JOURNAL OF NORTHERN STUDIES Vol. 6 • No. 1 • 2012, pp. 9–30

THOMAS B. LARSSON, GUNHILD ROSQVIST, GÖRAN ERICSSON & JANS HEINERUD

Climate Change, Moose and Humans in Northern Sweden 4000 cal. yr BP

ABSTRACT Major cultural and environmental changes took place in the interior of Northern Sweden, beginning about c. 4200 cal. yr BP (or 2200 cal. BC). We present a causal, plausible, relationship linking climate change, a key resource and human culture. Moose (*Alces alces*) disappeared relatively fast from the human culture evidenced by a rapid decrease in usage and symbolism. Given the climatic data reconstructed at hand, a drastic change towards colder and wetter conditions seems to have happened 4200–3600 BP, which affected moose population numbers and composition significantly. After analyzing multiple data sources we suggest that moose had become very rare due to climate change and that many of the northern Fennoscandian hunting cultures had no choice but to change their subsistence pattern and, perhaps, change their general way of life, as a response to the altered situation. Linking the past to the present we speculate whether climate change as the primary driver, together with human harvest as the secondary, can result in fast extinction of a key species.

KEYWORDS 4000 BP, northern Fennoscandia, moose, climate, humans, changes

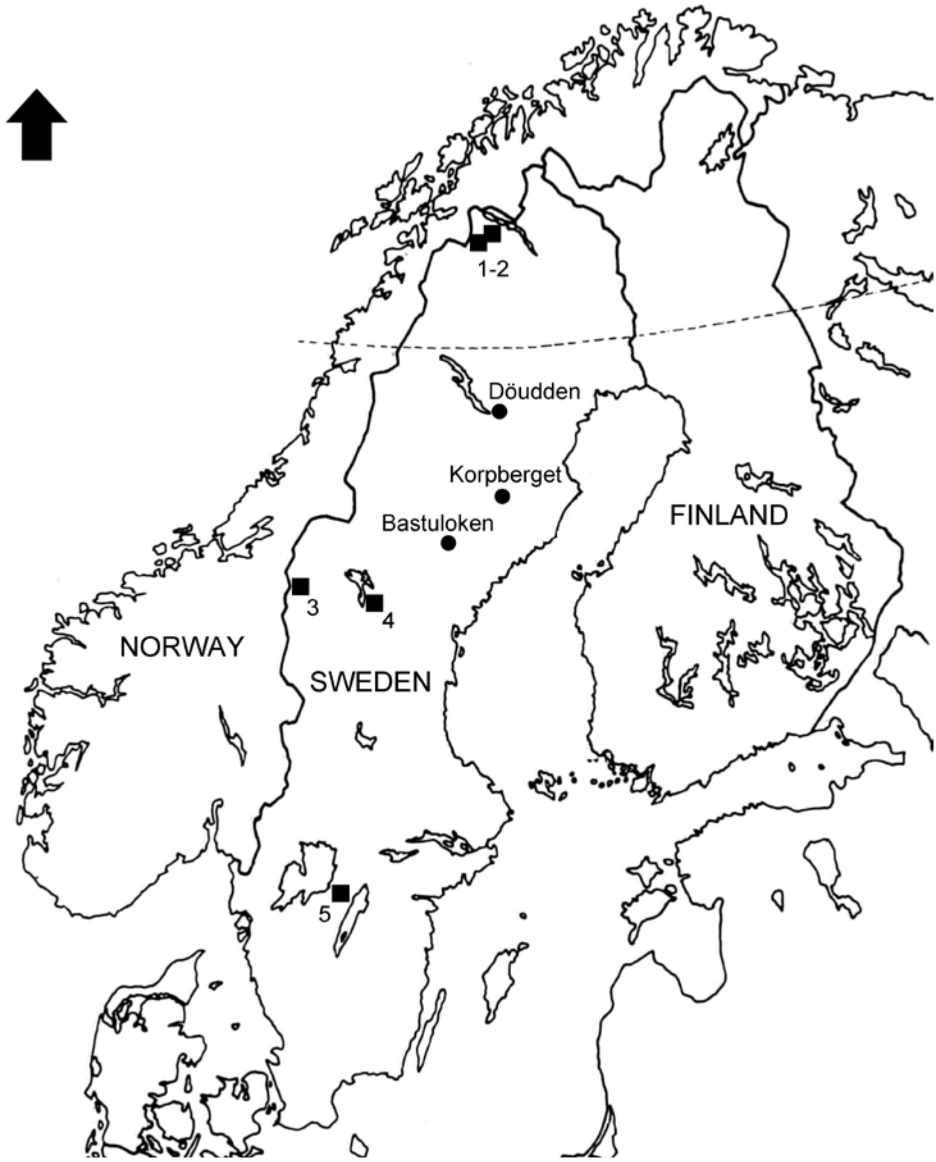


Fig. 1. Map of Fennoscandia with three of the archaeological sites mentioned in the text marked. The square symbols mark sites with lake isotope records used in this study: 1–2) Alakkasjaure; 3) Spåime; 4) Blektjärnen; 5) Igelsjön.

Introduction

The abrupt climate change that occurred around 4000 cal. yr. BP (see Fig. 2) coincides with a major societal change among the hunting communities of northern Fennoscandia. The distinct period 4200–3800 cal. yr. BP marks the very end of a more than two millennia long economic and cultural relationship between moose and man. It is the termination of this bond and its potential cause that is the focus of this paper. The change in the northern hunting communities occurring about 4000 BP has been known for a long time among archaeologists, but it has mainly been interpreted in sociocultural terms (e.g. Baudou 1978; Baudou 1992; Forsberg 1985; Forsberg 1988).

The key question is which environmental change scenario can best explain the sudden disappearance of moose from available data sources as evidenced by archaeological data and cultural representation? Most likely the answer lies in the combination of how moose life history evolved (i.e. how an individual optimizes its resources over the entire life span to balance reproduction and survival (Stearns 1992; Ericsson & Wallin 2001; Ericsson *et al.* 2001)) and short-term climatic variation mediated via forage availability and plant quality (Albon & Langvatn 1992; Fryxell & Sinclair 1988; Ericsson, Ball & Danell 2002). We lay the foundation for our analysis by starting with exploring the human culture at that time. The dates in this paper are given as cal. years (yr) BP, unless otherwise noted.

Compared to South and Middle Sweden, the evidence of farming is extremely sparse in Northern Sweden during the transition from the Neolithic to the Epineolithic period. Some of the earliest indications of farming are provided by pollen analyses from the Bothnian coast in the province of Medelpad (4600 BP; Huttunen & Tolonen 1972), and carbonized seeds have been found at the excavation of a Neolithic coastal settlement at Bjästamon in Västernorrland (4600–4500 BP; Runeson 2007: 94–95). In the interior of Northern Sweden there is no early evidence of farming, but plant food may have been a complement to meat and fish. Instead, an abundance of archaeological data from the Mesolithic and Neolithic periods strongly suggests that hunting and trapping wildlife, combined with fishing, constituted the main subsistence activities, more or less until the first centuries AD (e.g. Baudou 1977: 141; Baudou 1992: 64 f.).

In the hunting/trapping context, one animal in particular—moose (*Alces alces*)—achieved a very special status among the Neolithic human population, both in a symbolic/ritual way, as well as being the main course on the menu (Ekman & Iregren 1984; Spång 1981; Lindgren 2001; Ekholm 2007; Larsson 2009; Larsson 2010a; Larsson 2010b). As early as the late Paleolithic era, bones from moose are found in Russia, and during the Mesolithic era we witness what has been described as "the Early Holocene expansion of the moose in Eurasia" (Sher 1987: 89 ff.; Holm 1991: 96).

Bones from Neolithic settlements in Northern Sweden (Ekman & Iregren 1984) show that moose and beaver (*Castor fiber*) were the two most hunted mammalian species. Moose has a long history in the northern parts of Europe, Russia and Siberia as an animal of ritual importance. Archaeological sources strongly indicate that moose played a significant role in the metaphysical, ritual and artistic dimension of the northern hunter's worldview (Tilley 1991; Lindgren 2001; Lindgren 2002; Fandén 2002). For example, moose-head staffs of antlers from the Oleniy-Ostrov cemetery in Lake Onega, are dated to c. 7500 BP (Gurina 1956; Carpelan 1977; Lindqvist 1994: 240 ff.; Zhul'nikov 2006: 172). The distribution of moose- and bear-related artefacts from the Mesolithic and Neolithic eras in north-western Eurasia is illustrated by Fig. 3.

Climate Change

The long term evolution of Holocene temperature change in Fennoscandia, with an early- to mid-Holocene warm period and a late-Holocene cooling, has mainly been reconstructed using fossil plant evidence in lakes and peat archives (e.g. Bjune *et al.* 2004; Davis *et al.* 2003; Barnekow *et al.* 2008; Seppä *et al.* 2009). Data with higher temporal resolution indicates that shorter-term smaller temperature anomalies (e.g. Seppä *et al.* 2009) and vegetation shifts (e.g. Hammarlund *et al.* 2004; Karlsson *et al.* 2007) occurred superimposed on the general trend. Reconstructions of past changes in lake and peat bog hydrology indicate that significant regional shifts in precipitation also occurred. A key event was the synchronous and dramatic shift that occurred around 4000 BP (Hammarlund *et al.* 2003; Rosqvist *et al.* 2004; Rosqvist *et al.* 2007; Väliranta *et al.* 2007; St. Amour *et al.* 2010; Andersson *et al.* 2010; Charman *et al.* 2009; Jonsson *et al.* 2010a).

Reconstructed annual and July temperature deviations based on pollen and chironomids (not biting midges) reveal that small negative annual temperature (0.1 C) and July temperature (0.2 C) deviations occurred around 4000 cal yr BP (Seppä *et al.* 2009; Velle *et al.* 2005). These fairly small deviations in temperature can hardly explain the detected vegetation shifts in the alpine tree line zone (Hammarlund *et al.* 2004; Karlsson *et al.* 2007).

Reconstructions of past changes in oxygen isotopic composition of lake waters show a common and rapid response to a major change in precipitation after 4200 cal yr BP. Two of the studied lakes are located above the present tree line, in Jämtland and northern Swedish Lapland (Fig. 2). These are through flow systems with relatively short lake water residence time

(Jonsson *et al.* 2010b; St. Amour *et al.* 2010). From the through flow lake records we infer that the amount of winter precipitation increased and that melting snow influenced the lake water isotope composition over the summer, which has been recorded by the diatoms and aquatic cellulose used for the reconstructions. The lower temperatures (Seppä *et al.* 2009) shortened the ice and snow free period. A comparison between isotopic records from these lakes and meteorological parameters over the past c. 150 years shows that the general isotope depletion occurring over this time period, and the isotope minima occurring at the end of the 1980s/early 1990s can best be explained by an increase in winter precipitation (Jonsson *et al.* 2010b). This increase can be related in turn to the North Atlantic Oscillation's (NAO) positive phase.

The change detected in the isotope records in the closed lakes (Västergötland and Jämtland) at the same time is also best explained by a relative increase in winter precipitation, which depleted the lake water (which is recorded by the authigenic and biogenic carbonates in the lakes), and by cooler and probably also more humid summers which decreased evaporation (Hammarlund *et al.* 2003; Andersson *et al.* 2010).

From the simultaneous response in all these lakes (Fig. 2) we infer that

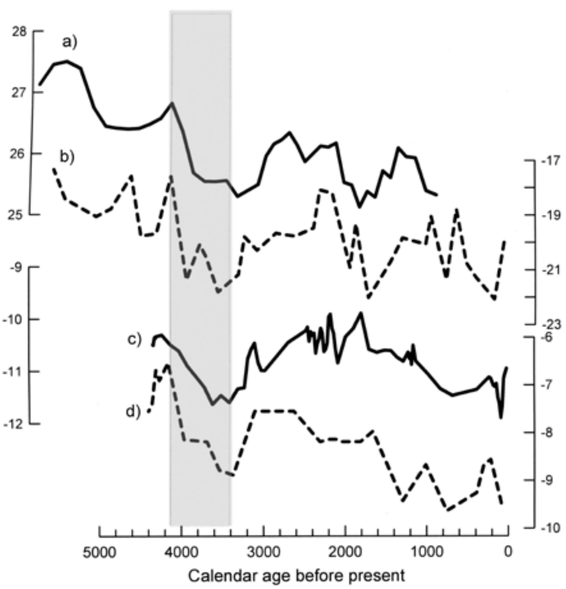
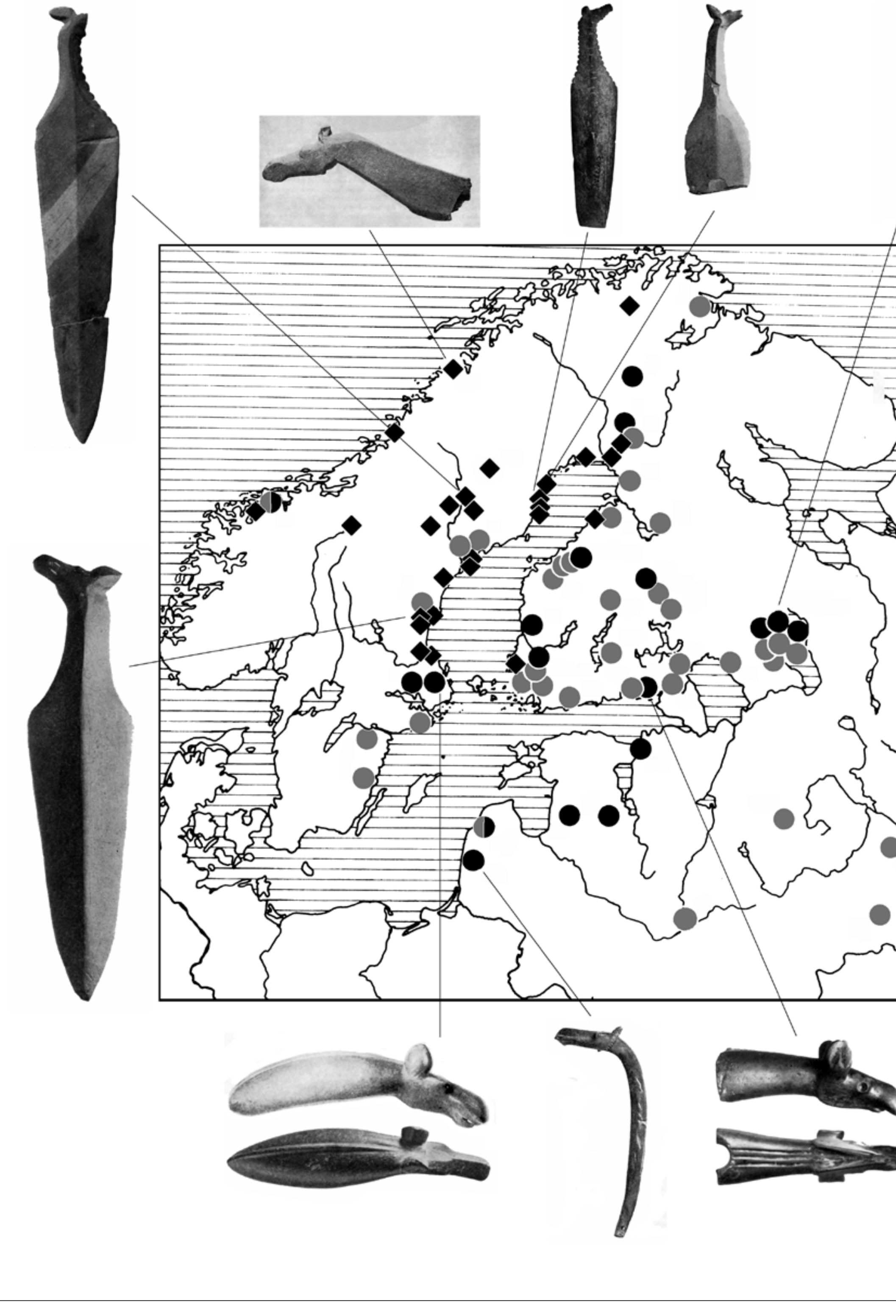


Fig. 2. Four climate reconstructions based on stable isotopes in lake sediments. a) $\delta^{18}O$ from diatoms, Vuolep Alakkasjaure, Lapland (Rosqvist *et al.* 2004); b) $\delta^{18}O$ from aquatic cellulose, Lake Spåime, Jämtland (St. Armour *et al.* 2010); c) $\delta^{18}O$ from carbonate, Lake Blektjärnen, Jämtland (Andersson *et al.* 2010); d) $\delta^{18}O$ from carbonate, Lake Igelsjön, Västergötland (Hammarlund *et al.* 2003).



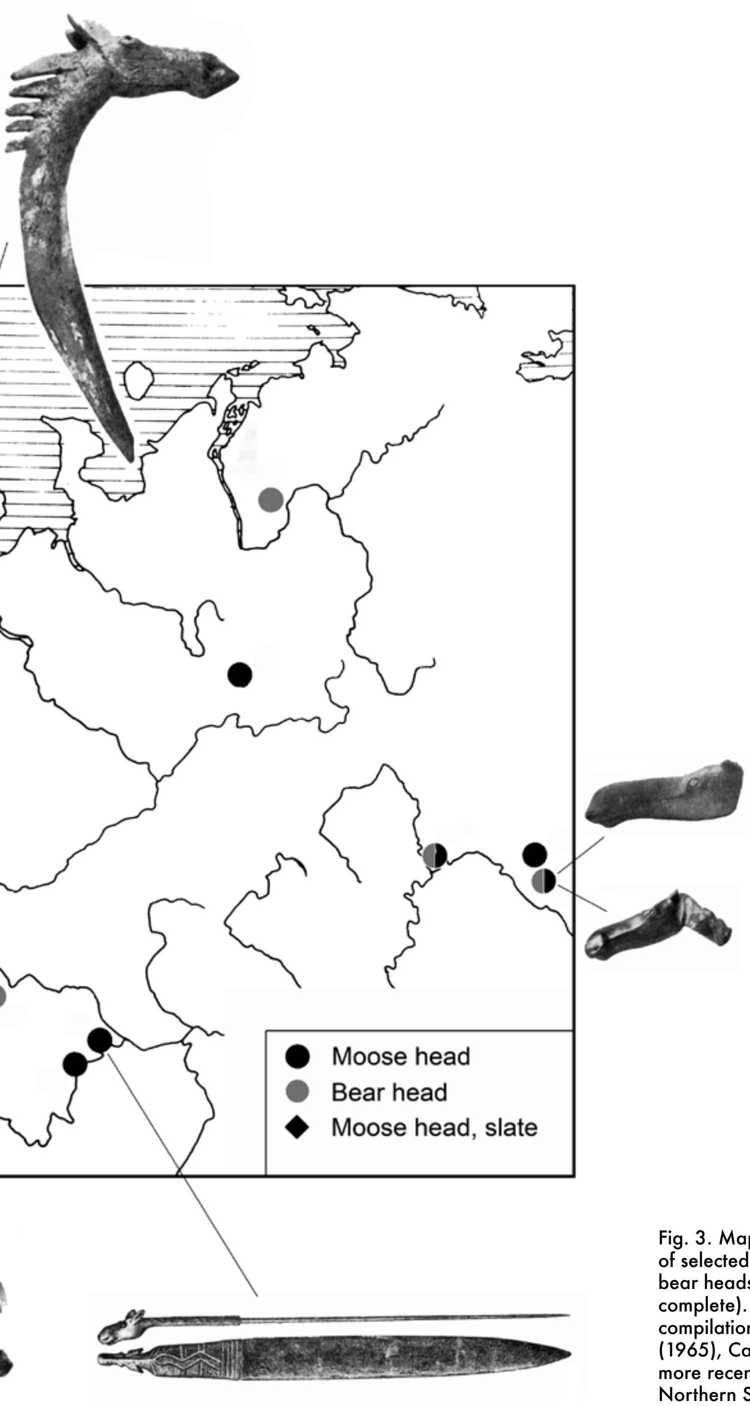


Fig. 3. Map showing the distribution of selected artefacts with moose and bear heads in Northern Europe (not complete). The map is based on a compilation of data from Meinander (1965), Carpelan (1977) and some more recent finds of slate items from Northern Sweden.

the rapid shift in precipitation after 4200 cal yr BP must have been caused by a significant and persistent change in atmospheric circulation, which was most likely associated with a shift in the NAO pattern. The palaeoclimatic data indicates that this climate deterioration lasted almost 1000 years.

We conclude that the increase in winter precipitation, which prolonged the snowmelt period and shortened the vegetation period had, together with the minor lowering of temperature (Seppä *et al.* 2009), a significant effect on natural resources and on human society.

Archaeological Evidence

The Neolithic harvesting of moose is particularly evident when excavating a certain type of site in the interior of Northern Sweden, characterized by semi-subterranean structures with a surrounding embankment (Swedish *boplatsvall*). The structures have been interpreted as walls surrounding houses, used mainly during the winter (Janson & Hvarfner 1960: 34; Rydström 1984; Baudou 1977: 98; Baudou 1992: 62; Lundberg 1997: 125 ff.; Spång 1997: 87 ff.). On these sites bones of moose comprise 90–98 per cent of all the bones found at excavations, while the rest mainly derives from beaver (Ekman & Iregren 1984; Lundberg 1997: 114; Ekholm 2007; Larsson 2009; Larsson 2010a; Larsson 2010b; Larsson *et al.* 2009).

According to available archaeological information, the primary use of the embanked semi-subterranean structures in the interior of Northern Sweden with traces of large-scale moose processing ended around 3700 BP (Lundberg 1997).

A recent excavation of a small part of an embankment (5 m^3) of a semi-subterranean structure at Bastuloken in Västernorrland, Sweden, produced 30 kilos of unburnt bones from moose (Storå *et al.* 2011). According to the osteological analysis of the bones from the site, the intense splintering of even the smaller toe-bones from moose (to get the marrow) might be an indication of food shortage (Storå *et al.* 2011: 58)—a signal of a declining moose population in the area.

Twelve pieces of bone from different stratigraphical layers (by 10 cm in depth) have been ^{14}C dated (Larsson 2009; Larsson 2010a). The excavated part of the embankment had accumulated moose bones during a period of c. 500–600 years (4400–3800 BP), and the most intense bone deposition occurred at the beginning of that phase, between 4400 and 4200 BP (Fig. 4). If we transform these figures to cal. BC (2δ), the most intense phase took place 2500–2275 cal. BC. During the two first centuries of moose processing at Bastuloken, about 80 per cent of the total amount of bones in this part of the embankment was deposited. During the following 400 years, the

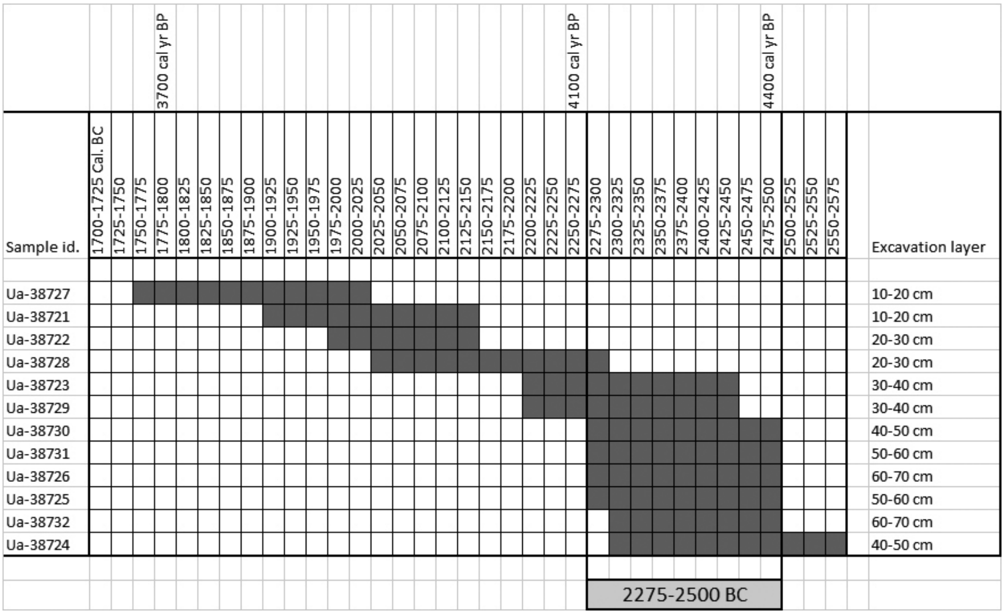


Fig. 4. Twelve ^{14}C dates (2δ) from the embanked site at Bastuloken, Västernorrland, Sweden, arranged in a chronological sequence. Each box represents a time interval of 25 years.

accumulation of bones was less intense. This is indicated by the increased temporal distance between the dates for each excavated layer from the period after 4100 BP (Fig. 4). We can also see that the older layers contain more moose bones from smaller individuals than in the later strata (Storå *et al.* 2011: 61). This might indicate a changed harvesting pattern where larger animals were preferred, or it indicates reduced reproductive performance and consequently a higher proportion of older and thus larger animals in the entire moose population during the period 4400–3800 BP.

If we are to interpret the information given by the ^{14}C dates, the construction was established shortly after 4500 BP, and the moose related activities were very intense during the first two centuries. After that short "overture" something happened; perhaps the climate change discussed above, which drastically reduced the moose population in the region. The date 3800 BP marks the beginning of the end at Bastuloken, and the structure was abandoned, at least for moose processing purposes.

Data from the osteological report by Ekman and Iregren has been used to inform on the presence/absence of bones from moose, reindeer and beaver from excavated and dated sites. For example, from the Neolithic period 20 sites contained bones from moose, 20 sites had bones from beaver, while only 5 sites contained bones from reindeer. According to this data, both moose and beaver have their peak during the Neolithic era. If calculating the importance of the three species in terms of body weight, Ekman and Iregren (1984: 38) are very specific: "The total dominance of elk [moose] is fully evident from the table. The yields of beaver and reindeer are of only marginal importance compared with the elk."

An osteological analysis of material from Döudden—a prehistoric settlement with three chronological layers, close to Arjeplog in Norrbotten, Sweden—also shows the decrease in moose harvesting after 4200 BP (Bergman 1995: 108 ff.). The dating of the layers is: Layer A 7200–5800 BP; Layer B 4200–3400 BP; Layer C 1800–1600 BP (Bergman 1995: Table 17). Bones from moose dominate Layer A, while bones from beaver and reindeer are in total dominance in Layer B. In the youngest phase, Layer C, the moose bones, once again, dominate the scene, even if the absolute quantity of bones is lower compared with Layer A (Bergman 1995: Tables 20–21). The shifting frequency of moose bones from the different chronological layers at Döudden fits nicely with the general model proposed in this paper, suggesting climate change causing a period of "moose drought" between c. 4000 and 3000 BP.

Pitfall Traps

In parts of Northern Sweden (Jämtland, Västernorrland and Västerbotten in particular) there are large numbers of preserved pitfall traps from prehistoric and historical times (Kjellström & Selinge 1994: 60 f.). The use and dating of pitfalls have been discussed among archaeologists (e.g. Spång 1981; Spång 1997; Hansson & Rathje 1995/1996; Ramqvist 2007), and this hunting technique was used in Sweden, Norway and Finland for thousands of years. In Sweden it was forbidden by law in 1864. The pitfalls were used for catching both moose and reindeer (*Rangifer tarandus*), and excavations in Finnish Lapland have revealed Neolithic pitfall systems that were mainly used for reindeer trapping, judging from the bone materials found on nearby contemporaneous settlements (Halinen 2005: 111). In the Northern Swedish woodland zone the situation is different, with a pronounced emphasis on moose trapping during the Neolithic era, while reindeer seem to gain in economic importance during the Epineolithic and Early Metal Age (Ekman & Iregren 1984; Forsberg 1985; Aronsson 1991).

Many of the Northern Swedish pitfall traps have been excavated and a compilation of ^{14}C dates from the province of Västerbotten is shown in Fig. 5 (based on Spång 1981 and Selinge 2001). The ^{14}C dates presented by Spång (1981: 284) and graphically presented in Broadbent (1982: 90), are taken from many different excavated sites in Västerbotten, while the dates presented by Selinge (2001: 181) derive from only three pitfall systems along the Stavse stream in Åsele parish. The diagram (Fig. 5) shows a notable gap in dates be-

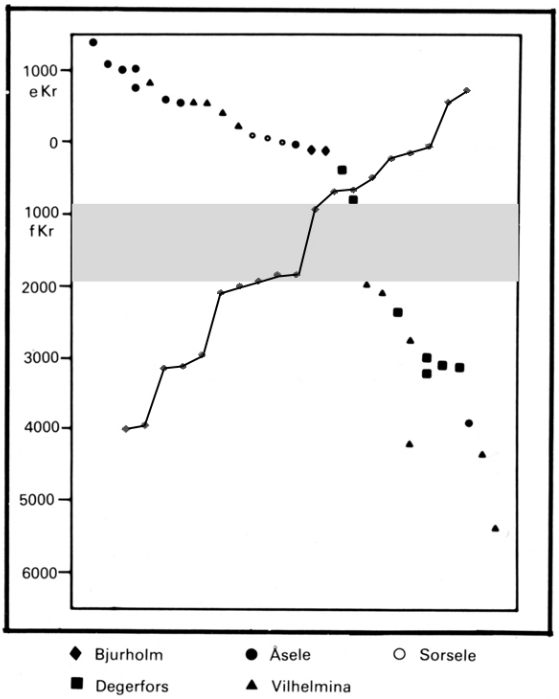


Fig. 5. Compilation of ^{14}C dated pitfall traps (cal. BC) from five parishes in Västerbotten, Sweden (after Spång 1981). The ^{14}C dates connected by a line are from excavated pitfall traps along a single stream (Stavse stream) in Åsele parish (Selinge 2001: 181). The two independent series both show a notable 'gap' between c. 2000 and 1000 cal. BC (4000–3000 cal. yr BP).

tween 4000 and 3000 BP for the Stavse series, and the same gap can be noted for the series presented by Spång (1981). In the province of Jämtland, 88 pitfalls have been ^{14}C dated (by 2004) and only four of these are dated to the Neolithic period (earlier than 4000 BP). Instead, the majority of the dated pitfalls belong to two other chronological phases, one older 3300–2200 BP, and one younger phase, ranging between 1700 and 400 BP (Bengtsson 1993; Lofterud 2005: 27; Ramqvist 2007). Altogether 66 per cent or 58 of the 88 dates from Jämtland belong to the younger phase. The extremely few Stone Age dates from Jämtland mark a major difference if we compare with the dates from the adjacent province of Västerbotten, from which we have distinctive ^{14}C evidence of pitfall trapping during the Neolithic era. Compared to the embanked semi-subterranean structures, which became extinct c. 3800 BP, the pitfall traps were just going through a long but temporary abandonment. A millennium later, some of the old pits were restored and new trapping systems were constructed (Selinge 2001: 181; Ramqvist 2007).

The End of Moose Symbolism and the Beginning of a New Era

Neolithic rock carvings and rock paintings in the region are totally dominated by images of moose, for example at the famous site Nämforsen in Ångermanland, Sweden (Hallström 1960; Larsson & Broström 2011). Also, small stone sculptures as well as ornaments on stone (slate) tools from the Neolithic feature moose heads (Almgren 1911: 152 ff.; Hallström 1960; Baudou 1992; Lindqvist 1994; Lindgren 2001; Lindqvist 2002). At Nämforsen, more than 1000 images of moose were engraved in the naked rock surfaces close to the rapids (Engelmark & Larsson 2005; Larsson & Broström 2011). Here we also find images of humans with moose-head staffs in their hands, similar to the real staffs found in Oleniy-Ostrov (Fig. 3). New ^{14}C results from a recent excavation of a prehistoric settlement downstream of the rapids, suggest that the human activities at Nämforsen started already 6000 BP (Larsson & Olofsson 2006; Larsson 2008). The long-term human activities close to the rock art in Nämforsen have been discussed for a long time by archaeologists (for recent contributions, see Käck 2009 and Sjöstrand 2011), but, interestingly enough, it seems as if the most intense use of the activity area closest to the carvings (the Ställverket site) belongs to a later date than the majority of the moose images, that is, after c. 3700 BP (Ericsson 1996: 44; Käck 2009: 61 ff.). This phase is characterized by bifacially chopped arrow- and spearheads of quartzite or similar materials. So, the major manufacturing and deposition of artefacts at Ställverket in fact occurred slightly after the "palmy days" of rock art.

The rock paintings at Korpberget (two moose images and spots of red colour), in Västerbotten, Sweden, mirror the same phenomenon as Nämforsen, with human activities adjacent to the rock art some centuries after the period of making them. Excavations in 2009 and 2010 at Korpberget revealed a concentration of charcoal dated to 4400 BP (2500 cal. BC), while the artefacts found—27 arrowheads of bifacially chopped quartzite—belong to a later phase, that is, 3700 BP or later (Fig. 6). At both Nämforsen and Korpberget people made images of moose before 3700 BP and in the following centuries they returned to these places to "sacrifice" or manufacture objects of the new material quartzite in great quantities. The arrowheads at Korpberget were found in more or less the same square metre at the excavation, but no traces of chopping debris were found. The arrowheads (or complete arrows) were manufactured elsewhere and brought and deposited (perhaps sacrificed) close to the rock painting.

Arrowheads of quartzite have also been found directly beneath rock paintings (featuring moose, humans and a bear) at Flatruet in Jämtland,

Fig. 6. Photo showing the 27 quartzite points in bifacial technique found when excavating in front of the rock painting at Korpberget, Lycksele (Photo: P. Engman/County Museum of Västerbotten).

Sweden (Hansson 2006). An excavation carried out in 2003 below the painting revealed three arrowheads of quartzite. The points of the arrows were all damaged and splinter was found together with the arrows, indicating that the arrows were actually shot against the painted images. The arrowheads from Korpberget were not damaged in this way.

Once again we can see a time lag between the making of rock art and the later activities in front of them (offerings or rituals), involving the new quartzite material and bifacial chopping technique. The later activities could have been rituals and sacrifices, with the main purpose to bring moose back to the old trapping and hunting grounds—a quite "logical" behaviour in times of drastic climate change and a moose population at the edge of extinction.

Concluding Discussion

We argue that the documented climate change between 4200 and 3800 BP caused a rapid and major drop in moose population in the interior of Norrland. This drop is the main cause behind the archaeologically noted decrease in the amount of moose bones found on excavated settlements from that period and the total abandonment of moose symbolism in society. Further, we believe that the changes in the use of raw materials for tool making recorded at that time—from quarts/slate to quartzite—is related to changes in hunting techniques and strategies, which included and increased exploitation of reindeer (Forsberg 1985). We argue that these observed changes were related to a major decline of moose population, triggered off by an abrupt climate change.

Given a scenario with a drastically changed climate in just a couple of hundred years, moose may be losers that dragged humans along with them or at least changed human culture. The climate reconstructions above show that the weather became wetter and colder. Spring likely arrived later, summers became shorter and maybe autumn also arrived earlier. Moose were thus likely to be affected in several ways during the annual cycle.

Female moose in colder climate with shorter growing seasons will suffer relatively higher costs of somatic effects (body mass, size) on reproduction. Fewer females will be in such a good condition physiologically that they will come into heat and be ready for mating in September–October—given the length of the vegetation period is reduced. Furthermore, females both weaning calves *and* migrating may be less capable to alter both timing of migration and reproduction. Females will therefore most likely increase the time between subsequent litters, further reducing the population growth rate. Despite the harsher conditions in our scenario, some females will reach the physiological threshold later in the autumn. Thus, they will breed later and consequently give birth later and miss the crucial timing to phenology.

Moose in Sweden follow Bergmann's rule with larger body sizes on northern latitudes (Ball *et al.* in revision). In Sweden, from the very north to the very south, the body size difference is in the order of one magnitude roughly correlating with seasonality. As capital breeder it stores energy when conditions are favourable for later use. This is a strategy beneficial in landscapes with a strong seasonal component like in northern Fennoscandia and also buffer so animals can keep a foothold in the landscape. For female moose as capital breeders, the timing of reproduction and the summers are of critical importance, as they are facing conflicting demands from lactating calves and regaining lost body mass.

Overall, put in the historical perspective of climate change, longer winters resulted in shorter vegetation season and a retreat of the forest line. Summers were likely also wetter and somewhat cooler. Although this may not have been detrimental for the living conditions of moose, the shorter growing season and probably deeper snow during winter reduced the reproductive rate and increased the death rate. As a result moose distribution was restricted to the best habitats of the region and as a consequence they became more vulnerable to human persecution. In short, conditions probably worsened so fast that moose could not adapt fast enough or retreated from northern Fennoscandia. The fate of moose thus probably reshaped the whole of human society according to the line of argumentation (Ericsson *et. al.* 2011).

Our argumentation brings us into the old archaeological-anthropological debate on whether hunter-gatherer adaptation to ecological change also produced cultural change (Steward 1955; Binford 2001); an issue most recently addressed by Jordan (2008). If this is a "universal law" or not is not theorized here, but we interpret the events occurring about 4000 BP in the interior of northern Sweden as being triggered by an abrupt climate deterioration causing a major decline of the moose population. The changes that are observable in the archaeological data from Northern Sweden around 4000 BC are illustrated in Fig. 7.

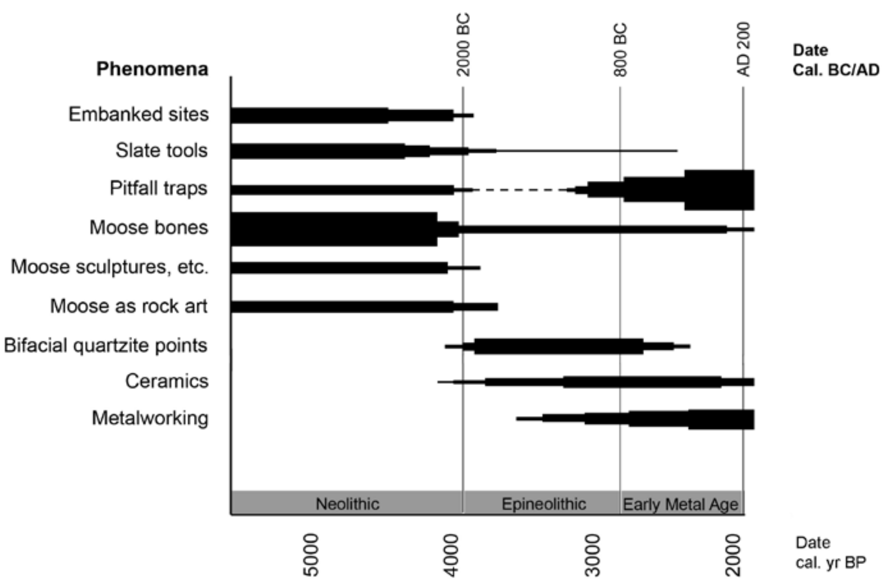


Fig. 7. Major changes in Northern Sweden c. 4000 cal. BP, as evidenced by selected archaeological sources.

The changes observable in the preserved material culture from the subsequent "Epineolithic period" include many new features (Baudou 1978: 17; Baudou 1992: 95 ff.; Forsberg 2010): Chopped points (quartzite) in bifacial technique; Points of Sunderøy type of slate; The introduction of ceramics; The introduction of bronze metalworking (casting).

A major change in the settlement pattern among the North Swedish hunting communities (c. 3800 BP) has been suggested by Forsberg (1985; 1988: 95 ff.), with summer base camps and reindeer trapping in the mountain foothill areas, and winter dwellings in the forest zone.

The exploitation of reindeer in the mountain foothill areas is a new feature in this model, and perhaps a response to a diminishing moose population in the forest area. A colder climate, with increased tundra vegetation in the mountain foothill regions, could have favoured the reindeer population at the same time as it significantly reduced the moose population in the woodlands. In this scenario the changing settlement pattern with hunting camps in higher terrain, as noticed by Forsberg (1985), becomes easy to explain; it was the result of human adaptation to a new major food source, triggered off by drastically changing climate conditions. In Northern Finland reindeer seem to have been a major food resource during both the Neolithic and the Epineolithic periods (Halinen 2005). The decrease in moose hunting and increase in reindeer harvesting in the interior of Northern Sweden during the Epineolithic period, discussed here and by Forsberg (1985), cannot be archaeologically identified in Northern Finland.

In the interior of northern Fennoscandia, the material culture now shows clear signs of eastern contacts, reaching towards Northern Russia and Siberia. This is particularly evident if looking at the thin spear- and arrowheads of quartzite, made in bifacial chopping technique (Baudou 1992: 95; Forsberg 1985). Also, the early pottery (Hulthén 1991; Forsberg 2001) and the types of metal artefacts (and casting moulds) found in this area, point towards eastern connections, maybe as a result of certain individuals' exchange networks, rather than large-scale communal contacts. This idea has recently been applied to the Fennoscandian Epineolithic period by Forsberg (2010), following the "Actor-Network-Theory" outlined by Latour (2005).

Following the hypothesis of climate change as a major cause behind changes in the human exploitation of moose, we must also note that the return of the forest cover in northern Fennoscandia around 1600 BP (as observed by Karlsson *et al.* 2007: 45), correlates extremely well in time with the real boom for the construction of pitfall traps in Northern Sweden (Ramqvist 2007: 170)—the moose had returned in great numbers and the hunt was on! The increase in moose harvesting around 1600 BP is also noted at the settlement at Döudden in Norrbotten (Bergman 1995: Table 21).

The expansion of sedentary farming communities along the Bothnian coast and river valleys (1800–1000 BP), and their need for furs and skins, could also be a factor explaining the "pitfall boom" among the hunters of the interior, with whom the farmers most certainly traded (Ramqvist 2007: 173). It is quite possible that the need for moose products among the farmers coincided with an expansion of the moose population during that time (due to a more favourable climate), making the pitfall traps extremely important. In this scenario, a large part of the moose products were to be traded, instead of forging the social and ritual foundation of the hunter community, as in the "early days." Maybe because of this, the animal never regained its ritual, symbolic or ideological status, even if moose once again became a major economic factor.

REFERENCES

Albon, S. D. & Langvatn, R. (1992). "Plant phenology and the benefits of migration in a temperate ungulate," *Oikos*, 65:3, pp. 502–513.

Almgren, O. (1911). "Ett karelskt stenvapen med älghufvud funnet i Uppland 1. Arkeologisk utredning" ['A Karelian stone weapon with moose head found in Uppland 1. Archaeological investigation'], *Fornvännen*, 1911, pp. 153–163.

Anderssson, S., Rosqvist., G., Blauw, M. & Wastegård, S. (2010). "Late Holocene climate change in central Sweden inferred from lacustrine stable isotope data," *Journal of Quaternary Science*, 25, pp. 1305–1316.

Aronsson, K.-Å. (1991). *Forest Reindeer Herding A.D. 1–1800. An Archaeological and Palaeoecological Study in Northern Sweden* (Archaeology and Environment 10), Umeå: Umeå University.

Ball, J. P., Lundmark, C., Ericsson. G., Wallin, K., & Danell, K. (in revision). "Bergmann's rule, Allen's rule, and snow. Testing hypotheses of geographic variation in moose morphology."

Barnekow, L., Bragé, P., Hammarlund, D. & St. Amour, N. (2008). "Boreal forest dynamics in north-eastern Sweden during the last 10,000 years based on pollen analysis," *Vegetation History and Archaeobotany*, 17, pp. 687–700.

Baudou, E. (1977). "Den förhistoriska fångstkulturen i Västernorrland" ['The prehistoric hunting culture in Västernorrland'], in *Västernorrlands förhistoria*, eds. E. Baudou & K.-G. Selinge, Härnösand: Västernorrlands läns landsting, pp. 11–152.

— (1978). "Kronologi och kulturutveckling i mellersta Norrland under stenåldern och bronsåldern" ['Chronology and culture developement in Middle Norrland during the Stone and Bronze Age'], in *Studier i norrländsk forntid* 1. *Till Ernst Westerlund 9 november 1975* (Acta Bothniensia occidentalis 1), ed. A. Huggert, Umeå: Västerbottens läns hembygdsförening, pp. 8–18.

— (1992). *Norrlands forntid* ['The prehistory of Norrland'], Höganäs: Wiken.

Bengtsson, P. G. (1993). "Hur gamla är de jämtländska fångstgroparna?" ['How old are the pit-fall traps in Jämtland?'], seminar paper, Mitthögskolan, Östersund.

Bergman, I. (1995). *Från Döudden till Varghalsen* ['From Döudden to Varghalsen'] (Studia Archaeologica Universitatis Umensis 7), Umeå: Umeå University.

Binford, L. R. (2001). *Constructing Frames of Reference. An Analytical Method for Archaeological Theory Building Using Hunter Gatherer and Environmental Data Sets*, Chicago: University of California Press.

Bjune, A. E., Birks, H. J. B. & Seppä, H. (2004). "Holocene vegetation and climate history on a continental-oceanic transect in northern Fennoscandia based on pollen and plant macrofossils," *Boreas*, 33, pp. 211–223.

Broadbent, N. (1982). *Den förhistoriska utvecklingen under 7000 år* ['The prehistoric development during 7,000 years] (Skelleftebygdens historia 3), Skellefteå: Skellefteå kommun.

Carpelan, C. (1977). "Älg- och björnhuvudföremål från Europas nordliga delar" ['Objects with moose and bear heads from the northern part of Europe'], *Finskt Museum*, 82, pp. 5–67.

Charman, D. J., Barber, K. E., Blaauw, M., Langdon, P. G., Mauquoy, D., Daley, T. J., Hughes, P. D. M. & Karofeld, E. (2009). "Climate drivers for peatland palaeoclimate records," *Quaternary Science Reviews*, 28, pp. 1811–1819.

Davis, S., Brewer, S., Stevenson, A. C. & Guiot, J. (2003). "The temperature of Europe during the Holocene reconstructed from pollen data," *Quaternary Science Reviews*, 22, pp. 1701–1716.

Ekholm, T. (2007). "Bastuloken. En osteologisk analys av benmaterialet från en stenåldersboplats i västra Ångermanland" ['Bastuloken. An osteological analysis of bones from a Stone Age settlement in western Ångermanland'], seminar paper in Osteology, Högskolan på Gotland, Visby.

Ekman, J. & Iregren, E. (1984). *Archaeo-zoological investigations in northern Sweden* (Early Norrland 8), Stockholm: Kungl. Vitterhets Historie och Antikvitets Akademien.

Engelmark, R. & Larsson, T. B. (2005). "Nämforsens ristningar nu fler än tvåtusen" ['The rock carvings at Nämforsen, now more than two thousand'], *Populär Arkeologi*, 4, p. 4.

Ericsson, G., Ball, J. P. & Danell, K. (2002). "Moose offspring body mass along an altitudinal gradient," *Journal of Wildlife Management*, 55:1, pp. 91–97.

Ericsson, G., Larsson, T. B., Rosqvist, G. & Jonasson, C. (2011). "Älgen flyr när klimatet ändras" ['Moose disappear when the climate changes'], *Miljötrender*, 4, pp 12–13.

Ericsson, G. & Wallin, K. (2001). "Age-specific moose *Alces alces* mortality in a predator free environment. Evidence for senescence in females," *Ecoscience*, 8, pp. 157–163.

Ericsson, G., Wallin, K., Ball, J. P. & Broberg, M. (2001). "Age-related reproductive effort and senescence in free-ranging moose *Alces alces*," *Ecology*, 82, pp. 1613–1620.

Ericsson, K. (1996). "De norrländska kvartsitspetsarna. En studie av deras datering och betydelsefunktion i det förhistoriska samhället" ['The north Swedish quartzite points. A study of their dating and function in prehistoric society'], seminar paper, Umeå University.

Fandén, A. (2002). *Schamanens berghällar. Nya tolkningsperspektiv på den norrländska hällsristnings- och hällmålningstraditionen* ['The shaman's rocks. New perspectives on the northern Swedish petroglyphs'], Nälden: Lofterud produktion.

Forsberg, L. (1985). *Site Variability and Settlement Patterns* (Archaeology and Environment 5), Umeå: Umeå University.

— (1988). "Bosättningsmönster vid Lule och Ume älv under bronsålder och förromersk järnålder" ['Settlement patterns along the Lule and Ume rivers during the Bronze and Pre-Roman Iron Ages'], *Arkeologi i Norr*, 1, pp. 51–101.

— (2001). "Keramiken från Råingetlokalerna" ['The ceramics from the Råinget localities'], *Tidsspår*, 2001, pp. 129–150.

— (2010). "The spread of new technologies in Early Fennoscandia. A view without borders," in *Transference. Interdiciplinary Communications 2008/2009*, ed. W. Østreng, Oslo; www.cas.uio.no/publications_/transference.php; access date 14 May 2012.

Fryxell, J. M., & Sinclair, A. R. E. (1988). "Causes and consequences of migration by large herbivores," *Trends in Ecology and Evolution*, 3, pp. 237–241.

Gurina, N. N. (1956). Гурина, Н. Н. *Оленеостровский могильник* (Материалы и исследования по археологии СССР 47) ['The burial ground at Oleneostrov (Materials and research in Archaeology in the USSR 47)'], Moscow & Leningrad: Izd. Akademii Nauk.

Halinen, P. (2005). *Prehistoric Hunters of Northernmost Lapland. Settlement Patterns and Subsistence Strategies* (Iskos 14), Helsinki: Suomen muinaismuistoyhdistys.

Hallström, G. (1960). *Monumental Art of Northern Sweden from the Stone Age. Nämforsen and other Localities*, Stockholm: Almqvist & Wiksell.

Hammarlund, D., Björck, S. J., Buchardt, B., Israelson, C. & Thomsen, C. T. (2003). "Rapid hydrological changes during the Holocene revealed by stable isotope records of lacustrine carbonates from Lake Igelsjön, southern Sweden," *Quaternary Science Reviews*, 22, pp. 353–370.

Hammarlund, D., Velle, G., Wolfe, B. B., Edwards, T. W. D., Barnekow, L., Bergman, J., Holmgren, S., Lamme, S., Snowball, I. F., Wohlfarth, B. & Possnert, G. (2004). "Palaeolimnological and sedimentary responses to Holocene forest retreat in the Scandes Mountains, west-central Sweden," *The Holocene*, 14, pp. 862–876.

Hansson, A. (2006). "The rock paintings at Flatruet. An archaeological survey," *Adoranten*, 2006, pp. 109–115.

— & Rathje, L. (1995/1996). "Den som gräver en grop åt andra" ['The one who digs a pit for others'], *Arkeologi i Norr*, 8/9, pp. 23–42.

Holm, L. (1991). *The Use of Stone and Hunting of Reindeer. A Study of Stone Tool Manufacture and Hunting of Large Mammals in the Central Scandes c. 6000–1 BC* (Archaeology and Environment 12), Umeå: Umeå University.

Hulthén, B. (1991). *On Ceramic Ware in Northern Scandinavia during the Neolithic, Bronze and Early Iron Age. A Ceramic-Ecological Study* (Archaeology and Environment 8), Umeå: Umeå University.

Huttunen, P. & Tolonen, M. (1972). "Pollen-analytical studies of prehistoric agriculture in northern Ångermanland," in *Palaeo-Ecological Investigations in Northern Sweden*, ed. P. Huttunen, Stockholm: Kungl. Vitterhets Historie och Antikvitets Akademien, pp. 9–34.

Janson, S. & Hvarfner, H. (1960). *Från norrlandsälvar och fjällsjöar* ['From Norrland's rivers and mountain lakes'], Stockholm: Riksantikvarieämbetet.

Jonsson, C. E., Andersson, S., Rosqvist, G. & Leng, M. J. (2010a). "Reconstructing past atmospheric circulation changes using oxygen isotopes in lake sediments from Sweden," *Climate of the Past*, 6:1, pp. 49–62.

Jonsson, C. E., Rosqvist, G. C., Leng, M. J., Bigler, C., Bergman, J., Tillman, P. K. & Sloane, H. J. (2010b). "High-resolution diatom $\delta^{18}O$ records, from the last 150 years, reflecting changes in amount of winter precipitation in two sub-Arctic high-altitude lakes in the Swedish Scandes," *Journal of Quaternary Science*, 25, pp. 918–930.

Jordan, P. (2008). "Tracking 'technological choice' amongst northern hunter gatherers," in *Archaeology of Settlements and Landscape in the North* (Vuollerim Papers on Hunter-Gatherer Archaeology 2), ed. A. Olofsson, Vuollerim: Vuollerim 6000 år, pp. 81–111.

Käck, J. (2009). *Samlingsboplatser* ['Aggregation sites'] (Studia Archaeologica Universitatis Umensis 24), Umeå: Umeå University.

Karlsson, H., Hörnberg, G., Hannon, G. & Nordström, E.-M. (2007). "Long-term vegetation changes in the northern Scandinavian forest limit. A human impact-climate synergy?" *The Holocene*, 17, pp. 37–49.

Kjellström, R. & Selinge, K.-G. (1994). "Fångst och fängsel" ['Trapping and traps'], in *Sveriges Nationalatlas. Kulturminnen och kulturmiljövård*, ed. K.-G. Selinge, Stockholm: Sveriges Nationalatlas, pp. 60–63.

Larsson, T. B. (2008). *Arkeologisk undersökning av Raä 158, Ådals-Liden sn, Ångermanland 2006* ['Archaeological excavation 2005 of Raä 158, Ådals-Liden parish, Ångermanland'] (UMARK 48), Umeå: Umeå University.

— (2009). *Arkeologisk delundersökning av boplatsvall, Raä 183, Ramsele sn, Västernorrlands län, 2009* ['Archaeological investigation of embanked settlement, 2009, Raä 183, Ramsele parish, County of Västernorrland'] (UMARK 52), Umeå: Umeå University.

— (2010a). *Arkeologisk delundersökning av boplatsvall, Raä 183, Ramsele sn, Västernorrlands län, 2010* ['Archaeological investigation of embanked settlement, 2010, Raä 183, Ramsele parish, County of Västernorrland'] (UMARK 58), Umeå: Umeå University.

— (2010b). "Människan och älgen vid Bastuloken. En delundersökt boplatsvall från neolitikum i Västernorrland" ['Humans and moose at Bastuloken. A partly excavated embanked Neolithic settlement in Västernorrland'], *Arkeologi i Norr*, 12, pp. 1–16.

— & Broström, S.-G. (2011). *The Rock Carvings at Nämforsen, Sweden. The Survey 2001–2003* (UMARK 62), Umeå: Umeå University.

Larsson, T. B., Grabowski, R. & Ericsson, G. (2009). *Arkeologisk delundersökning av boplatsvall, Raä 471:1, Sorsele sn, Västerbottens län, 2009* ['Partial archaeological excavation of embanked settlement, 2009, Raä 471:1, Sorsele parish, County of Västerbotten'] (UMARK 53), Umeå: Umeå University.

Larsson, T. B. & Olofsson, J. (2006). *Arkeologisk undersökning 2005 av Raä 158, Ådals-Liden sn, Sollefteå kommun* ['Archaeological excavation 2005 of Raä 158, Ådals-Liden parish, Sollefteå rural district'] (UMARK 43), Umeå: Umeå University.

Latour, B. (2005). *Reassembling the Social. An Introduction to Actor-Network-Theory*. Oxford: Oxford University Press.

Lindgren, B. (2001). "Hällbilder. Kosmogoni och verklighet" ['Rock art. Cosmogony and reality'], *Tidsspår*, 2001, pp. 43–81.

— (2002). "Hällmålningar. Ett uttryck för materiella och immateriella dimensioner" ['Rock art. An expression of material and immaterial dimensions'], in *Hällbilder & hällbildernas rum* (Studier i regional arkeologi 2), eds. L. Klang, B. Lindgren & P. H. Ramqvist, Örnsköldsvik: Regional Arkeologi, pp. 55–75

Lindqvist, A.-K. (2002). "Stenåldersboplatsen vid Kornsjövägen i norra Ångermanland" ['The Stone Age settlement at Kornsjövägen in Northern Ångermanland'], in *Hällbilder & hällbildernas rum* (Studier i regional arkeologi 2), eds. L. Klang, B. Lindgren & P. H. Ramqvist, Örnsköldsvik: Regional Arkeologi: pp. 77–86.

Lindqvist, C. (1994). *Fångstfolkets bilder. En studie av de nordfennoskandiska kustanknutna jägarhällristningarna* ['The hunters' pictures. A study of the north Fenno-Scandian coastal hunters' rock-engravings'] (Theses and Papers in Archaeology 5), Stockholm: Stockholm University.

Lofterud, K. (2005). *Älggropar* ['Moose pits'], Nälden: Lofterud produktion.

Lundberg, Å. (1997). *Vinterbyar* ['Winter villages'] (Studia Archaeologica Universitatis Umensis 8), Umeå: Umeå University.

Meinander, C. F. (1965). "Skifferknivar med djurhuvudskaft" ['Slate knives with handles with animal heads'], *Finskt Museum*, 71 (1964), pp. 5–33.

Ramqvist, P. H. (2007). "Fem Norrland. Om norrländska regioner och deras interaktion" ['Five Norrland. About Northern Swedish regions and their interaction'], *Arkeologi i Norr*, 10, pp. 153–180.

Rosqvist, G., Jonsson, C. E., Karlén W., Yam, R. & Shemesh, A. (2004). "Diatom oxygen isotopes in pro-glacial lake sediments from northern Sweden. A 5,000 year record of atmospheric circulation," *Quaternary Science Reviews*, 23:7–8, pp. 851–859.

Rosqvist, G., Leng, M. J. & Jonsson. C. E. (2007). "North Atlantic region atmospheric circulation dynamics inferred from a Late-Holocene lacustrine carbonate isotope record, northern Swedish Lapland," *The Holocene*, 17:7, pp. 867–873.

Runeson, H. (2007). "Den goda ordningen" ['The good order'], in *Stenålderns stationer. Arkeologi i Botniabanans spår*, eds. P. Gustafsson & L. G. Spång, Stockholm: Riksantikvarieämbetet, pp. 71–115.

Rydström, G. (1984). "The fire-cracked stone mound. A winter settlement," in *Papers in Northern Archaeology* (Archaeology and Environment 2), ed. E. Baudou, Umeå: Umeå University, pp. 75–86.

Selinge, K.-G. (2001). "Fångstgropar i Nämforsens uppland" ['Pitfall traps in the uplands of Nämforsen'], *Tidsspår*, 2001, pp. 153–186.

Seppä, H., Bjune, A. E., Telford, R. J., Birks, H. J. B. & Veski, S. (2009). "Last nine-thousand years of temperature variability in Northern Europe," *Climate of the Past*, 5:3, pp. 523–535.

Sher, A. V. (1987). "History and evolution of moose in USSR" (Proceedings of the Second International Moose Symposium, Uppsala [Sweden], 21–25 Aug. 1984), *Swedish Wildlife Research*, Suppl. 1:1, pp. 71–79.

Sjöstrand, Y. (2011). *Med älgen i huvudrollen. Om fångstgropar, hällbilder och skärvstensvallar i mellersta Norrland* ['With moose as the leading part. On pitfall traps, rock art and fire-cracked stone embanked settlements in Middle Norrland'] (Stockholm Studies in Archaeology 55), Stockholm: Stockholm University.

Spång, L.-G. (1981). "Fångstgropar. Lämningar efter forntida älgfångst" ['Pitfall traps. Remains of prehistoric moose trapping'], *Västerbotten*, 4, pp. 282–290.

— (1997). *Fångstsamhälle i handelssystem* ['Hunting community in a trading system'] (Studia Archaeologica Universitatis Umensis 9), Umeå: Umeå University.

St. Amour, N. A., Hammarlund, D., Edwards, T. W. D. & Wolfe, B. B. (2010). "New insights into Holocene atmospheric circulation dynamics in central Scandinavia inferred from oxygen-isotope records of lake-sediment cellulose," *Boreas*, 39, pp. 770–782.

Stearns, S. C. (1992). *The Evolution of Life Histories*, Oxford: Oxford University Press.

Steward, J. H. (1955). "The concept and method of cultural ecology," in *Theory of Cultural Change. The Methodology of Multilinear Evolution*, J. H. Steward, Urbana: University of Illinois Press, pp. 30–42.

Storå, J., Strand, L. & Fridén-Rolstadaas, M. (2011). *Osteologisk analys av obrända och brända skelettfynd från stenålderslokalen Bastuloken Raä 183, Ramsele sn, Västernorrlands län* ['Osteological analysis of unburnt and bunt skeleton findings from the Stone Age site Bastuloken, Raä 183, Ramsele parish, County of Västernorrland'] (Rapport 2011:10), Osteologiska forskningslaboratoriet, Stockholm: Stockholm University.

Tilley, C. (1991). *Material Culture and Text. The Art of Ambiguity*, London: Routledge.

Väliranta, M., Korhola, A., Seppä, H., Sarmaja-Korjonen, K., Tuittila, E.-S., Laine, J. & Alm, J. (2007). "High-resolution reconstruction of wetness dynamics in a southern boreal raised bog, Finland, during the late Holocene: A quantitative approach," *The Holocene*, 17, pp. 1093–1107.

Velle, G., Brooks, S. J., Birks, H. J. B. & Willassen, E. (2005). "Chironomids as a tool for inferring Holocene climate. An assessment based on six sites in southern Scandinavia," *Quaternary Science Reviews*, 24, pp. 1429–1462.

Zhul'nikov, A. M. (2006). Жульников. А. М. *Петроглифы Карелии. Образ мира и миры образов* ['Petroglyphs of Karelia. World picture and the worlds of the pictures'], Petrozavodsk: Skandinavia.