

Mesolithic Pyrotechnology: Practices and Perceptions in Early Holocene Coastal Norway

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Substantial pyrotechnological structures and large quantities of charcoal are rarely found on Early Holocene sites in coastal Norway. Nevertheless, information on the use of fire and fuel types is available and presented in this article, a survey of sites dating from 10,000 to 8000 uncal BP. Possible fuel types and preferences are discussed and it is argued that most fires would have been small and short-lived, making extensive use of low vegetation. This suggests that food must have been largely consumed raw, fermented, or dried. The distinction between the use of shrubs and trees must have had implications for the perception of their properties, which appear to have persisted even after the emergence of more forested landscapes.

Keywords: Early Holocene, Mesolithic, pyrotechnology, fuel, food preparation

INTRODUCTION

The frequent absence of charcoal from Early Holocene sites is a well-known and frustrating obstacle to dating pioneer settlements along the Norwegian coast. This lack of datable material is attributed in part to a settlement pattern assumed to be dominated by short-term occupations, which yield little charcoal and other organic material, and in part to poor preservation due to age, exposure, and weathering (see Sergant et al., 2006). In addition, the general absence of stone-lined hearths reduces the visibility of fireplaces and the detection of charcoal fragments.

There may, however, be more to it. Does the lack of charcoal and distinctive hearths perhaps also indicate specific pyrotechnological practices, notably some that differ from later practices? And could this

indicate different kinds of interaction with fuel sources and food preparation, and thus suggest different perceptions of vegetation and other resources?

In order to investigate this topic, detailed information on the use of fire on Mesolithic settlement sites will be interrogated along the following lines. Which practices are evident in the archaeological record? What fuel sources were available; what were their properties; and what were the prehistoric preferences? These findings will be discussed in relation to practices connected to heating, light, cooking, and other purposes.

ARCHAEOLOGICAL EVIDENCE FROM EARLY HOLOCENE NORWAY

Archaeological evidence for pyrotechnological activities includes charcoal and other

burnt material such as bone or shell, fire-cracked or scorched stones, red-burnt and sooty soil, and burnt lithic material. Unfortunately, without radiocarbon dates, there is always a risk that pyrotechnological activities post-date the period being investigated, as the many late dates from Early Holocene sites in Norway show. Charcoal outside a convincing archaeological context could derive from natural fires and therefore does not contribute to an evaluation of pyrotechnological practices. In order to limit this study to well-defined Early Holocene activity, only sites with radiocarbon dates from material linked to a distinct structure and/or contemporary lithics have been considered (see tables in online [Supplementary Material](#)).

The following constitutes an overview of the evidence for the use of pyrotechnology along the coast of Norway ([Figure 1](#)). The main emphasis is on data from northern Norway, but summary accounts of data from other regions are also provided, the latter including a few upland sites. This overview is arbitrarily limited to the period 10,000–8000 uncal BP, roughly 11,500–9000 cal BP, covering the Early and much of the Middle Mesolithic in Norway. Norwegian archaeology employs chronozones (Bjerck, 2008b: 74, table 3.1), in which the period 9500–8000 BC is termed the Early Mesolithic and the period 8000–6500 BC the Middle Mesolithic. Here, the term Early Holocene refers to the entire timespan covered by these periods. The large Mesolithic dwellings from Tønsnes are slightly later but included since the information from these adds significantly to the discussion.

Northern Norway

While many Early Holocene sites are found in northern Norway, most are known only from surveys and early surface

collections with limited documentation. Breivik (2014: 1481, 2016: appendix C4) lists 164 Early Mesolithic sites from the region, but only twelve per cent of these have been investigated in the last three decades and have a minimum of documentation. In early excavations, fire-cracked stones may not have been noticed as significant; but, even on recently excavated sites, awareness of such finds and their recording vary. Hence, for the majority of sites, it is difficult to ascertain whether and which pyrotechnological activities were carried out. Sites with conclusive evidence for an Early Holocene use of fire are predominantly those with remains of dwellings. This overview includes seventeen sites from northern Norway with radiocarbon dates ([Supplementary Table S1](#), hereafter [Table S1](#)), several of which included more than one excavated unit, a unit being understood as a feature or set of features. Out of twenty-eight units, twenty are definitively dwelling structures.

In these twenty-eight units, some patterns can be recognized. Reports of patches or concentrations of sooty soil and scattered pieces of charcoal dominate. In many cases, several stratified and partly overlapping lenses of charcoal or sooty soil have been found. House A15536 at Tønsnes (no. 12 on [Figure 1](#) and [Table S1](#)) provides evidence of at least twelve consecutive episodes of pyrotechnological activity inside one unit ([Figure 2](#)), but even some of the earliest sites, such as Nii'beræppen 3 (no. 3 on [Figure 1](#) and [Table S1](#)) and Løkvika (no. 7 on [Figure 1](#) and [Table S1](#)), have several stratified and overlapping patches. Examples of small depressions with charcoal suggest either that a fire was deliberately lit in these, or that they were formed by clearing out debris. The Middle Mesolithic dwellings at Tønsnes demonstrate that the remains of fires were systematically cleared out from the structures' interior to middens or refuse areas outside



Figure 1. Map of Norway with the four regions and numbering of the sites listed in the online supplementary Tables S1 and S2. Map by permission of J.E. Arntzen, Arctic University of Norway.

(Skandfer, 2010: 158; Gjerde & Skandfer, 2018). Fire-cracked stones are found on numerous sites, but only in small quantities. These are typically not found in concentrations but scattered around the site.

There are exceptions to these scatters and lenses of charcoal, indicating the

active use of stones and pits but not of stone-lined hearths. At Kvitberg (no. 10 on Figure 1 and Table S1), a pit contained fire-cracked stones and charcoal; and the pit at Tønsnes 104380 (House 3) contained several small concentrations of charcoal, but no fire-cracked stones



Figure 2. Successive thin charcoal lenses at Tønsnes 10 A15536, Troms, northern Norway. Photograph by permission of M. Cerbing, Arctic University Museum of Norway.

(Skandfer, 2010: 140). It seems likely that this was a location for pyrotechnological activity rather than a refuse pit. At Mohalsen II (no. 15 on Figure 1 and Table S1) in the southernmost part of the northern region, two separate fireplaces were identified: they consisted of a concentration of potato-sized pebbles in one layer mixed with sooty soil and fragments of charcoal. A little under half of these were fire-cracked.

Numerous Early Holocene dwellings have been excavated in the north in recent years without charcoal being recovered (e.g. Gjerde & Hole, 2013), and a number of well-investigated sites with no definite remains of dwellings have similarly left no indications of distinct fireplaces (e.g. Blankholm, 2008; Kleppe, 2014). In several cases, some fire-cracked stones were found. At the undated site Målsnes, for example, only 0.27 per cent of all lithic material was affected by fire and the

number of fire-cracked stones was fewer than twenty-five (Thuestad, 2005: 84; Blankholm, 2008). In these cases, i.e. where modern documentation and an awareness of the importance of fire-cracked stones are present, the indications that pyrotechnological activities took place directly on site are limited.

Central Norway

The recent summary by Breivik and Bjerck (2018) provides a good overview of all the Early Mesolithic sites (c. 11,500–10,000 cal BP) from central Norway. For the Early Mesolithic, 244 sites are known from the region but, as in northern Norway, most are known from surveys and surface collections only. Roughly fifty have been excavated, some fifty-four per cent during the last three decades; even some sites investigated early in the

twentieth century have yielded reasonably detailed information. Some sites contain numerous units. Breivik and Bjerck's overview suggests seventy-eight units with pyrotechnological activity and another twenty-six possible ones. However, only twenty-one such units are radiocarbon-dated, of which twelve are from one site, Nyhamna site 48 (no. 20 on [Figure 1](#) and [Supplementary Table S2](#), hereafter [Table S2](#); Breivik, 2016; Breivik & Bjerck, 2018).

Nyhamna site 48, one of the best-known sites, possesses six units with burnt flint artefacts out of eighteen units, but no other indications of fire activity (Breivik & Bjerck, 2018). The other twelve units yielded charcoal and sooty sediments (see [Table S2](#)). Particularly interesting are the 1 × 1 m to 1 × 2 m concentrations of small to medium-sized stones, some fire-cracked, some burnt, and others without traces of fire ([Figure 3](#)). Some were found over shallow depressions, whereas in other cases the stones were placed directly on the contemporary ground surface. Similar features are known from other Early Mesolithic sites in central Norway, including other Nyhamna sites (Nyhamna 72 and 76; also no. 20 on [Figure 1](#) and [Table S2](#)), Kvernbergmyra (no. 18 on [Figure 1](#) and [Table S2](#)) and Kvernberget (no. 19 on [Figure 1](#) and [Table S2](#)), and the structures at Mohalsen II mentioned above are near identical.

Western and southern Norway

There is a notable lack of coastal radiocarbon dates from Early Holocene sites from regions further south, despite an increasing number of sites excavated in recent years in connection with development-led projects. In addition, many of the stones found on southern Norwegian sites are of Larvikitt, a type of rock that does not

respond well to heat (Åhrberg, 2012: 14; Jakslund, 2014), making the identification of pyrotechnological activity a challenge.

The only radiocarbon-dated Early Holocene feature in this coastal region is a shallow pit with a large amount of scorched stone at Kotedalen (no. 23 on [Figure 1](#) and [Table S2](#)). A couple of concentrations or small pits with charcoal were also found on the south-western coast, but not dated (Nærøy, 1994: 126; Åstveit, 2018).

In southern Norway, concentrations of fire-cracked stones often associated with shallow pits dominate. In some cases, the quantities are substantial, in particular at the inland site of Knubba (no. 29 on [Figure 1](#) and [Table S2](#)).

Numerous concentrations of fire-cracked stones with or without charcoal have been found on Early Holocene sites in southern Norway and interpreted as the remains of hearths. Many of these produced later dates, in the Late Mesolithic, Bronze Age, or Iron Age. While some of these not securely dated features are similar to those that are well-dated, others appear different, e.g. features with larger stones on their perimeter (e.g. at Pauler sites 1–4, and at Bakke; Jakslund, 2012a, 2012b). Some of these features may reflect the excavator's preconception of the appearance of 'proper' fireplaces. Alternatively, these features may indeed be later in date, or they may represent a genuine Early Holocene regional variation (Mansrud & Eymundsson, 2016). Furthermore, there are examples in south-western Norway of pyrotechnological features at Early Holocene sites where the radiocarbon determinations date to later periods (Nærøy, 1994). Here, no features without Early Holocene radiocarbon dates have been included.

In contrast to the coastal region, there is evidence of Early Holocene pyrotechnological activity in the mountain regions of western and south-western Norway, with



Figure 3. Unit G at Nyhamna 48: concentration of stones sorted by size inside a tent-ring. Photograph by permission of T.E. Linge, NTNU University Museum, Trondheim, Norway.

concentrations measuring *c.* 1 m in diameter containing fire-cracked, red-burnt, fist-sized stones (Bang-Andersen, 2015: 85). These features appear to be located on the surface rather than in shallow depressions. Only a few were stone-lined. Some contained small fragments of charcoal consisting predominantly of birch and willow, although remains of oak and pine were also found (Bang-Andersen, 2006, 2015: 87).

Early Holocene practices

There are many similarities in the evidence along the coast. First, patches of burnt sand or gravel with charcoal fragments are regularly reported. These dominate in the north. Several stratified and overlapping patches of heat-affected sand and scattered charcoal fragments probably represent repeated but separate occupation episodes

within a unit. Second, irregular to circular concentrations of stones or stone packings are frequently encountered on the coast of central and southern Norway and in the south-western uplands. There are numerous instances of shallow depressions or pits with scorched or fire-cracked stones and charcoal. The quantity of scorched or fire-cracked stones is seldom given in reports but they appear to be scattered and infrequent in the north while there are more substantial concentrations further south. Stone-lined hearths are known but seemingly uncommon. Overall, it seems that the use of stones in pyrotechnological activities was more extensive in the central and southern regions.

Concentrations of stones and the presence of scorched and fire-cracked stones indicate that they were actively employed but to varying degrees. In several cases, these concentrations appear to be *in situ*, while in others the stones have been

moved from their initial position. The presence of scorched or fire-cracked stones is often interpreted as a key element in heating a dwelling. While this is possible in some cases, I will argue that, at some sites, it is likely that such stones were linked to food preparation.

FUEL OPTIONS: EARLY HOLOCENE VEGETATION

In order to evaluate the resources available for pyrotechnological activities, a brief account of the developing vegetation is useful. The initial human colonization of coastal Norway took place at the very beginning of the Holocene, as temperatures increased markedly. In many areas the ice had only just retreated, isostatic movement caused the coastal zone to rise from the sea, and the landscape was accordingly characterized by a tundra-like vegetation as topsoil was sparse and many plants and trees had not yet colonized the emerging land. Although parts of the coast were deglaciated very early (between 14,600 and 11,700 cal BP in the far north), initial sedimentation was halted by cold conditions during the Younger Dryas 12,900–11,700 cal BP (e.g. Fimreite et al., 2001; Allen et al., 2007; Birks et al., 2012). The vegetation in the northernmost regions at the transition to the Holocene consisted of sagewood (*Artemisia*), rockfoil (*Saxifraga*), sorrel (*Rumex*), heather (*Ericales*), crowberry (*Empetrum*), and some dwarf shrubs including dwarf birch (*Betula Nana*) and willow (*Salix*) in varying proportions (Birks et al., 2012: 113; Sjögren & Damm, 2019).

Birch trees proper (*Betula pubescens*) arrived somewhat later. Hilary Birks (2015) documents a delayed and progressive establishment of birch woodland from south to north, with dates of 10,890 cal BP in western Norway to 10,100 cal BP in the

north at the transition to the Middle Mesolithic. While she uses the sites with the most reliable records, these are all located in exposed areas, which does not necessarily reflect conditions at optimal locations. There appears to be general agreement that smaller stands of birch trees could have existed rather earlier in favourable fjord areas in the north and reached the outer coast later (Vorren et al., 2009: 416; Birks et al., 2012: 117; Huntley, 2013). The dates for the early appearance of birch are somewhat disputed, with some arguing for their emergence alongside the first human colonization (Fimreite et al., 2001; Vorren et al., 2009). Macrofossils from birch trees are known from northern Norway as early as c. 9900 cal BP, only a few centuries after deglaciation in the area (Jensen et al., 2002). Taking into consideration dates for pine in the north-easternmost part of Norway as early as around 10,000 cal BP (Seppä & Hammarlund, 2000), and macrofossils of pine in inner northern areas before 9000 cal BP, perhaps as early as 9700 cal BP (Jensen et al., 2002), the presence of some early isolated stands of birch and a few pines does indeed seem possible, even in the Early Mesolithic. While these would never be prominent in palaeobotanical records, they would nevertheless have stood out in the landscape for the early foragers.

Birch woodland was present earlier further south (Birks, 2015), and the formation of semi-open woodland in the coastal zone of south-western Norway is suggested already at the transition to the Holocene at 11,700 cal BP (Bang-Andersen, 2012: 111), allowing more extensive woodland to develop during the Early Mesolithic, possibly even pine and oak (Bang-Andersen, 2006: 12). There is ample evidence for the existence of pine in the mountains of south-western Norway well before 9500 cal BP (Selsing, 2010).

FUEL PREFERENCES: VEGETATION

The available wood anatomical analyses of charcoal from the sites show that birch was frequently used, but also willow, aspen, rowan, hazel, buckthorn, and crowberry, suggesting that small twigs and branches were used extensively. As it is notoriously difficult to differentiate between birch shrub (*Betula nana*) and birch trees (*Betula pubescens*) (Bishop et al., 2013: 3893), the preference for one or other species is hard to determine. It is possible that other longer living species were used more frequently than recorded, as excavators will have selected short-lived species for radiocarbon dating. Additional information on identified wood species, which frequently includes willow, aspen, and hazel, can be found in Tables S1 and S2.

The presence of pine and even oak in some Early Mesolithic assemblages has been ascribed to driftwood or to the use of fossil firewood (Bang-Andersen, 2006), although, as noted above, pine and oak may have been available, if not close to the sites, then in the region. Bang-Andersen (2006) has proposed that oak and pine could be the remains of burnt implements, such as tool handles, or other 'structural' wood.

The variable degree of preservation of charcoal from the different types of fuel is an important factor (Théry-Parisot et al., 2010). Oak and pine are more likely to be underrepresented in assemblages, as they are less resistant to pressure than, for instance, birch (Bishop et al., 2015: 64), and wood that was already decaying when burned is also less well preserved. Experiments emphasize the complexity of the taphonomic processes involved, given the diversity of factors ranging from the selection of the fuel to post-depositional processes (Théry-Parisot et al., 2010: 150), while other experiments show that the higher the temperature of the fire, the

less charcoal it produces (Vanlandeghem et al., 2020).

This overview of the Early Holocene environment shows that access to firewood was rather limited at first. Yet even heather and shrubs are well suited for fires, and in northern Norway the earliest colonizers had to rely mainly on shrubs. Traditional knowledge among the Sami reveals that shrubs such as willow, dwarf birch, juniper, and heather are useful for quick, short-lived fires. Dwarf birch is easily lit, burns well even when fresh, and is used widely in the mountains today (Ryd, 2005: 239, 305). Willow shrub is widely found and mostly used fresh rather than as deadwood, as the former burns longer and produces better embers, and can be revived even after a rain shower. Dense and extensive patches of willow in the mountains are regularly given toponyms because they provide a good source of firewood (Ryd, 2005: 251). Where willow and dwarf birch are not available, crowberry, burned with its roots, is an important resource (Ryd, 2005: 341). Weather conditions need to be dry and preferably a little windy for the fire to light, and it produces a lot of smoke. Under the right conditions, crowberry burns easily and for a long time (Ryd, 2005: 97), and it has been suggested that lightning could have caused extensive natural fires in the arid Early Holocene climate (Birks, 2015: 42).

Wood from fresh birch trees (i.e. not dry deadwood) was commonly collected for firewood near Sami dwellings. It burns well, provides much heat, and the embers are long-lasting (Ryd, 2005: 216). However, green birch needs constant tending, as the embers die if they do not receive enough air. It also needs to keep burning at high intensity, requiring much wood. This has been demonstrated by a winter experiment in a reconstructed Sami dwelling in northern Sweden (Liedgren &

Östlund, 2011): as soon as the fire died, the temperature dropped, and the stone packing did not help maintain the heat during the night. The experiment concluded that the purpose of the fire was not primarily to produce a high and even temperature inside the dwelling, but to assist in shorter tasks such as cooking and drying clothes (Liedgren & Östlund, 2011: 911).

Green pine is of little use as firewood, while dry pinewood burns well but goes out easily and leaves few embers. The gasses from the embers are toxic (Ryd, 2005: 128).

The evidence for extensive use of shrubs in the Early Holocene along the Norwegian coast suggest that many fires were small and short-term affairs. This corresponds well to the often small patches of burning with few stones encountered in the north; the frequent use of willow, hazel, and aspen in other regions indicates that such fires were also common elsewhere. Birch, whether as shrubs or trees, was the most commonly employed species and could have been used green.

FUEL OPTIONS: BONE AND BLUBBER

A few hearths have yielded burnt bones, representing either the remains of meals or the deliberate use of bones for fuel. As more substantial vegetation was scarce at the time of early settlement, and in certain areas (considering that many sites were in exposed locations), the use of bone for fuel is worth considering.

The fire must be lit using vegetal material before adding the bones. Dry bones light faster but fresh bones burn longer. Adding bones to a fire produces good flames, but the burning stops when the flames die and it does not produce embers (Théry-Parisot et al., 2005). Experiments (Vaneekhout et al., 2010) show that one

of the difficulties with bone as fuel is that the temperature becomes more unstable as the bone:wood ratio increases and the fire produces less heat with more bone. On the other hand, a fire with a fifty per cent bone content produced better light than one with twenty-five per cent bone. Bones from terrestrial mammals, such as elk or bear, burn well, whereas the temperature dropped when seal bone was added.

Bone as fuel works adequately when a flame is needed for light and drying but it is inefficient for long-term fires or to produce a lasting heat. Bones do however contribute to a long-burning fire if mixed with wood. Estimates suggest that the quantity of bone needed is quite high (to keep one hearth burning for six hours over ten kilograms of bone are needed, the equivalent of more than one animal weighing 40–60 kg; Théry-Parisot et al., 2005).

There is no definitive evidence for the use of bones as fuel from the early Norwegian sites. A few features in northern Norway contained bone, but only in limited amounts. The Middle Mesolithic site at Sujala in northern Finland yielded some 620 g of burnt bone, predominantly those of reindeer but also some bird bones, recovered from a large birch charcoal and bone stain, *c.* 2.5 m in diameter (Rankama & Kankaapä, 2007; Kankaapä & Rankama, 2011: 44). This find may be a result of better preservation and more careful excavation techniques. Alternatively, the site could represent an incoming eastern inland practice, with more regular use of bone for fuel, in line with a probably more extensive exploitation of reindeer.

At several sites, charcoal and soot were found as a deposit consisting of charred organic material mixed with gravel and sand. It has been suggested that this indicates the use of blubber (Bjerck, 2008a: 251; Bjerck et al., 2016: 56), but the

analysis of one such deposit showed a pre-dominance of plant remains, with only a small proportion of animal lipids (Isaksson, 2008). This has been an issue for some debate (e.g. Åstveit, 2014).

There is at present no evidence from the Atlantic coast that blubber was used as fuel. However, on an Early Holocene site on skerries on the eastern Swedish archipelago, small black lumps of burnt organic matter containing marine fatty acids were found, as well as more than one kilogram of burnt seal bone (Pettersson & Wikell, 2014). Whether the seal blubber was used for fuel or whether the finds indicate processing and cooking is unknown. Historically, blubber was widely used to heat and light dwellings in the circumpolar region, and there is little doubt that seals were a prominent resource along the Norwegian coast during the Early Mesolithic (Bjerck et al., 2016). Blubber was then readily available on the outer coast, where the vegetation was sparse. Experiments show that seal oil is ideal for high temperatures over a long period and, if fat is added to wood, the amount of charcoal increases (Vanlandeghem et al., 2020).

Ulla Odgaard (2003, 2007), who experimented with burning blubber with moss wick, estimates that a dome-shaped tent, measuring 4 m in diameter and covered by two layers of caribou skins, could thus be heated to +8° Celsius even when the outside temperature was -30° (Odgaard, 2003: 358). The amount of fat needed for two months was estimated to be 175 kg or twelve seals. While 8° may not be considered acceptable living conditions today, it is reasonably warm if wearing skin clothing. Several people in a small dome-shaped dwelling also generate a good deal of heat. Additionally, 8° would suffice to melt ice for drinking water (Odgaard, 2003), and the heat from a lamp would also help dry meat or clothes hung above

it (Odgaard, 2007: 12). Historical documents also record that blubber was sufficient for both heat and light (Damm, 2016). There are no stone or ceramic lamps from Early Holocene Norway, and only in a few cases are flat stone slabs recorded (e.g. at Kvernbergmyra).

DISCUSSION

Taphonomic processes are undoubtedly responsible for the limited amounts of charcoal and other organic matter preserved in pyrotechnological contexts. Cases where sites were sealed under thick layers of turf, such as the stratified lenses at Tønsnes in the north, the Nyhamna sites in central Norway, and upland sites in south-western Norway, are examples of practices that were probably more common. Nevertheless, there is much to suggest that the extensive use of shrubs for small, short-lived fires is responsible for the sparse record of charcoal from Early Holocene contexts.

Our overview of conclusive evidence for early pyrotechnological activities in Norway suggests that open fires were mostly small. This is certainly true for the northern region, where the archaeological remains typically consist of patches of charcoal and some fire-cracked stones. The lack of more substantial firewood in the Early Holocene suggests that most fires were fuelled by shrub vegetation and dwarf birch or branches from birch woodland. This corresponds well to practices documented on archaeological sites in the North American Arctic (Alix, 2016). The use of bone or blubber is not unequivocally documented. Seal bones are less suitable than reindeer bones for fuel, while blubber is well known as a fuel. In the north of Norway and in the upland regions further south, both being regions with sparse vegetation, charcoal of species such as pine

and oak are not uncommon. In the north, pine may have been driftwood. In any case, if fuel has to be carried over some distance, prioritizing larger branches would be most efficient.

Further south, more substantial features and a more extensive use of stones is documented more frequently. Numerous stone concentrations about one metre in diameter are recorded, although which kind of repeated pyrotechnological activity they represent is less certain. It is possible that they functioned as a heat-preserving foundation for an open fire, or the stones may have been heated elsewhere and moved into the dwelling for heating purposes. In these regions, shrubs such as willow were used for fuel, although a range of species are represented in the charcoal. Depressions associated with pyrotechnological activities are common, possibly to control the spread of the fire or in some cases resulting from the clearance of embers and ash.

Overall, there is little evidence to suggest the presence of extensive, blazing wood-fuelled open fires. Smaller short-lived fires using shrubs and wooden debris appear more likely to have been the common practice. This would have been enough to heat small dwellings, perhaps in combination with heated stones, to melt snow for water, and to dry clothes. Light would have been limited within the dwellings but adding bone would have increased the flames.

Culinary options and preferences

We often associate pyrotechnology with food preparation, yet there is nothing to suggest that the popular image of hunters roasting meat over large fires was a common practice in Early Holocene Norway. Neither is there any evidence of deep cooking pits, as known from later

periods. On the other hand, boiling fish or meat in a container using heated stones is a likely option. While there was no pottery, animal hides or even stomachs could have been used. The smooth, small, rounded pebbles from the central Norwegian sites may be related to this practice rather than to heating dwellings (Bjerck, 2008a; Åstveit, 2014: 93). Experiments show that a single stone may be enough to cook porridge (Thornton, 2016). Meat may also have been prepared on flat stone slabs or packed in moss (Bennett & Rowley, 2004: 84). Flat stones are, however, not common on the sites studied here.

It is highly likely that in the Early Mesolithic along the coast of Norway most food was not cooked in our sense of the word. In many northern societies (Hrdlička, 1945; Brody, 1987; Jolles, 2002; Bennett & Rowley, 2004; Burch, 2006; Tyman, 2009), some food was consumed raw (e.g. blubber, marrow, liver, blood, eggs, sometimes also fish, shellfish, and meat). Fermenting, wind-drying, and freezing were ubiquitous practices. In cold northern climates, drying typically takes place outdoors in the wind, rather than inside a dwelling with the help of a fire. Fermenting the meat of fish, birds, and mammals (e.g. reindeer and seal) is known from many areas and is efficient in cold climates. It typically only requires leaving the fish or carcass for some days to ferment before consumption. Fermentation of fish is documented from Mesolithic Sweden (Boethius, 2016). In many cases, raw or fermented food was mixed with fat or marine oils and berries. The dried or frozen fish and meat would be eaten uncooked but beaten and dipped in oil. Many recipes describing fermentation and preservation in fat or seal oil are also well known among the Sami (Fjellström, 1985; Larsen, 2014), even when access to fuel supplies increased.

What's in a tree? Environmental perceptions

Recent publications have emphasized the role of hearths for social and ritual purposes (Mansrud & Eymundsson, 2016; Mithen, 2019), but here the focus is on the interaction between humans and their environment and on the impact of this interplay on human understanding. Our perceptions come into being through this active interplay, a dynamic relationship between the needs and practices of humans and the provisions and potentials offered by their surroundings. How we perceive things affects how we engage with them. The pyrotechnological practices in Early Holocene coastal Norway were quite consistent over several millennia even though the vegetation changed and provided new possibilities. The impact of established practices and perceptions persisted even beyond the pre-boreal vegetation phase.

Most fires in the Early Holocene were fuelled with shrubs or limited quantities of firewood, with implications for contemporary perceptions of the environment. The practices resulted in a distinction being made between low vegetation and shrubs on the one hand and more substantial trees on the other. The former provided firewood, food (leaves and berries), and possibly bedding, the latter supplied the material for structures and tools and were only secondarily used for fuel.

The early vegetation, and in particular the first stands of proper trees, were not predominantly used for fuel. These early stands must have stood out in the pre-boreal landscape, perhaps functioning as way-markers and landmarks. They could also have provided shelter from wind and rain. Crucially, longer, stronger pieces of wood were essential for making a range of equipment, most notably boats and paddles. They were also required for bows, harpoon shafts, arrow shafts, floats, and

structural elements of dwellings (for comparative data from Alaska, see Burch, 2006: 186–87). Small conical tents may have only required a single pole, while small, dome-shaped structures covered with hides may have been built from quite thin, flexible branches that still needed to be quite long, such as willow (Odgaard, 1995; Fretheim et al., 2018). In a recent evaluation of Early Mesolithic dwellings along the Norwegian coast, most structures are interpreted as fully portable, while some are seen as composite dwellings combining portable and fixed elements (Fretheim et al., 2018). It is likely that driftwood was employed for some of this, but fresh, flexible wood offering the possibility of choosing specific branches must have been highly valued.

It appears that shrubs and other low vegetation was used for basic needs: for small fires to provide heat and light and as welcome additions to the diet. I suggest that trees were perceived differently. Their sparse occurrence in the Early Holocene landscape and their crucial role in the production of implements needed for survival made them particularly important. Even in recent historical times, certain trees were respected or even venerated (Bergman et al., 2004; Taylor, 2020) and, although this may not have been the case in Early Holocene Norway, the practices identified suggest a different role for trees. Interestingly, these perceptions and their associated pyrotechnological practices do not seem to change significantly in the Middle Mesolithic, despite the emergence of more woodland.

Adjacent regions

Structured hearths are uncommon in the western European Mesolithic (Sergant et al., 2006). Pyrotechnological activity inside dwellings is typically indicated by

patches of dark soil with charcoal, either in pits or on flat surfaces, at times with a stone lining (Grøn, 2021). Sites in northern Sweden contained charcoal and burnt bones, often found in concentrations of red-stained sand. Where documented, the fuel in northern Sweden was willow and birch (Östlund, 2018). Similarly, a couple of Late Glacial sites in northern Germany had concentrations of burnt lithics and charcoal fragments (Clausen & Schaaf, 2015). The size of these concentrations across north-western Europe varies from *c.* 0.5 to *c.* 1.0 m in diameter. These features are remarkably similar to those from coastal Norway.

A few exceptions to these finds deserve mention. First, the famous nut-roasting hearths from northern continental Europe often reveal themselves as layers of bark mats and sand mixed with burnt hazelnuts (e.g. Bokelmann, 1981). Experiments show that large quantities of nuts can be processed in a short time (Holst, 2010) without requiring open fires burning over a long time. In northern Sweden, some larger pits (1 × 2 m and 0.5–1.0 m deep) containing substantial amounts of fire-cracked stones (up to 100 kg) are known from the Early Holocene (Bergman, 2008; Östlund, 2018). They are interpreted as roasting pits by comparison with historically known practices among the Sami (Bergmann et al., 2004). Duvensee site 13 in Schleswig-Holstein is a unique, briefly occupied site where two pine trunks, presumably dry deadwood, had been placed opposite each other and gradually shoved onto the fire where they met (Bokelmann, 1986).

These examples demonstrate that pyrotechnological practices varied between and within regions, as they fulfilled diverse functions. We must assume that people in the Early Holocene had extensive skills and knowledge of producing, maintaining, and using fires, a critical survival skill for northern hunter-gatherers.

CONCLUSION

There is significant potential in analysing pyrotechnological activity, which goes far beyond dating sites and the use of fire. A systematic study of the available evidence can provide insights into practices relating to the heating and lighting of dwellings as well as food processing, and lead to discussions of environmental perceptions.

To expand this potential, we must emphasize the importance of documenting and disseminating information relating to these activities. Results from wood-anatomical analyses should include not just the samples dated but also the variety of species found in other samples. The amount of charcoal found needs to be quantified where possible, as should details on burnt lithics and quantities of burnt bone. In particular, more detailed information is required concerning the amount, size, form, and location of scorched and fire-cracked stones. If this is recorded routinely, the basis for the interpretation of individual episodes and for comparison between sites will increase markedly.

SUPPLEMENTARY MATERIAL

To view supplementary material for this article, please visit <https://doi.org/10.1017/aea.2021.31>.

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BIOGRAPHICAL NOTES

Charlotte Brysting Damm is professor of archaeology at the Arctic University of Norway. Her work primarily concerns Holocene hunter-gatherers with an emphasis on northern Fennoscandia. The main themes of her research are interaction and networking across northern regions, demography and mobility,

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La technologie du feu au Mésolithique : pratiques et perceptions le long des côtes norvégiennes pendant l'Holocène précoce

On ne découvre que rarement des structures substantielles servant à la gestion du feu et peu de grandes concentrations de charbon de bois sur les sites côtiers de Norvège datant de l'Holocène précoce. Des données relatives à l'usage du feu et aux matériaux combustibles existent cependant et sont présentées dans cette étude concernant des sites datant de 10,000 à 8000 bp (non-calibré). L'auteur considère les différents types de combustibles et les préférences de leurs utilisateurs et suggère que la plupart des foyers représentaient de petits feux de courte durée alimentés surtout par une végétation basse (buissons, broussaille). Il en découle que les aliments auraient été consommés crus, fermentés ou séchés. Les différences dans l'utilisation des buissons et des arbres se reflétaient dans la perception de leurs qualités intrinsèques et ces distinctions semblent avoir persisté même après l'émergence de paysages plus boisés. Translation by Madeleine Hummler

Mots-clés: Holocène précoce, Mésolithique, technologie du feu, matériaux combustibles, préparation d'aliments

Mesolithische Feuerstechnologie: Gebrauch und Auffassung im frühen Holozän entlang der Küsten Norwegens

Größere Feuerstellen und erhebliche Mengen von Holzkohle kommen selten in den Fundstellen des frühen Holozäns entlang der norwegischen Küsten vor. Jedoch gibt es Angaben über den Gebrauch von Feuer und der verschiedenen Brennstoffe, die hier in einem Überblick der Fundstellen mit Radiokarbonaten zwischen 10,000 und 8000 uncal BP untersucht werden. Die Autorin betrachtet mögliche Brennstoffarten und Vorzüge bei ihrer Wahl und gelangt zum Schluss, dass die meisten Feuerstellen kleine Feuer von kurzer Dauer darstellten und vor allem Büsche verwendeten. Dies deutet darauf hin, dass die Nahrungsmittel weitgehend roh, vergoren oder getrocknet verspeist wurden. Die unterschiedliche Verwendung von Büschen und Bäumen hat sehr wahrscheinlich die Auffassung ihrer Eigenschaften beeinflusst, welche scheinbar sogar nach der Entstehung von besser bewaldeten Landschaften andauert haben. Translation by Madeleine Hummler

Stichworte: frühes Holozän, Mesolithikum, Feuerstechnologie, Brennstoffe, Speisenzubereitung