VERTAISARVIOITU
KOLLEGIALT GRANSKAD
PEER-REVIEWED
www.tsv.fi/tunnus

7

Yersinia pestis, the demise of the giant's church culture and disappearance of Asbestos Ware in Late Neolithic Finland

Jarkko Saipio

Abstract

The Late Neolithic (ca. 2900–2300 BC) featured three distinct archaeological zones in southern and central Finland: The Corded Ware Culture, the Giant's Church Culture and the Finnish Lake District. There were obvious cultural boundaries, but also multi-faceted interaction between these zones. Around 2500 BC indications of sharp population decline and erosion of the prevailing social organisation appeared across these zones. This article suggests that this crisis may have been related to a *Yersinia pestis* epidemic of which there are contemporary indications in the Eastern Baltic region. The *Yersinia pestis* strain encountered in the Eastern Baltic had excellent possibilities to spread in central and southern Finland, assuming that it was highly virulent.

Keywords: *Yersinia pestis*, population decline, Asbestos Ware, Corded Ware.

7.1 Introduction

The period of 2500–2300 BC appears as an important turning point in the archeological record of southern and central Finland. It seems appropriate to talk about a transition from the Late Neolithic (ca. 2900–2300 BC) to the Final Neolithic, ca. 2300–1800 BC (Hakonen 2021; Nordqvist & Mökkönen 2017; Pesonen 2021). Forms of this phenomenon differ in different regions, but the general trend is a sharp decrease in archaeological signals, accompanied by apparent changes in the social organisation (e.g. Lavento 2001; Tallavaara & Pesonen 2020; Tallavaara et al. 2010).

The change between the Late and Final Neolithic is especially conspicuous in three regions: The Finnish Lake District; the Bothnian Bay area and SW Finland. Intriguingly, the societies touched by this phenomenon were not very similar to each other. In the Lake District, the emblematic sites of the period were settlements with one or two large house pits containing burnt bones dominated by freshwater fish (Mökkönen 2011). The Bothnian Bay area featured clusters of large village-like settlements that subsisted on seal and salmon and practiced monumental building (e.g. Okkonen 2003; Hakonen 2021). In SW Finland, the archaeological record is dominated by the pan-European phenomenon of Corded Ware Culture, with evidence of animal husbandry (e.g. Nordqvist 2016).

This article suggests that all of these societies confronted an invisible enemy against which they were quite helpless: A contagious deadly disease. To justify such a hypothesis, it is necessary to provide an overview of the birth and demise of these societies.

7.2 Formation of two Asbestos Ware cultures

The early part of the Middle Neolithic in southern and central Finland was defined by the relatively uniform Typical Comb Ware Culture (ca. 3900–3500 BC), connected with indications of population increase, semi-sedentary or sedentary settlement pattern, and long-distance exchange networks over wide areas in Russia and the Eastern Baltic (e.g. Halinen 2015; Pesonen 2021: 90–91). Aquatic resources were the backbone of subsistence (e.g. Halinen 2015; Mökkönen 2011). The period coincides with the Holocene thermal maximum and general abundance of terrestrial and aquatic food resources in southern and central Finland (e.g. Pesonen 2021: 91; Tallavaara & Seppä 2012).

The relatively short TCW period was followed by rapid regionalisation. In SW Finland and the Finnish southern coast, TCW was succeeded by Late Comb Ware ca. 3550–3200 BC and Pyheensilta Ware, ca. 3400–2700 BC(?) (Pesonen 2021: 92–93). In other parts of southern and central Finland, as well as in Russian Karelia and the southern Kola Peninsula, the rest of the Neolithic period was defined by asbestos-tempered ceramics (e.g. Nordqvist 2018: 104–111). In Finland, the dominant ceramic styles of the period were Kierikki Ware (ca. 3600–3100 BC) and Pöljä Ware (ca. 3400–2500 BC).

In the Lake District and most of coastal Finland, archaeological signals weakened after the TCW peak but remained strong compared to the situation at the end of the Neolithic (Tallavaara & Pesonen 2020; Tallavaara & Seppä 2012; Tallavaara et al. 2010). Village-like settlements were succeeded by fewer but larger house pits in the Lake District and the southeastern coast, indicating continuation of semi-sedentary or sedentary settlement pattern in smaller communities (Mökkönen 2011: 55–65; Nordqvist 2018: 99, 103–104). In SW Finland, the Late Middle Neolithic (ca. 3500–2900 BC) interlude between the TCW period and the Corded Ware period is badly known but marine subsistence pattern apparently continued (e.g. Halinen 2015; Pesonen 2021: 92–93).

In the Bothnian Bay, the post-TCW development was very different. There is strong evidence of increasing social complexity and increasing stratification, built on intensive utilisation of marine resources, including organised seal train oil production (e.g. Hakonen 2021; Núñez & Okkonen 2005; Okkonen 2003). Village-like settlements became much larger than they were during the TCW period (e.g. Hakonen 2021; Núñez & Okkonen 2005; Okkonen 2003). There were also monumental buildings in the form of cairns and enigmatic massive stone enclosures, called "Giant's Churches" (e.g. Hakonen 2021; Núñez & Okkonen 2005; Okkonen 2003). These enclosures are up to 40 x 70 m in size, with 2–3 m wide, low walls (Hakonen 2021: 85). It is unclear why these structures were built but their monumentality suggests enhanced need for ideological control (e.g. Hakonen 2021: 106–107; Núñez & Okkonen 2005: 34–35). It seems appropriate to define the period 3500–2000 BC in the Bothnian Bay area as Giant's Church Culture, to distinguish it from the rest of the Asbestos Ware zone (Okkonen 2003: 219–228).

The late Middle and Late Neolithic Bothnian Bay area also became an important node in long-distance exchange networks, river connections to the White Sea region being of obvious importance (Nordqvist 2018: 111). Strikingly, the Lake Onega–White Sea zone and the Bothnian Bay area form two unparalleled clusters of late Middle and Late Neolithic amber objects in eastern Fennoscandia, despite the fact that the amber obviously originated from the southern shores of the Eastern Baltic (Nordqvist 2018: 111; Núñez & Franzen 2011). The rich cultural layers of Giant's Church Culture settlements also contained flint points of a Northwest Russian type, native copper from the north-

Figure 7.1. Late Neolithic in southern and central Finland and contemporary sites with evidence of *Yersinia pestis* in the Eastern Baltic region. Map J. Saipio.

western coast of Lake Onega and red slate daggers from northern Scandinavia (e.g. Nordqvist 2018: 111; Núñez & Okkonen 2005; Okkonen 2003). Organised defense of important river routes is indicated by a palisaded settlement on the Kierikkisaari Island in the River Ii-Joki and ring-shaped villages around River Siikajoki (Hakonen 2021:126–127; Koivunen 2002; Pesonen et al. 2020).

Obviously, a high demand for asbestos in the Giant's Church Culture likely required regular import from the Lake District. Anthrophyllitic asbestos apparently originating in the northeastern Lake District has been encountered in Kierikki and Pöljä Ware all over the distribution area of the said ceramic styles (Lavento & Hornytzkyj 1996). Interestingly, very few late Middle or Late Neolithic amber or flint objects have been found in the Lake District. Asbestos probably travelled through down-the-line exchange, in contrast to the distribution of amber.

7.3 The rise and fall of the Corded Ware Culture

The appearance of the Corded Ware phenomenon (ca. 2900–2200 BC) in SW Finland was likely related to a migration from the Eastern Baltic region (e.g. Halinen 2015: 60, 66–68). The Finnish Corded Ware zone also covered the southern coast, as well as the southern and western edges of the Lake District (Fig. 7.1).

Corded Ware Culture differed radically from the local Neolithic traditions in terms of its lithic and ceramic technology, burial customs and locations of dwelling sites (Halinen 2015: 100, 113–114; Nordqvist 2016; Nordqvist & Häkälä 2014). It brought with it the distinct pit inhumation tradition where axes and ceramic vessels were the typical grave goods. Dwelling sites were now often located by meadows suitable for pasturing (e.g. Halinen 2015: 114; Nordqvist & Häkälä 2014: 21).

According to analyses of grog temper in Corded Ware vessels from Finland, Sweden and Estonia, the Finnish Corded Ware Culture maintained close contacts to Swedish and the Eastern Baltic Corded Ware groups over the sea, possibly through exogamy (Holmqvist et al. 2018). Relations between the Finnish Corded Ware communities and surrounding hunter-gatherer cultures were probably defined by a mixture of hostilities and peaceful gatherings or even co-habitation at specific sites over

the centuries. Evidence of direct contacts between the Corded Ware population and Asbestos Ware populations are especially notable on the southern edge of the Bothnian Bay area. Corded Ware has been found together with Pöljä Ware also along the southern and southwestern edges of the Lake District. Furthermore, there is a sparse distribution of single finds of Corded Ware axes over most of the Lake District (Nordqvist & Häkälä 2014: 12–15).

The Finnish Corded Ware Culture apparently underwent profound change after 2400 BC. Emblematic Corded Ware pottery developed into Kiukainen Ware that may have incorporated elements of Comb Ware tradition or eastern Swedish Pitted Ware (ca. 3300–2300 BC) that has also been encountered in SW Finland (see Pesonen 2021: 30–38, 43). More or less concurrently with this techno-stylistic change in ceramics, dwelling sites of the Finnish Corded Ware zone became strongly marine-oriented again, great significance of sealing and fishing being confirmed by osteological material and artefact finds (e.g. Bläuer & Kantanen 2013; Edgren 1992: 108–111; Halinen 2015: 68, 114). Importantly, the emblematic Corded Ware burial tradition involving axes and beakers was also abandoned. Significance of these profound changes is enhanced by recent evidence that the Finnish Corded Ware Culture lingered for some time after the appearance of the Kiukainen Culture (Pesonen et al. 2019). It seems that the Corded Ware society did not experience a smooth transformation, but a conscious abandonment of its ideological bases.

7.4 Collapse and decline in the Asbestos Ware zone

More or less concurrently with the appearance of the Kiukainen Culture, the Giant's Church Culture took a sharp turn towards less archaeological visibility. According to shore displacement studies, large pit house villages disappeared around 2500 BC and the number of other shore-bound sites also decreased considerably (Pesonen et al. 2020: 11; Tallavaara & Pesonen 2020: 6). Complete lack of direct post-2500 BC AMS dates from Pöljä Ware (Pesonen 2021: 97) suggests that the asbestos network of southern and central Finland broke down around the same time. It also seems that little to no amber travelled to the Bothnian Bay area after this date (see Núñez & Franzen 2011: Fig. 7.2; Table 7.1).

In the Lake District, the archaeological signal in the period 2500–1800 BC is even lower in absolute terms (Lavento 2001: 143–144). Mika Lavento (2001: 183) suggests that parts of the region became totally deserted. These "dark centuries" were followed by an apparent influx of a new population from the east, represented by Textile Ware (ca. 1900/1800–500 BC) and Seima-Turbino bronzes (Lavento 2001). Textile Ware also spread to the Bothnian Bay area, where the declining Giant's Church tradition was abandoned for good (e.g. Okkonen 2003: 231–232).

These were not isolated developments. Sharp Final Neolithic weakening in archaeological signals, followed by the emergence of Bronze Age societies is also discernible in the Eastern Baltic and Russian Karelia regions (Lang 2018: 309; Lavento 2001; Nordqvist 2018: 121). Evidence of pop-

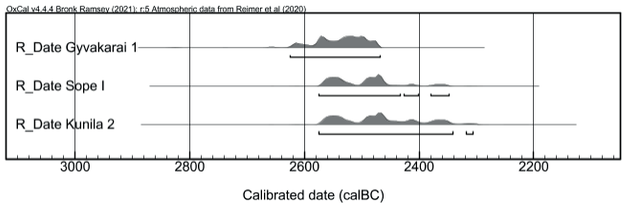

Figure 7.2. Multiple plot of AMS dates associated with *Yersinia pestis* in Corded Ware burials in the Eastern Baltic. Calibration with OxCal v. 4.4.4 (Bronk Ramsey 2009), atmospheric data (IntCal20) by Reimer et al. 2020).

ulation decline around 2500 BC has also been noted in different parts of southern Scandinavia, but in these areas it appears to have been followed by a revival within a few centuries (Nielsen et al. 2019). In contrast, the archaeological signal in the Lake District remained very weak in the period 2000–1500 BC and showed, on a regional level, a fairly slow strengthening after that (Lavento 2001; Tallavaara et al. 2010). In the Bothian Bay area, it remained a thin shadow throughout the Early Metal Period when compared to the Middle and Late Neolithic situation (Okkonen 2003: 231; Tallavaara & Pesonen 2020).

Notably, the situation was different in the Kainuu region, north of the Lake District. The region obviously became a new hotspot in long-distance exchange networks between Fennoscandia and different parts of Russia in the Textile Ware Period (Lavento 2001). Notable clusters of Textile Ware settlements are also known around specific lakes in the Lake District, despite complete lack of known Textile Ware sites around many major lakes rich in Neolithic settlements. This strongly suggests that the dramatic Final Neolithic weakening in the archaeological signal is related to a genuine population crash rather than just research biases and lowered archaeological visibility of material culture, as suggested by some archaeologists (see Hakonen 2021: 165–172; Mökkönen 2011: 63–65).

7.5 The invisible enemy?

The most popular archaeological theory about the reasons of the Final Neolithic crises is the impact of a gradually cooling climate on resource availability (e.g. Lavento 2001; Tallavaara & Pesonen 2020; Tallavaara & Seppä 2012; Tallavaara et al. 2010). This explanation is problematic in that it rests on the idea that Late Neolithic fisher-hunter-gatherers in southern and central Finland were very vulnerable to long-term temperature decline, unlike Bronze Age societies that practiced both cultivation and foraging in the same areas (Tallavaara & Pesonen 2020; Tallavaara & Seppä 2012). It is unconvincing that early underdeveloped agriculture would have been more resilient to climate change than foraging with millennia of cumulative experience (Hakonen 2021: 171). As a matter of fact, it is hard to see how the birth of the Kiukainen Culture would fit this idea. The idea also goes against the accumulating evidence of small-scale cultivation in different parts of southern and central

Site	Burial	Lab. code	BP	CalBC 68.3%	CalBC 95.4%	Context	References
Latvia, Rinnukalns	RV 2039	Kia-46462	5049±33	3944–3792	3956–3715	Narva	Lübke et al. 2016; Susat et al. 2021
Sweden, Frälsegården	Gökhem 2	Ua-20947	4425±40	3306–2931	3331–2918	Funnel Beaker	Rascovan et al. 2019
		UBA-14087	4368±27	3011–2921	3086–2907		
Sweden, Frälsegården	Gökhem 4	AAR-10235	4341±44	3011–2904	3092–2887	Funnel Beaker	Rascovan et al. 2019
Lithuania, Gyvakarai	Gyvakarai 1	Poz-61584	4030±30	2578–2477	2625–2469	Corded Ware	Andrades Valtueña et al. 2017
Estonia, Sope	Sope I	UBA-29064	3969±32	2567–2461	2575–2383	Corded Ware	Rasmussen et al. 2015; Varul et al. 2019
Estonia, Kunila	Kunila 2	Poz-10825	3960±40	2569–2352	2575–2307	Corded Ware	Andrades Valtueña et. al. 2017

Table 7.1. The AMS dates of Neolithic human remains with evidence of *Yersinia pestis* in northern Europe. Calibration with OxCal v. 4.4.4 (Bronk Ramsey 2009), atmospheric data (IntCal20) by Reimer et al. 2020).

Finland during the Late and Final Neolithic (e.g. Alenius et al. 2020; Mökkönen 2011; Vanhanen 2019).

This is not to say that climate development had no role in the Final Neolithic crises. It is also undeniable that cultural practices affect archaeological visibility of material culture. However, there is a clear need of another major factor to explain the depth and scope of the crisis.

Indications of wide-spread population crashes in specific parts of Europe in the 3rd millennium BC have recently been connected to rapidly accumulating aDNA evidence of *Yersinia pestis*, the bacterium causing plague (Andrades Valtueña et al. 2017; Rascovan et al. 2019; Rasmussen et al. 2015; Spyrou 2018). In northern Europe, the earliest evidence of Yernisia pestis infection is related to a fisher-hunter-gatherer buried in a shell midden in Latvia during the Middle Neolithic (Table 1; Susat et al. 2021). The bacterium has also been found in two Middle Neolithic individuals in a megalithic grave of the Funnel Beaker Culture in Sweden (Rascovan et al. 2019). These cases represent two early *Yersinia pestis* lineages that may not have survived beyond the Middle Neolithic and may not have been very virulent (Susat et al. 2021).

Significantly, the next known appearance of *Yersinia pestis* near Finland is related to three Corded Ware burials at three different sites in the Eastern Baltic (Fig. 7.1–2; Table 7.1). AMS dates obtained from bones of the deceased render it possible that these cases represent the same epidemic or a series of epidemics around 2500 BC (Table 17.; Fig. 7.2). These three cases appear to form the clearest archaeological cluster of *Yersinia pestis* occurrences in prehistoric Europe in the current research situation (see Andrades Valtueña et al. 2017; Rascovan et al. 2019; Rasmussen et al. 2015; Spyrou et al. 2018; Susat et al. 2021). The *Yersinia pestis* strain noted in these individuals represents a lineage that has been encountered in different parts of Eurasia approximately over the period 2700 to 1600 BC (Susat et. el. 2021). It had the full genetic potential to be spread via fleas by ca. 1800 BC, but around 2500 BC it may have encountered humans principally by causing pneumonic plague (Andrades Valtueña et. al. 2017; Rascovan et al. 2019; Spyrou et al. 2018; Susat et al. 2021).

It has been suggested that the lineage was not very virulent at the time it reached the Eastern Baltic region, since the graves of the infected Corded Ware individuals were accompanied by other graves lacking evidence of *Yersinia pestis* (Susat et al. 2021: 5). However, archaeothanatological analysis of the Sope I burial has revealed that the deceased was brought to the cemetery as disarticulated bones that were arranged so that the result resembled a normative Corded Ware burial (Varul et al. 2019). There are indications of a secondary burial also in the other Estonian case of a *Yersinia pestis* infected Corded Ware individual, Kunila 2 (Varul et. al. 2019: 470). Not all plague victims may have been awarded with such a reburial.

Direct evidence of *Yersinia pestis* in Neolithic Finland would be extremely hard to obtain by the current methods, due to the acidic soils that generally do not preserve unburned human or animal remains for thousands of years. However, it seems likely that the *Yersinia pestis* strain that reached Corded Ware communities in Estonia also spread to the Finnish Corded Ware zone, given the evidence of regular contacts between these regions. This would have also opened a way to the densely populated communities of the Giant's Church Culture through their contacts with the Finnish Corded Ware communities. Pöljä Ware communities of the Lake District would have been exposed to the bacterium through the contacts with both the Corded Ware Culture and the Giant's Church Culture. The asbestos network would subsequently have provided a good base for disease transmission between communities within the Lake District. Pöljä Ware communities of southern and central Finland may have had very little adaptive resistance to the Late Neolithic *Yersinia pestis* lineage compared to contemporary populations in Central Europe.

In short, spread of *Yersinia pestis* provides a good explanation for the Final Neolithic turning point in southern and central Finland, assuming that it created severe epidemics. In addition to causing

population losses, it would have challenged the prevailing ideologies of the Corded Ware Culture and the Giant's Church Culture by demonstrating their powerlessness against the wrath of invisible powers. The legitimacy of the prevailing social order in these societies may already have been weakened by the consequences of an unfavorable climate development.

The initial spread of *Yersinia pestis* may have been followed by less severe and more localised epidemics that hindered demographic recovery in conjunction with the cooling climate, reminiscent of the situation in medieval Europe after the Black Death pandemic of 1347–1350. *Yersinia pestis* epidemics may also have initiated cultural changes that reduced archaeological visibility of Lake District communities during the Final Neolithic. Most notably, the curious time gap between Pöljä Ware and Textile Ware could be explained by the dissolvement of the asbestos network and subsequent replacement of ceramics by vessels made of organic materials.

7.6 Conclusion

The turn to the Final Neolithic in southern and central Finland was not a smooth cultural change but a crisis of which the Late Neolithic cultures never recovered. There is no obvious reason why gradual environmental developments would have resulted in such a wide-ranging change in the archaeological record at this point in time. However, the spread of a highly virulent strain of *Yersinia pestis* would be a fitting explanation, and there are strong indications that a new strain of *Yersinia pestis* did appear in the region at the right time. Future research will hopefully establish whether this strain was able to cause severe epidemics.

References

Alenius, T., Marquer, L., Molinari, C. Heikkilä, M. & Ojala, A. 2020. The environment they lived in: anthropogenic changes in local and regional vegetation composition in eastern Fennoscandia during the Neolithic. *Vegetation History and Archaeobotany* 30: 489–506.

Andrades Valtueña, A., Mittnik, A., Key, F. M., Haak, W., Allmäe, R., Belinskij, A., Daubaras, M., Feldman, M., Jankauskas, R., Janković, I., Massy, K., Novak, M., Pfrengle, S., Reinhold, S., Šlaus, M., Spyrou, M.A., Szecsenyi-Nagy, A., Tõrv, M., Hansen, S., Bos, K.I., Stockhammer, P.W., Herbig, A. & Krause, J., 2017. The Stone Age Plague: 1000 Years of Persistence in Eurasia. *Current Biology* 27: 3683–3691.

Bläuer, A. & Kantanen, J. 2013. Transition from hunting to animal husbandry in Southern, Western and Eastern Finland: new dated osteological evidence. *Journal of Archaeological Science* 40: 1646–1666.

Bronk Ramsey, C. 2009. Bayesian analysis of radiocarbon dates. *Radiocarbon* 51(1): 337–360.

Edgren, T. 1992. *Den förhistoriska tiden*. In M. Norrback (ed.) Finlands historia I: 9–270. Espoo: Schildts.

Hakonen, A. 2021. *Local Communities of the Bothnian Arc in a Prehistoric World.* Oulu: University of Oulu.

Halinen, P. 2015. Kivikausi. In G. Haggrén, P. Halinen, M. Lavento, S. Raninen & A. Wessman *Muinaisuutemme jäljet. Suomen esi- ja varhaishistoria kivikaudelta keskiajalle*: 17–121, 537–542, 557–567. Helsinki: Gaudeamus.

Holmqvist, E., Larsson, Å. M., Kriiska, A., Palonen, V., Pesonen, P., Mizohata, K., Kouki, M. & Räisänen, J. 2018. Tracing grog and pots to reveal Neolithic Corded Ware Culture contacts in the Baltic Sea region (SEM-EDS, PIXE). *Journal of Archaeological Science* 91: 77–91.

Koivunen, P. 2002. Kierikkisaari island in Yli-Ii – A Stone Age pile settlement? In H. Ranta (ed.) *Huts and Houses. Stone Age and Early Metal Age buildings in Finland*: 123–128. Helsinki: The National Board of Antiquities.

Lang, V. 2018. *Läänemeresoome tulemised*. Tartu: Tartu Ülikooli Kirjastus.

Lavento, M. 2001. *Textile Ceramics in Finland and on the Karelian Isthmus – Nine Variations and Fugue on a Theme of C.F. Meinander*. Suomen muinaismuistoyhdistyksen aikakauskirja 109.

Lavento, M. & Hornytzkyj, S. 1996: Asbestos types and their distribution in the Neolithic, Early Metal Period and Iron Age Pottery in Finland and Eastern Karelia. In T. Kirkinen (ed.) *Pithouses and Potmakers in Eastern Finland. Reports of the Ancient Lake Saimaa Project.* Helsinki Papers in Archaeology 9: 41–70. Helsinki: University of Helsinki Department of Archaeology.

Lübke, H., Brinker, U., Meadows, J. & Bērziņš, V. 2016. New research on the human burials of Riņņukalns, Latvia. In J. Grünberg, B. Gramsch, L. Larsson, J. Orschiedt & H. Meller (eds.) *Mesolithic Burials–Rites, Symbols and Social Organization of Early Postglacial Communities*: 241–256. Halle: Verlag Beier & Beran.

Mökkönen, T. 2011. *Studies on Stone Age Housepits in Fennoscandia (4000–2000 cal BC): Changes in Ground Plan, Site Location, and Degree of Sedentism*. University of Helsinki: Helsinki.

Nielsen, S. V., Persson, P. & Solheim, S. 2019. De-Neolithisation in southern Norway inferred from statistical modelling of radiocarbon dates. *Journal of Anthropological Archaeology* 53: 82–91.

Nordqvist, K. 2016. From separation to interaction: Corded Ware in the eastern Gulf of Finland. *Acta Archaeologica* 87 (1): 49–84.

Nordqvist, K. 2018. *The Stone Age of North-Eastern Europe 5500–1800 calBC: Bridging the Gap Between the East and the West*. Oulu: University of Oulu.

Nordqvist, K. & Häkälä, P. 2014. Distribution of the Corded Ware in the areas north of the Gulf of Finland: An update. *Estonian Journal of Archaeology* 18(1): 3–29.

Nordqvist, K. & Mökkönen, T. 2017. Periodisation of the Neolithic and radiocarbon chronology of the Early Neolithic and the beginning of the Middle Neolithic in Finland. *Documenta Praehistorica* 44: 78–86.

Núñez, M., & Franzén, P. 2011. Implications of Baltic amber finds in northern Finland 4000–2000 BC. *Archaeologia Lituana* 120*:* 10–24.

Núñez, M. & Okkonen, J. 2005. Humanizing of North Ostrobothnian landscapes during the 4th and 3rd millennia. *Journal of Archaeological Science* 15: 25–38.

Okkonen, J. 2003. *Jättiläisen hautoja ja hirveitä kiviröykkiöitä. Pohjanmaan muinaisten kivirakennelmien arkeologiaa*. Oulu: Oulun yliopisto.

Pesonen, P. 2021. *Continuity and Discontinuity in Early, Middle and Late Neolithic Pottery Types of Eastern Fennoscandia: Reflections from Bayesian Chronologies*. Helsinki: University of Helsinki.

Pesonen, P., Larsson, Å. M. & Holmqvist, E. 2019. The chronology of Corded Ware Culture in Finland: Reviewing new data. *Fennoscandia archaeologica* XXXVI: 1–12.

Pesonen, P., Tallavaara, M. & Halinen, P. 2020. Siikajoen kivikautiset kehäkylät. *Muinaistutkija* 1/2020: 2–14.

Rascovan, N., Sjögren, K.-G., Kristiansen, K., Nielsen, R., Willerslev, E., Desnues, C. & Rasmussen, C., 2019. Emergence and spread of basal lineages of Yersinia pestis during the Neolithic Decline. *Cell* 176: 1–11.

Rasmussen, S., Allentoft, M. E., Nielsen, K., Orlando, L., Sikora, M., Sjögren, K.-G., Pedersen, A. G., Schubert, M., Van Dam, A., Kapel, C. M. O., Nielsen, H. B., Brunak, S., Avetisyan, P., Epimakhov, A., Khalyapin, M. V., Gnuni, A., Kriiska, A., Lasak, I., Metspalu, M., Moiseyev, V., Gromov, A., Pokutta, D., Saag, L., Varul, L., Yepiskoposyan, L., Sicheritz-Pontén, T., Foley, R.A., Mirazón Lahr, M., Nielsen, R., Kristiansen, K., Willerslev, E., 2015. Early divergent strains of Yersina pestis in Eurasia 5000 years ago. *Cell* 163: 571–582.

Reimer, P. J., Austin, W. E. N., Bard, E., Bayliss, A., Blackwell, P. G., Bronk Ramsey, C., Butzin, M., Cheng, H., Edwards, R. L., Friedrich, M., Grootes, P., Guilderson, T. P., Hajdas, I., Heaton, T. J., Hogg, A. G., Hughen, K. A., Kromer, B., Manning, S. W., Muscheler, R., Palmer, J. G,, Pearson, C., van der Plicht, J., Reimer, R. W., Richards, D. A., Scott, E. M., Southon, J. R., Turney, C. S. M., Wacker, L., Adolphi, F., Büntgen, U., Capano, M., Fahrni, S. M., Fogtmann-Schulz, A., Friedrich, R., Köhler, P., Kudsk, S., Miyake, F., Olsen, J., Reinig, F., Sakamoto, M., Sookdeo, A. & Talamo, S. 2020. The IntCal20 Northern Hemisphere radiocarbon age calibration curve (0–55 cal kBP). *Radiocarbon* 62(4): 725–57.

Spyrou, M. A., Tukhbatova R. I., Wang C. C., Andrades Valtueña, A., Lankapalli A. K., Kondrashin, V. V., Tsybin V. A., Khokhlov, A., Kühnert, D., Herbig, A., Bos K. I, & Krause J. 2018. Analysis of 3800-year-old Yersinia pestis genomes suggests Bronze Age origin for bubonic plague. *Nature Communications* 9: 2234: 1–10.

Susat, J., Lubke, H., Immel, A., Brinker, U., Macane, A., Meadows, J., Steer, B., Tholey, A., Zagorska, I., Gerhards, G., Schmölcke, U., Kalnin, M., Andre Franke, A., Petersone-Gordina, E., Teßman, B., Tõrv, M., Schreiber, S., Andree, C., Berzin, V., Nebel, A. & Krause-Kyoral, B. 2021. A 5,000-year-old hunter-gatherer already plagued by Yersinia pestis. *Cell Reports* 35: 109278.

Tallavaara, M. & Pesonen, P. 2020. Human ecodynamics in the north-west coast of Finland 10,000–2000 years ago. *Quaternary International* 549: 26–35.

Tallavaara, M. & Seppä, H. 2012. Did the mid-Holocene environmental changes cause the boom and bust of hunter-gatherer population size in eastern Fennoscandia? *Holocene* 22: 215–225.

Tallavaara, M., Pesonen, P. & Oinonen, M. 2010. Prehistoric population history in eastern Fennoscandia. *Journal of Archaeological Science* 37: 251–260.

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

Varul, L., Galeev, R. M., Malytina, A. A., Tõrv, M., Vasilyev, S. V., Lõugas, L. & Kriiska, A. 2019. Complex mortuary treatment of a Corded Ware Culture individual from the Eastern Baltic: A case study of a secondary deposit in Sope, Estonia. *Journal of Archaeological Science: Reports* 24: 463–472.