasses (Jäkärä 1998, 5; Lempiäinen 2009, 129–130; Lempiäinen-Avci, Laakso, and Alenius 2017; Sulas et al. 2022; Tranberg 2015, 43) and feather fragments (Berglund & Rosvold 2021; Kirkinen et al. 2020).

In Finland, evidence of intestinal parasite remains has been recovered from the abdominal area of an Iron Age inhumation burial at Luistari, Eura (Juhola et al. 2019). Intestinal parasites can be linked to poor health and lack of hygiene, as well as cooking methods (Juhola et al. 2019). Vajanto (2016), on the other hand, has observed the remains of an external parasite, the body louse, on an Iron Age garment. This indicates that the clothes were used regularly and not as a special funerary attire as previously assumed. In addition, Lipkin et al. (2021) have examined insect remains in post-medieval church burials, and in many cases, they have been able to identify the burial season based on the insect species. The good preservation of microfaunal remains in the soil and archaeological contexts is often due to firm shells or chitinous exoskeletons of insects.

The Early Medieval Cemetery at Toppolanmäki

Toppolanmäki is a small inhumation cemetery in the inland region of Häme in Southern Finland (Figure 1). The site was found in 1936 during sand extraction when bones and early medieval artefacts were found. In the same autumn, Jorma Leppäaho (1938) excavated two graves at the site in a rescue excavation: 1/1936 and 2/1936. In the following year, Sakari Pälsi (1937) excavated eight more graves and mapped several depressions that were considered as possible graves. Three of these were determined as possible unfurnished graves in the excavation of 1951 (Erä-Esko 1952).

At least 17 individuals, all adults, were buried at the site during the twelfth century AD (Moilanen 2021, 196). The burial customs at the site are varied, and they include inhumations and cremations, single, double and multiple burials, furnished and unfurnished graves, different kinds of coffin structures, and varied use of objects, e.g. sharp objects struck into the coffin structures. The burial practices can be considered as part of the general variation of the era (Moilanen 2021). It has been suggested that the cemetery was used by a single farmstead that possibly located c. 150 m from the site by the lake Vanajavesi (Leppäaho 1938). Common village cemetery did not likely exist in the area. This idea is supported by the distribution of cemeteries in the vicinity. The nearest contemporaneous inhumation cemeteries of Moijanen and Kiiliä are located at a distance of c. 700 m and 2 km (Figure 1), and they are equally small, i.e. they consist of only a few burials (Moilanen 2021, 193–195).

Material and Methods

Graves and Soil Samples

The two reopened graves are discussed in this article in the order of the most recent excavations. Grave 3 (hereafter G3/1937) was initially found in 1937, left *in situ*, and reopened in 2017 (Pälsi 1937; Moilanen 2018b). The grave belonged to an adult male, who was placed in the grave in a supine position without a coffin or artefacts. During the excavation in 2017, it was noted that the bottom of the grave pit, the pelvic area, and the vertebrae were located in undisturbed soil that had not been touched in the initial excavation in 1937 (Moilanen 2018b). Therefore, it was assumed that the samples taken from this soil were unlikely to be contaminated by modern material. The samples for macrofossils were taken from under the skull (sample 1), the pelvic area (sample 2) and below the ankles (sample 3) (Figure 2). Subsamples from sample 2 were used to study both pollen and microfauna, as the pelvic area was considered the best location for possible parasites.

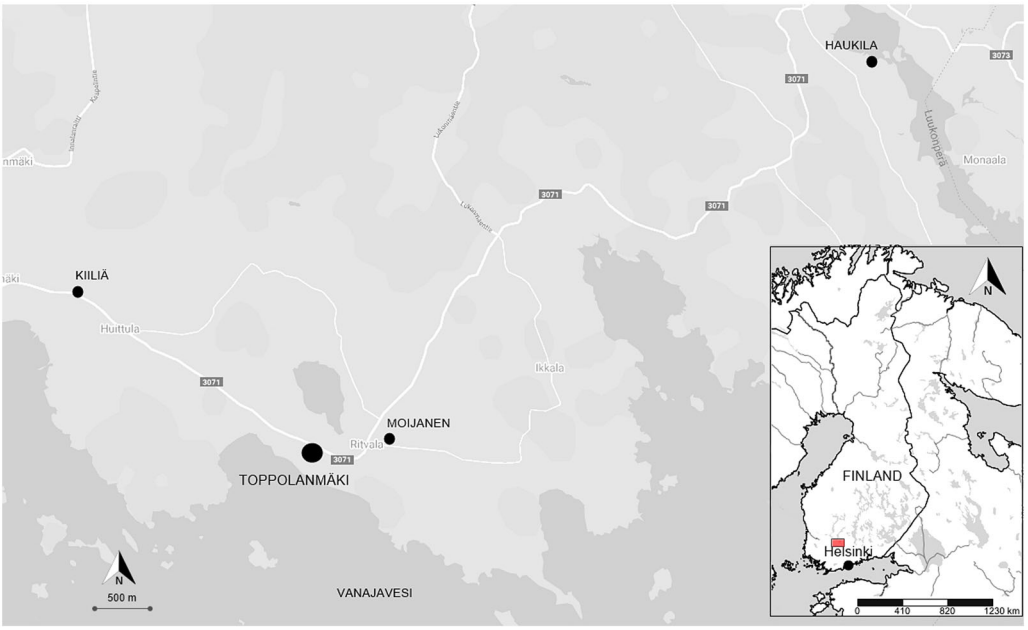

Figure 1. The location of Toppolanmäki in Finland. The nearby sites with inhumation burials (Moijanen and Kiiliä) and the cremation cemetery of Haukila are also marked on the map.

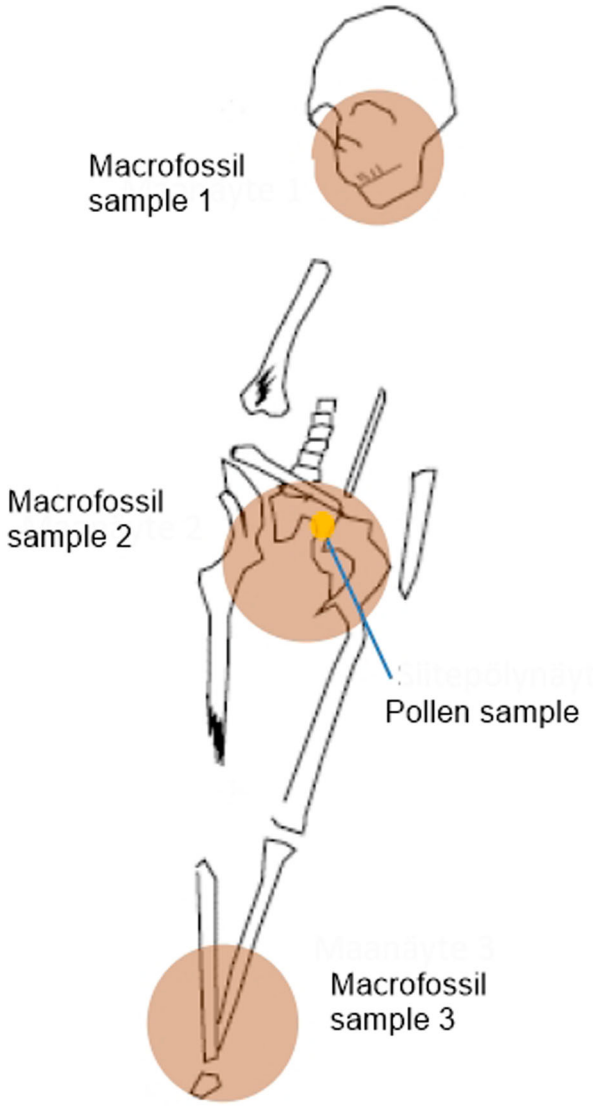

Figure 2. The locations of samples from Grave 3/1937.

Grave 2 (hereafter G2/1936) was found in 1936 (Leppäaho 1938) and reopened in 2018 (Moilanen 2019). Based on the analysis of original photographs and written documentation, the grave was a burial of three adults who had been placed in a rectangular coffin on top of each other, heads in opposite directions (Moilanen 2021, 60–62). No artefacts were found in the grave.

The grave had been severely disturbed in the previous excavation in 1936. The bones had been commingled in the search for artefacts, and the skeletons were not *in situ* anymore (Moilanen 2019). The grave was considered too disturbed for any remaining macrofossils from the time of the burial, so large soil samples were not taken. However, one of the femurs was broken and had been filled with dark, almost black, soil. The consistency and colour of this soil differed significantly from the rest of the disturbed grave, where the soil was yellow and coarse sand. It was concluded that the dark soil most likely represents the original material of the grave from the time of decomposition, and therefore this soil was sampled for pollen and microfauna.

Macrofossil Analysis

Three soil samples with a total volume of 7.8 l were analysed for macrofossil content. The samples were flotated using a mesh size of 0.25 mm (0.5 mm for sample 3), and the remaining heavy fraction was sieved using a mesh size of 1 mm. A total of 350 ml of organic matter was analysed, consisting mainly of charcoal and some recent plant debris. The samples were studied using a binocular microscope. Plant

remains were identified using a reference collection at the Finnish Museum of Natural History and reference literature (Cappers, Bekker, and Jans 2006).

Pollen and Spore Analysis

Subsamples (1 g) from graves 3/1937 and 2/1936 were used in pollen analysis. The samples were chemically treated following the standard procedures with KOH and HF treatments to remove soil matter from pollen grains (Fægri and Iversen 1989). The pollen grains were mounted and stained using a safranin-glycerine mixture, and the samples were examined with a light microscope using the x400 magnification. Due to low pollen concentration in the samples, only 256 pollen and spores were counted from the grave G3/1937 and 231 from the grave G2/1936. The identification of pollen was based on the publications of Fægri and Iversen (1989), Reille (1992; 1998) and Beug (2004). The taxonomy and nomenclature follow Hämet-Ahti et al. (1998).

Calculations for pollen percentages were based upon the basic sum of P, which includes all terrestrial pollen grains. Percentages of spores were calculated based on the sum of P + Spores. Pollen diagram was constructed using Grimm's (1991) TILIA and TILIA GRAPH programmes.

Microfauna Analysis

Subsamples (0.5 g) from graves 3/1937 and 2/1936 were used in the analysis. They were prepared at the cleanroom laboratory of the Helsinki Institute of Physics. To extract the microfauna, the samples were deflocculated by soaking and shaking in 5% weight by volume sodium hexametaphosphate $(NaPO_3)_6$ solution for 24 h. The chemical was then removed by rinsing three times with sterile water, at 3000 rpm for 10 min. The samples were treated twice with a heavy liquid separation technique: LST Fastfloat at 2.0 sg density, centrifuged at 2000 rpm for 10 min and rinsed with sterile water three times. The fraction was pipetted on slides, and coverslips were secured with nail polish.

The samples were observed and imaged using transmitted and polarised light microscopy with 100–400× magnification at the laboratories of the University of Helsinki and the Nanomicroscopy Centre of Aalto University. The analysis was based on the morphological features of particles detected with the microscope.

Table 1. Macrofossil remains from Toppolanmäki burial.

Sample ID	1	2	3
Context	Below skull	Around stomach	Dark soil at lower limbs
Soil volume (l)	2.6	3	2.2
Organic matter (ml)	100	80	170
Charred plant remains			
Bearberry seed (*Arctostaphylos uva-ursi*)			1
Cone scale	2		
Small branches	*		
Uncharred seeds			
Raspberry (*Rubus idaeus*)	*		*
Common sorrel (*Rumex acetosa*)			*
Fat-hen (*Chenopodium album*)			*
Violet (*Viola* sp.)	*		
Other remains			
Rodent droppings	*		
Earthworm cocoons	*	*	*
Insect exoskeletons			*
Uncharred seeds	*		*

Note: The presence of small, charred branches was noted with * as well as the presence of other remains consisting of animal and plant remains of recent origin.

Results

Macrofossils

Charred plant remains consisted of small branches and cone scales (probably from *Pinus sylvestris* or *Picea abies*) found from below the skull and a bearberry seed from the sample taken from the lower limbs of the deceased (Table 1). Samples taken around the stomach did not contain plant macrofossils. Charred remains can be considered deriving from the time of the burial or they could even derive from fires predating the burial.

Earthworm cocoons were found in the samples as well as rodent droppings, insect exoskeletons and uncharred seeds. These remains appear to derive from natural bioturbation, such as burrowing by earthworms and rodents.

Table 2. Pollen and spore data, identified from the Toppolanmäki graves.

	Number of pollen grains and spores (%)	
	Grave 2/1936	Grave 3/1937
Picea	–	2 (1)
Pinus	11 (4.8)	90 (44.1)
Betula	2 (0.9)	11 (5.4)
Alnus	3 (1.3)	1 (0.5)
Tilia	–	1 (0.5)
Populus	4 (1.7)	3 (1.5)
Salix	3 (1.3)	–
Juniperus	146 (63.8)	82 (40.2)
Cyperaceae	–	1 (0.5)
Poaceae	47 (20.5)	2 (1)
Filipendula	–	1 (0.5)
Asteraceae	4 (1.7)	1 (0.5)
Chenopodiaceae	1 (0.4)	–
Cichoriaceae	–	3 (1.5)
Cerealia	–	6 (2.9)
Rumex	3 (1.3)	–
Urtica	4 (1.7)	–
Plantago	1 (0.4)	–
Lycopodium	–	35 (1.7)
Polypodiceae	2 (0.9)	3 (1.2)
Pteridium	–	7 (2.7)
Sphagnum	–	7 (2.7)
Total	231	256

Note: The number of counted pollen grains and spores are shown in the table, with the percentage of the total pollen count in the brackets.

Pollen and Spores

The sample from grave 3/1937 included 204 pollen grains and 52 spores (Table 2, Figure 3). Trees were present in 52.9%, shrubs (*Juniperus*) in 40.2%, herb pollen in 3.9%, cultivated in 2.9% and spores in 20.3%. The most abundant pollen was *Pinus* (present in 44.1%), *Juniperus* (40.2%) and *Lycopodium* (13.7%). Of herbs and grasses, the most abundant pollen types were Cichoriaceae (1.5%) and Poaceae (1%).

The sample from grave 2/1936 included 229 pollen grains and 2 spores (Table 2). The three most common taxa were *Juniperus*, Poaceae and *Pinus*, which together covered 89% of the found pollen grains. The most common species was *Juniperus* (present in 63.8%), while grasses covered 20.5% and *Pinus* 4.8%.

Microfauna

No remains of intestinal parasites were detected in the samples. However, the shells of 13 testate amoebae (Protozoa: Rhizopoda) were detected in the sample from grave 2/1936 (Figure 4). They were identified as the genus *Euglypha*, which inhabit peatlands dominated by *Sphagnum* moss. The identification was based on the Microworld online database (Siemensma 2020 https://www.arcella.nl) and verified by Minna Väliranta, Environmental Change Research Unit (ECRU), University of Helsinki.

Discussion

When discussing the findings and their possible meanings, we must keep in mind that the initial opening of the graves in the 1930s at Toppolanmäki could have contaminated the features with modern pollen material. However, several factors suggest that the findings originate from the initial burial contexts, not from contamination. These include the following observations: grave 3/1937 was partially undisturbed, the plant remains in the graves did not contain a large number of species that grow nearby today, and the graves contained only a minimal amount of uncharred macrofossil remains, which, in our opinion, should have been larger if indeed modern contamination. Also, the original excavation of grave 2/1936 occurred in late autumn, at a time when there is no or very little pollen in the air. Therefore, it is unlikely that recent pollen material would have gotten into the graves. The Toppolanmäki site is located on a dry, sandy hill. The modern vegetation at the site consists of a heath forest with mainly pine trees, rowans, bilberries and other dwarf shrubs. The site is located only 200 m from Lake Vanajavesi, but there is no direct view of the lake because vegetation blocks the line of sight. The photographs taken in the 1930s indicate that the vegetation was very similar at the time of the first excavation to what it currently is (Figure 5). Therefore, contamination from the time of the excavation should have included the same plants that are growing nearby today. Also, the excavation of 1937 never completely revealed the skeleton in the grave 3/1937. The bottom of the grave was undisturbed and still contained dark soil coloured by the decomposition fluids. Although there was some evidence of rodents and earthworms burrowing in the grave, the macrofossil analysis did not reveal an extensive amount of modern, unburnt plant material. Grave 2/1936 was more disturbed, but one of the femurs had been filled with dark soil that likely represents the original material in the grave.

None of the three macrofossil samples taken from the grave 3/1937 contained clear evidence of plants that could have been used in the funerary ritual or represent the food consumed by the buried individual. Some of the observed plant remains could originate from local vegetation transported to the grave by earthworms or rodents. Charred plant remains of bearberry and conifers might not relate to the inhumation burial ritual, in which no fire appears to have been used. These remains might instead originate from earlier fires. The most exciting evidence of plant use in the graves was obtained from the pollen and the microfauna analyses. A total of 256 pollen and spores were identified from grave 3/1937, most of which belonged to pine, juniper and clubmoss (Lycopodium annotinum). From grave 2/1936, a total of 231 pollen and spores were identified. Most of these belonged to juniper, grasses (Poaceae) and pine.

The plant remains that can most likely be linked with burial rituals are the mosses. They are clearly species that do not belong to the natural vegetation of the site. Clubmoss and *Sphagnum* grow near the ground surface, and their spores do not spread with the wind. Therefore, it is unlikely that the spores of these plants were transported to the gravesite by the wind, thus supporting the view that no modern contamination is involved.

It is possible that moss was used as soft padding under the corpse in the grave 3/1937. Although moss spores were not identified from the grave 2/1936, indirect evidence of the presence of moss in the grave was acquired. The sample included the remains of testate amoebae (Euglypha spp.). Testate amoebae are microscopic protozoa consisting of numerous taxa, each inhabiting a specific ecological niche. Testate amoebae live inside a protective shell made, for example, of silica or calcium, depending on the species. Thus, their fossil shells can be preserved for thousands of years in peat and sediments. For these reasons, testate amoebae analysis is considered a powerful tool for ecologists to reconstruct past environments (Charman et al. 2007; Mitchell, Charman, and Warner 2008; Väliranta et al. 2012).

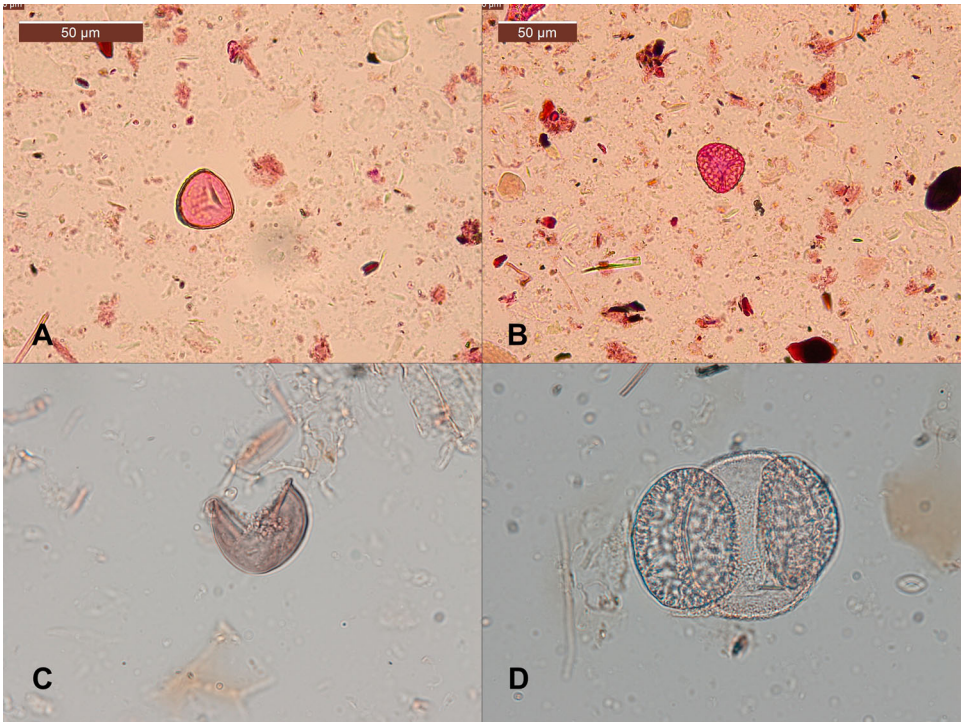

Figure 3. Pollen and spores identified in the samples. (A) *Sphagnum* spore from grave 3/1937. (B) *Lycopodium* spore from grave 3/1937. (C) Juniper pollen from grave 2/1936. (D) Pine pollen from grave 2/1936.

The 13 testate amoebae shells recovered in this study from grave 2/1936 belonged to the genus *Euglypha*, which dwells in *Sphagnum* moss peatlands. This suggests that the amoebae originate from a significantly different environment than the studied site. The best explanation for the presence of *Euglypha* in the graves at a dry and sandy cemetery is that people collected moss and used it for softening the coffins and the grave pits. Over time, the organic matter has decayed, but the durable silica shells of the amoebae within the moss have resisted destruction.

Interestingly, grave 2/1936 included a coffin, but grave 3/1936 was made in an earth pit without a coffin. In the previous case, the moss would likely have been placed inside the coffin, while in grave 3/1936 the padding would have been placed directly in the earth pit. Clubmoss has been used as a carpet weave in the Nordic countries in the later centuries (Hedlund 1951, 28), so it is also possible that the corpse was placed in the grave on a woven carpet or mattress which was softened with *Sphagnum* moss.

Moss spores and visible moss remains have previously been identified from several Late Iron Age and medieval graves in Finland (e.g. Asplund and Riikonen 2007; Kirkinen 2015, 108; Lempiäinen-Avci 2018; Tranberg 2015), and the usage of mosses extends to the historical period (Lempiäinen-Avci 2019, 28; Lempiäinen-Avci et al. 2017, 138; Tranberg 2015). Mosses have also been placed in graves in medieval England (Gilchrist 1999, 69; 2008, 137), and in addition to practical uses, they may have had specific meanings. With mosses, it is possible to create a soft surface where the individual has a comfortable place to rest. In the early medieval period, the corpses were often dressed in warm clothes, woollen socks and mittens, and covered with blankets or furs even

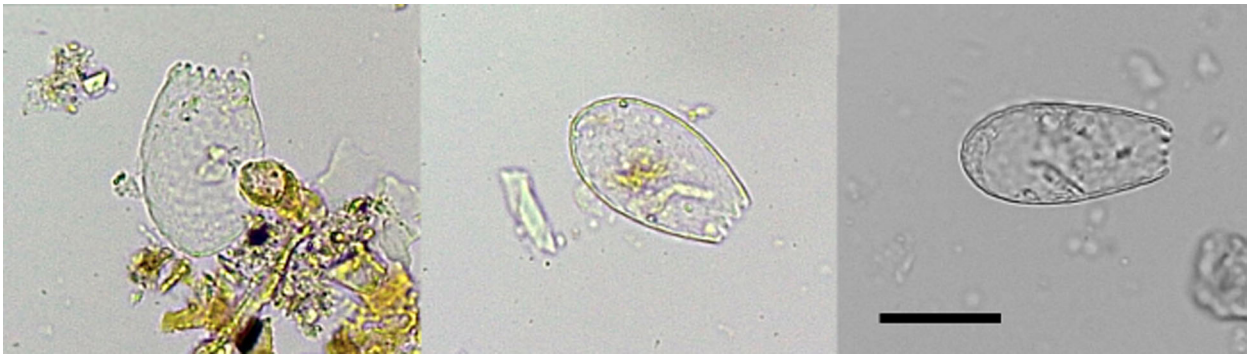

Figure 4. *Euglypha* spp. shells in sample 2/1936. Scale bar 25 µm.

Figure 5. The photo taken at the excavation in 1936 shows that the environment consisted of pine trees. Vanajavesi lake is located behind the forest and the excavation crew. Photo: Jorma Leppäaho.

if the burial happened in the summer months (e.g. Karisto et al. 2020; Kirkinen 2015; Lehtosalo-Hilander 2000; Riikonen 1990). Making the grave a warm and soft environment could thus reflect emotions, care and affection. Mosses may also have had a medicinal purpose. For example, clubmoss has been used to cure long-term diseases and wounds in historical folk medicine (Piippo 2018). According to the osteological analysis, the individual in grave 3/1937 may have suffered from chronic meningitis for weeks before his death (Salo 2017). This could promote the idea that plants that were considered to have healing properties were deliberately chosen for the grave (c.f. Karg et al. 2014).

Both sampled graves also included juniper pollen. Although some of it could be considered modern contamination, it should be noted that junipers do not grow in the vicinity of the site today. Apart from juniper and pine, only a few traces of wind-pollinated plants (spruce, birch and alder) were detected. This could indicate that the samples are uncontaminated, and the detected juniper pollen reflects the original pollen material from the time of the burial. Pollen diagrams from the nearby Sääksmäki area suggest that oat (Avena) and hop (Humulus) appear in the pollen record in the region from the thirteenth century onwards (Tolonen 1979). These plants are completely missing from the Toppolanmäki samples.

The amount of juniper pollen in grave 2/1936 was significantly higher than in grave 3/1937. Although juniper is a common species growing in meadows and grasslands in southern Finland, the proportion of juniper pollen is usually lower in analysed samples (Alenius, Mikkola, and Ojala 2008; Alenius et al. 2014; Sarmaja-Korjonen 2003). Therefore, the high amount of pollen in the grave 2/1936 could indicate that juniper branches were placed in it. It is equally possible that the surrounding environment was characterised by dry meadows and juniper bushes at the time of the burial, especially since grasses were also abundant in the samples. This is also supported by previous environmental pollen studies in the region (Tolonen 1978, 1979). It could even be speculated that the burial took place in early summer since the largest amount of juniper is usually in the air at the turn of May and June (Jantunen and Saarinen 2017, 24). It should be noted that the grave was initially excavated late in autumn, which makes it unlikely to have been contaminated by large amounts of juniper pollen during the excavation. The interpretations presented here do not have to exclude each other. It is possible that the early medieval environment was more open than today, juniper branches were deliberately placed in the graves, and that the burial 2/1936 took place in early summer.

The fragrant juniper has also been used as a spice and herb, in addition to which it may have had symbolic meanings. Juniper has a long history of use in the Iron Age funerary rituals. Charred juniper seeds and needles are relatively common finds in both Finnish and Swedish cremation burials in the Iron Age (Lempiäinen 2008; Hansson 2005). There are also several juniper finds from the nearby region. Interesting comparisons can be made with the early medieval cremation cemetery of Haukila, Valkeakoski, which is contemporaneous to Toppolanmäki and is located

ca. 10 km away (Figure 1). The soil samples from Haukila have revealed remains of charred juniper branches and seeds (Moilanen 2018a; Vanhanen 2017). Juniper branches could have been used simply as fuel on the funeral pyre, but it has also been suggested that the plant had symbolic properties establishing connections between the worlds of the living and the dead (Montgomery 2017, 16). The usage of juniper in early medieval inhumation burials could, therefore, indicate ritual continuation from previous periods and tell about persisting beliefs of magical properties of certain plants. These plants could have been placed in inhumation burials even after cremation had been abandoned.

Juniper also has a strong fragrance, and these kinds of plants were often believed to dispel diseases (e.g. Kallio-Seppä and Tranberg 2021; Tranberg 2015, 2018, 54), and they were used until the Early Modern Period. Juniper, together with a wide array of fragrant plants, was also added in the seventeenth century grave of Bishop Peder Windstrup in southern Sweden (Lagerås 2016). It would be interesting to associate the simultaneous burial of three individuals at Toppolanmäki grave 2/1936 with a possibly contagious disease (c.f., Moilanen 2021, 68) and the use of juniper with beliefs of its medicinal properties. However, this interpretation should be supported by molecular studies and the identification of pathogens from human bones.

It may also be worth noting that most of the detected plants in the Toppolanmäki graves were evergreen. We can assume that the choice of plants and possibly even the plant colours meant something to the individuals responsible for the burial. Seeing and understanding colour is a cultural and social phenomenon, and colour symbolism may have changed over time (e.g. Owoc 2002, 128; Pastoreau 2014, 46). However, nature wakes up with new sprouts and young leaves every spring. This has led to the green colour often being considered a universal symbol of new growth, regeneration and life (e.g. Becker 2000, 133; Pastoreau 2014, 23). In Christian contexts, evergreen plants may symbolise resurrection (Gilchrist and Sloane 2005, 124). Although it is impossible to know if these beliefs were present in early medieval Finland, it could be speculated that the common use of green plants in graves could be associated with preparing the deceased for a journey in a new life: the afterlife. Together with the evidence of furnishing the graves with soft and warm contents, this ties the usage of certain plants to the demonstration of care and compassion in the funerary rituals.

Conclusions

According to our study, soft mosses and fragrant juniper were placed in early medieval inhumation graves at Toppolanmäki, Finland. It seems that soft plants were used in both coffins and earth pits at the site. In the latter case, it is even possible that there was a woven carpet or mattress present in the grave (3/1937). We also identified indirect evidence of the presence of moss in a disturbed grave 2/1936. The grave included testate amoebae *Euglypha* spp., which thrives in habitats dominated by peat moss. This is the first time that moss-indicating microfauna have been reported from a grave, and the result suggests that the *Euglypha* shell could possibly be used as a new biological indicator of the use of moss at archaeological grave sites. We also suggest that the use of juniper in inhumation burials could indicate the continuation of beliefs concerning the ritual and magical properties of certain plants. The large amount of juniper and Poaceae pollen in grave 2/1936 could also indicate that the early medieval environment around Toppolanmäki was characterised by dry meadows and juniper bushes, and that the burial took place in early summer.

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References

Alenius, T., G. Haggrén, M. Oinonen, A. Ojala, and R.-L. Pitkänen. 2014. "The History of Settlement on the Coastal Mainland in Southern Finland. Palaeoecological, Archaeological, and Etymological Evidence from Lohjansaari Island, Western Uusimaa, Finland." *Journal of Archaeological Science* 47: 99–112.

Alenius, T., E. Mikkola, and A. Ojala. 2008. "History of Agriculture in Mikkeli Orijärvi, Eastern Finland as Reflected by Palynological and Archaeological Data." *Vegetation History and Archaeobotany* 17: 171–183.

Asplund, H., and J. Riikonen. 2007. "Kirkkomäki [The Kirkkomäki Site]." *Turun Maakuntamuseon Raportteja* 20: 9–44.

Becker, U. 2000. *The Continuum Encyclopedia of Symbols*. New York: Continuum.

Berglund, B., and J. Rosvold. 2021. "Microscopic identification of feathers from 7th century boat burials at Valsgärde in Central Sweden: Specialized long-distance feather trade or local bird use?" *Journal of Archaeological Science: Reports* 36 (2/2011):102828. doi:10.1016/j.jasrep.2021.102828.

Beug, H.-J. 2004. *Leitfaden der Pollenbestimmung fur Mitteleuropa und angrenzende*. 506 Gebiete Pfeil, Munchen.

Bouchet, F., N. Guidon, K. Dittmar, S. Harter, L. F. Ferreira, S. M. Chaves, K. Reinhard, and A. Araújo. 2003. "Parasite Remains in Archaeological Sites." *Memorias do Instituto Oswaldo Cruz* 98 (Suppl. 1): 47–52. doi:10.1590/s0074-02762003000900009.

Cappers, R. T. J., R. M. Bekker, and J. E. A. Jans. 2006. *Digitale Zadenatlas van Nederland*. Groningen: Barkhuis Publishing & Groningen University Library.

Charman, D. J., A. Blundell, and Accrotelm Members. 2007. "A New European Testate Amoebae Transfer Function for Palaeohydrological Reconstruction on Ombrotrophic Peatlands." *Journal of Quaternary Science* 22: 209–221. doi:10.1002/jqs.1026.

Cleve, N. 1948. "Spår av Tidigt Kristendom i Västra Finland [Traces of Early Christianity in Western Finland]." *Finskt Museum* 1947–1948: 67–85.

Dimbleby, G. W. 1957. "Pollen Analysis of Terrestrial Soils." *The New Phytologist* 56: 12–28.

Dittmar, K., and W. R. Teegen. 2003. The Presence of Fasciola Hepatica (Liver-Fluke) in *Humans and Cattle from a 4,500 Year Old Archaeological Site in the Saale-Unstrut Valley*, Germany, Vol. 98. Memorias do Instituto Oswaldo Cruz, Rio de Janeiro: 141–143. Suppl. I. https://doi.org/10.1590/s0074-02762003000900021.

Erä-Esko, A. 1952. *Ella Kivikosken kaivaus Valkeakosken Toppolanmäessä v. 1951 [The excavation at Valkeakoski Toppolanmäki by Ella Kivikoski]*. Excavation report. The Archives of Finnish Heritage Agency.

Fægri, K., and J. Iversen. 1989. *Textbook of Pollen Analysis*. 4th ed. by K. Faegri, P. O. E. Kaland, and K. Krzywinski. Chichester: John Wiley & Sons.

Fugassa, M. H., N. H. Sardella, V. Taglioretti, K. J. Reinhard, and A. Araújo. 2008. "Eimeriid Oocysts from Archeological Samples in Patagonia, Argentina." *Journal of Parasitology* 94 (6): 1418–1420. doi:10.1645/GE-1537.1.

Gilchrist, R. 1999. *Gender and Archaeology. Contesting the Past*. London: Routledge.

Gilchrist, R. 2008. "Magic for the Dead? The Archaeology of Magic in Later Medieval Burials." *Medieval Archaeology* 52: 119159.

Gilchrist, R., and B. Sloane. 2005. *Requiem. The Medieval Monastic Cemetery in Britain*. London: Museum of London Archaeology Service.

Goody, J. 1994. *The Culture of Flowers*. Cambridge: Cambridge University Press.

Grimm, E. C. 1991. *TILIA and TILIA-GRaPH*. Springfield: Illinois State Museum.

Hald, M. M., J. Mosekilde, B. Magnussen, M. J. Søe, C. H. Hansen, and M. F. Mortensen. 2018. "Tales from the Barrels: Results from a Multi-Proxy Analysis of a Latrine from Renaissance Copenhagen, Denmark." *Journal of Archaeological Science: Reports* 20: 602–610. doi:10.1016/j.jasrep.2018.06.006.

Hansson, A.-M. 2005. "Buried Plants. Fossil Plant Remains from two Early Medieval Burial Mounds in East-Central Sweden." *Journal of Nordic Archaeological Science* 15: 39–56.

Hansson, A.-M., and L. Bergström. 2002. "Archaeobotany in Prehistoric Graves – Concepts and Methods." *Journal of Nordic Archaeological Science* 13: 43–58.

Havinga, A. J. 1967. "Palynology and Pollen Preservation." *Review of Palaeobotany and Palynology* 2: 81–98.

Hämet-Ahti, L., J. Suominen, T. Ulvinen, and P. Uotila, eds. 1998. *Retkeilykasvio [Field Flora of Finland]*. Helsinki: Finnish Museum of Natural History, Botanical Museum.

Hedlund, G. 1951. *Dräkt och kvinnlig slöjd i Ovansjö socken 1750-1850*. Storvik: Ovansjö hembygdsförenings förlag.

Jäkärä, T. 1998. "Tutkimuskohteena hautarakenteet – esimerkkinä kaksi varsinaissuomalaista ruumiskalmistoa." *Muinaistutkija* 2/1998: 2–5.

Jantunen, J., and K. Saarinen. 2017. *Siitepölyä ilmassa! Allergiaa aiheuttavat siitepölyt Suomessa 1980–2015 [Pollen in the Air! Allergenic Pollen in Finland 1980–2015]*. Imatra: Etelä-Karjalan Allergia- ja Ympäristöinstituutti.

Juhola, T., A. G. Henry, T. Kirkinen, J. Laakkonen, and M. Väliranta. 2019. "Phytoliths, Parasites, Fibers, and Feathers from Dental Calculus and Sediment from Iron Age Luistari Cemetery, Finland." *Quaternary Science Reviews* 222: 105888. doi:10.1016/j.quascirev.2019.105888.

Kallio-Seppä, T., and A. Tranberg. 2021. "The Materiality of Odors: Experiencing Church Burials and the Urban Environment in Early Modern Northern Sweden." *Historical Archaeology* 55: 65–81.

Karg, S., U. Hansen Lund, A. M. Walldén, J. Glastrup, H. Pedersen, and F. O. Sonne Nielsen. 2014. "Vegetal Grave Goods in a Female Burial on Bornholm (Denmark) from the Late Roman Iron Age Period Interpreted in a Comparative European Perspective." *Danish Journal of Archaeology* 3 (1): 52–60.

Karisto, M., H. Kirjavainen, J. Riikonen, and J. Ruohonen. 2020. *Ravattula Costume. The Study of the Grave Find*. Turku: Suomen muinaistutkimuksen tuki ry.

Kirkinen, T. 2015. "The Role of Wild Animals in Death Rituals: Furs and Animal Skins in the Late Iron Age Inhumation Burials in Southeastern Fennoscandia." *Fennoscandia archaeologica* XXXII: 101–120.

Kirkinen, T., J. Riikonen, C. Dove, and J. Ruohonen. 2020. "The Identification and Use of Fur and Feathers Excavated from the Late Iron age and Early Medieval (12th-13th centuries) Ravattula Ristimäki Cemetery in Kaarina, Southwest Finland." *Fennoscandia Archaeologica* XXXVII: 45–59.

Kivikoski, E. 1955. "Suomen varhaisin kristillisyys muinaistieteellisen aineiston valossa [The Earliest Christianity in Finland Based on Archaeological Material]." In *Novella Plantatio*, edited by A. Maliniemi, M. Juva, and K. Pirinen, 21–41. Suomen kirkkohistoriallisen Seuran toimituksia 56, Helsinki: Suomen kirkkohistoriallinen seura.

Lagerås, P. 2016. "Från trädgård till grav: växterna i biskop Peder Winstrups kista." *Ale* 2016 (4): 15–28.

Lehtosalo-Hilander, P.-L. 2000. *Fishermen, Farmers, Warriors and Traders. The Excavated Past of Eura*. Vammala: Vammalan kirjapaino.

Lempiäinen, T. 2002. "Plant Macrofossils from Graves and Churches: The Archaeobotany of Graves from the Late Iron Age and the Middle Ages and of Medieval Churches in Finland and the Karelian Isthmus (Russia)." In *Nordic Archaeobotany – NAG 2000 in Umeå*, edited by K. Viklund, 161–172. Archaeology and Environment 15. Umeå.: Univesity of Umeå.

Lempiäinen, M. 2008. "Vadelmia ja kalaa viimeisellä aterialla. Hautojen arkeobotaaninen tutkimus myöhäisrautakaudelta uudelle ajalle [Raspberries and Fish for the Last Supper. Archaeobotanical Research on Graves from the Late Iron Age to the Post-Medieval Period]." Masters Thesis, Archaeology, University of Turku.

Lempiäinen, T. 2009. "Havaintoja kasvien jäännöksistä haudoista ja kirkkomailta [Notes on Plant Remains from Graves and Cemeteries]." In *Maasta, kivestä ja hengestä. Markus Hiekkanen Festschrift*, edited by H.-M. Pellinen, 126–136. Saarijärvi: Turun yliopisto, Helsingin yliopisto, Suomen kirkkohistoriallinen seura, Suomen keskiajan arkeologian seura.

Lempiäinen-Avci, M. 2018. "Tietolaatikko 8: Koroisten vainajien viimeinen leposija mäntyarkussa." In *Koroinen - Suomen ensimmäinen kirkollinen keskus*, edited by J. Harjula, S. Hukantaival, V. Immonen, T. Ratilainen, and K. Salonen, pp. 155. Turun Historiallinen Arkisto 71. Turun Historiallinen Yhdistys, Turku.

Lempiäinen-Avci, M. 2019. *Plant Remains in Archaeology: A Multidisciplinary Approach to Cultivation, Consumption, Trade and Migration of Economic Plants in Southern Finland AD 1000–1900*. Annales Universitatis Turkuensis, Ser A II OSA, Tom 351 I Biologica - Geographica - Geologica. University of Turku, Turku.

Lempiäinen-Avci, M., V. Laakso, and T. Alenius. 2017. "Archaeobotanical Remains from Inhumation Graves in Finland, with Special Emphasis on a 16th Century Grave at Kappelinmäki, Lappeenranta." *Journal of Archaeological Science: Reports* 13: 132–141.

Leppäaho, J. 1938. *Sääksmäki Ritvala Toppolanmäki. Kalmiston kaivaus 1936 [Sääksmäki Ritvala Toppolanmäki. Excavation of a Cemetery in 1936]*. Excavation Report. The Archives of Finnish Heritage Agency.

Lipkin, S., E. Ruhl, K. Vajanto, A. Tranberg, and J. Suomela. 2021. "Decay and Preservation in Seventeenth- to Nineteenth-Century Burials in Finland." *Historical Archaeology* 55: 49–64.

Miller, N. F. 1995. "Archaeobotany: Macroremains." *American Journal of Archaeology* 99 (1): 91–93.

Mitchell, E. A. D., D. J. Charman, and B. G. Warner. 2008. "Testate Amoebae Analysis in Ecological and Paleoecological Studies of Wetlands: Past, Present and Future." *Biodiversity and Conservation* 17 (9): 2115–2137.

Moilanen, U. 2018a. *Valkeakoski Haukila Koirankivi Tutkimuskaivaus rautakautisella kalmistolla 12.-22.6.2017 [Valkeakoski Haukila Koirankivi. Research Excavation at an Iron Age Cemetery 12.-22.6.2017]*. Excavation Report. Pirkanmaa Provincial Museum.

Moilanen, U. 2018b. *Valkeakoski, Toppolanmäki. Haudan nro 3/1937 tutkimuskaivaus 17.–18.6.2017 [Valkeakoski, Toppolanmäki. Excavation of Grave 3/1937]*. Excavation Report. Finnish Heritage Agency.

Moilanen, U. 2019. *Valkeakoski, Toppolanmäki. Haudan nro 2/1936 tutkimuskaivaus 13.–14.6.2018 [Valkeakoski, Toppolanmäki. Excavation of Grave 2/1936]*. Excavation Report, Finnish Heritage Agency.

Moilanen, U. 2021. *Variations in Inhumation Burial Customs in Southern Finland (AD 900-1400): Case Studies from Häme and Upper Satakunta. Annales Universitatis Turkuensis, Humaniora B Tom. 555*. Turku: University of Turku.

Montgomery, J. E. 2017. "Ibn Faḍlān and the Rūsiyyah." *Journal of Arabic and Islamic Studies* 3: 1–25. doi:10.5617/jais.4553.

Owoc, M. A. 2002. "Munselling the Mound: The Use of Soil Colour as Metaphor in British Bronze Age Funerary Ritual." In *Colouring the Past. The Significance of Colour in Archaeological Research*, edited by A. Jones, and G. MacGregor, 127–140. Oxford: Berg.

Pastoreau, M. 2014. *Green: The History of a Color*. Princeton, NJ: Princeton University Press.

Pälsi, S. 1937. *Sääksmäki, Ritvala, Hakala, Toppolanmäen kalmisto [Sääksmäki, Ritvala, Hakala, Toppolanmäki cemetery]*. Excavation Report. The Archives of Finnish Heritage Agency.

Piippo, S. 2018. *Suomen luonnon lääkekasvit [Herbs in Finnish Nature]*. Helsinki: Tammi.

Reille, M. 1992. *Pollen et spores d'Europe et d'Afrique du nord*. Marseille: Laboratoire de Botanique Historique et Palynologie.

Reille, M. 1998. *Pollen et spores d'Europe et d'Afrique du nord, Supplémant 2*. Marseille: Laboratoire de Botanique Historique et Palynologie.

Riikonen, J. 1990. *Naisenhauta Kaarinan Kirkkomäessä [Female Grave at Kaarina Kirkkomäki]*. Karhunhammas 12. Turku: Turun yliopisto.

Salo, K. 2017. *Osteological Analysis Valkeakoski Toppolanmäki KM 10461, 10581, 41248. SUGRIGE Project*. Unpublished osteological analysis report. Finnish Heritage Agency.

Sarmaja-Korjonen, K. 2003. "Contemporaneous Alnus Decline and the Beginning of Iron Age Cultivation in Pollen Stratigraphies from Southern Finland." *Vegetation History and Archaeobotany* 12: 49–59.

Siemensma, F. J. 2020. *Microworld, World of Amoeboid Organisms*. Kortenhoef: World-wide electronic publication. https://www.arcella.nl

Sulas, F., M. Schifter Bagge, R. Enevold, L. Harrault, S. Munch Kristiansen, T. Ljungberg, K. B. Milek, et al. 2022. "Revealing the Invisible Dead: Integrated bio-Geoarchaeological Profiling Exposes Human and Animal Remains in a Seemingly 'Empty' Viking-Age Burial." *Journal of Archaeological Science* 141: 105589. doi:10.1016/j.jas.2022.105589.

Taavitsainen, J.-P. 1997. "Suomen esihistorialliset palamattomat luuaineistot." In *Vanhojen luiden kertomaa*, edited by H. S. Vuorinen and U. Vala, 52–61. Helsinki: Helsinki University Press.

Tolonen, M. 1978. "The History of Agriculture in Sääksmäki Traced by Pollen Analysis." *Annales Botanici Fennici* 15 (1): 47–54.

Tolonen, M. 1979. "On the Prehistoric Agriculture in Sääksmäki." *S. Finland. Finskt Museum* 1979: 67–84.

Tranberg, A. 2015. "Burial Customs in Northern Ostrobothnian Region (Finland) from Late Medieval Period to 20th Century – Plants Inside the Graves." In *The Archaeology of Death in Post-Medieval Europe*, edited by S. Tarlow, 189–203. Warsaw/Berlin: DeGruyter Open Ltd.

Twiddle, C. L., and M. J. Bunting. 2010. "Experimental Investigations Into the Preservation of Pollen Grains: A Pilot Study of Four Pollen Types." *Review of Palaeobotany and Palynology* 162: 621–630.

Vajanto, K. 2016. *Dyes and Dyeing Methods in Late Iron Age Finland*. Helsinki: University of Helsinki.

Vanhanen, S. 2017. "Kasvimakrofossiilitutkimus Valkeakoski Haukila 2017 [Macrofossil Analysis, Valkeakoski Haukila 2017]." Unpublished analysis report, Finnish Heritage Agency.

Vanhanen, S. 2019. *Prehistoric Cultivation and Plant Gathering in Finland. An Archaeobotanical Study*. Helsinki: University of Helsinki.

Väliranta, M., A. Blundell, D. J. Charman, E. Karofeld, A. Korhola, Ü Sillasoo, and E.-S. Tuittila. 2012. "Reconstructing Peatland Water Tables Using Transfer Functions for Plant Macrofossils and Testate Amoebae: A Methodological Comparison." *Quaternary International* 268: 34–43. doi:10.1016/j.quaint.2011.05.024.