Introduction

The research about the prehistoric settlement in Norrland and Dalarna (an area of 270,924 km², see Figure 1) covering the Mesolithic period, 9000-4000 cal BC, has previously mainly focused on chronology, lithic technology and settlement organisation (Baudou, 1992: 55; Bergman et al., 2004; Knutsson and Knutsson, 2012; Olofsson, 2003). More recently, research has been oriented towards climate change, specifically the effects of the 8.2 k cold event, one of several cold periods in prehistory. It has been done by studying demographic fluctuations by ¹⁴C sum probability distributions as proxies (Apel et al., 2018; Manninen, 2014; Persson, 2017). The purpose of the present study is to investigate the movement of people into the ice-free areas of Norrland and Dalarna and their adaption to a changing environment. Only few dated contexts from this time period existed, and the establishment of a more detailed chronology and identification of hunted animals was needed. To accomplish this, burnt faunal specimens from Mesolithic sites with zooarchaeological assemblages were selected, analysed and dated.

As a preparation for the research presented in this paper, two pilot investigations were made; A cross-check of radiocarbon dates from stone age sites in northern Sweden (Ekholm, 2015a) and Mesolithic settlements in northernmost Sweden; economy, technology, chronology (Ekholm, 2016). The first paper deals with the reliability of the results from radiocarbon dated charcoal samples from previous excavations to test their usefulness for this study. To cross-check the results, samples from the analysed zooarchaeological record from the same features and contexts were radiocarbon dated as well, since they were expected to represent the actual occupation of the sites. The results from the charcoal samples indicated that they were reliable and useful for the study of long-term processes, but only as long as they were sampled correctly from contexts, since charcoal can derive from a forest fire, for example, whereas calcined bones are burnt on purpose. The second paper was a pilot study for the research in this paper, and it focused on comparing faunal data from Mesolithic sites from Norrbotten (BD in Figure 1b), with the surrounding area. Samples of burnt bone of known species and mainly from sealed contexts were chosen for radiocarbon dating. The results were discussed in relation to radiocarbon dated bone samples from a wider regional context, with a special focus on northern Finland. The present paper is an extension of that study.

Background

The last remnant of the Weichselian ice sheet covered Norrland during the preboreal (9600-8000 cal BC). This area was thus the last part of northern Europe to be settled by humans in the early Holocene (Stroeven et al., 2016, Figure 9). As the melting ice exposed new land both in the north and the south, it played an important role in the settlement process. Geological and climatic factors were essential for the introduction of plants, which in turn were essential for the establishment of fauna and humans.
As the ice slowly melted the vegetation from the surrounding areas spread into the newly ice free area. From south and north-east tundra vegetation with light loving herbs, shrubs and bushes established. The earliest plants were generally ranunculus (Ranunculus sp.), horsetail (Equisetum sp.) and dwarf willow (Salix herbacea) followed by bushes and small trees like dwarf birch (Betula nana) and willow (Salix sp.). The earliest trees (birch (Betula sp.), aspen (Populus tremula) and pine (Pinus sylvestris)) entered also very soon (Robertsson, 2009: 136; Väli-ranta et al., 2015: 3).

The earliest vegetation looked the same over the study area, but at around 6000 cal BC Hazel (Corylus avellana) entered Dalarna and Gävleborg, the southern part of the investigation area (Robertsson, 2009: 136). Spruce (Picea sp.) and larch (Larix decidua) on the other hand, entered Norrland from the north at 7000 cal BC and spread to the south, but never reached the mountain area. Later juniper (Juniperus communis) and buckthorn (Hippophaë rhamnoides) also immigrated from north to south (Robertsson, 2009: 136). This indicates that environments north and south of the melting ice had slightly different characteristics which should have had some implications for how the humans entering the area adapted to the new landscapes.

As soon as vegetation became established in the ice-free area, the archaeological record shows that both animals and humans followed (Ekholm, 2016: 14; Knutsson and Knutsson, 2012). The earliest archaeological site in the northern part of the study area, Aareavaara, 9305-8641 cal BC, (Figure 2) (Östlund, 2011: 18), is characterised by a simple quartz industry with no formal tools, reminiscent of the contemporaneous adaption of quartz amongst Early Suomusjärvi cultures to the east. On the oldest site in the southern part of the study area, Orsand, 8812-7611 cal BC, (Figure 2) situated south of the remaining ice, (Lindberg and Sandberg, 2010: 14), a lithic technology of a different character was identified, characterised by a pressure blade technology made from local igneous rock (Knutsson and Knutsson, 2012; Wehlin, 2014a, 2014b). This indicates a contemporaneous presence of humans both north and south of the ice. The idea was presented that the region during the pioneer phase was populated by hunter-gatherers both from the Asian continent in the east and north (Rankama and Kankaanpää, 2008) and from the European continent in the south (Berg-Hansen, 2017) as the ice slowly melted (Figure 3). It is discussed by the study by Günther et al. (2018) about DNA studies of populations migrating to southern Scandinavia.

These pioneer hunter-gatherers that may be associated to two different lithic traditions and two different adaptive strategies, one based on forest game moving in from the Russian taiga and one based on a marine diet (Bang-Andersen, 1989; Kindgren, 1995) living on the west coast of Scandinavia. The population moving in from the east and north were hunter-gatherers of Butovo/Veretye ancestry, deriving from the eastern taiga zone and were characterised by a lithic pressure blade technology, which produced conical cores with a faceted platform. The raw material was Cretaceous flint from Belarus and southern Lithuania and Carboniferous flint from north-western Russia (Zhilin, 2003, 2005). The lithic technology of the people from the south was characterised by a direct percussion blade production strategy, based on one-sided cores with opposed platforms typical of the Ahrensburg- and early Mesolithic cultures in northwestern Europe. Raw materials were mainly derived from ice-transported flint originating in the southernmost areas of Scandinavia (Berg-Hansen, 2017; Bjerck, 2009; Damlien, 2014; Eigeland, 2014; Glerstad, 2013).

The variation in lithic technologies indicates different adaptations to the raw material available in the new virgin landscape and possibly hints at the origins of the two populations that may have met halfway through Norrland where they created a cultural border zone in central Sweden, described in Taberlet et al. (1998) as a suture-zone, as the last of the ice finally disappeared ca 8000 cal BC (Knutsson and Knutsson, 2012; Taberlet et al., 1998: 457, 461).
During the late Preboreal, ca 8300 cal BC, the eastern lithic technology spread through social learning, migration, or both from northernmost Norway, southward along the Norwegian coast down to south Sweden (Bjerck, 1986; Damlien, 2014; Figure 1; Knutsson and Knutsson, 2012; Sørensen et al., 2013; Figure 1). This process created the cultural and demographic background for the subsequent settlement of northernmost Sweden as the ice during the preboreal and boreal slowly melted from the north and from the south. Eastern populations that adjusted to using locally available quartz for toolmaking (Knutsson et al., 2016) moved in from the north and populations from the west that had incorporated pressure blade technology in their cultural tradition, moved in from the south (Sørensen et al., 2013).

This migration theory has also been discussed by ancient DNA (aDNA) analysis. There are samples from northern Europe dated to Early/Middle Mesolithic (Günther et al., 2018; Figure 1a; Table 1) showing that the genome composition in Scandinavian hunter-gatherers (SHG) was a mix of eastern hunter-gatherers (EHG), descending from northeastern and eastern Europe, and western hunter-gatherers (WHG), descending from western, central and southern Europe (Günther et al., 2018; 2; Kashuba et al., 2019). Those results do not inform about the pioneers in the area of northern Fennoscandia, because the only sample possible to extract DNA deriving from that part of this area is from the Norwegian coast and from a later phase, when the SHG already lived in the area for at least 2500 years. There are no samples of human skeletal remains from, or before, the phase when the hypothesised population admixture took place in central Norrland.

In addition to differences in lithic assemblages, cultural differences are also manifest in economic strategies and pathways to exploiting animal resources. Since there is already a hypothesis that two different populations with two different lithic technologies settled the area, it is of interest to study the faunal remains at the sites associated within the realm of each lithic technological tradition. The work on faunal assemblages, presented here, will contribute to discussions of whether or not colonising groups

Table 1. Bone samples collected for the extended radiocarbon dating for the study.

| County            | Sample      | Site                | Raä no. | Context       | Species       | Bone element | Weight (g) |
|-------------------|-------------|---------------------|---------|---------------|---------------|--------------|------------|
| Västerbotten      | Vojmsjön A6:1 | Vojmsjön Vilhelmina 180:1 | –       | Alces alces   | Phalanx I     | 1.1          |
| Västerbotten      | Vojmsjön A6:2 | Vojmsjön Vilhelmina 180:1 | –       | Alces alces   | Phalanx II    | 2.5          |
| Västerbotten      | Vojmsjön A1:1 | Vojmsjön Vilhelmina 180:1 | Hearth  | Alces alces   | Phalanx II    | 2.5          |
| Västerbotten      | Vojmsjön A1:2 | Vojmsjön Vilhelmina 180:1 | Hearth  | Alces alces   | Phalanx II    | 2.5          |
| Tärna 1           | Tärna       | Tärna 550:1         | Cooking pit | Rangifer tarandus | Carpus 4     | 1.3          |
| Tärna 2           | Tärna       | Tärna 550:1         | Cooking pit | Rangifer tarandus | Radius 3     | 3.1          |
| Åsele 1           | Åsele       | Åsele 125:1         | Site    | Alces alces   | Phalanx I     | 1.6          |
| Åsele 2           | Åsele       | Åsele 125:1         | Site    | Alces alces   | Phalanx I     | 1.6          |
| Åsele 3           | Åsele       | Åsele 125:1         | Site    | Alces alces   | Phalanx II    | 1.5          |
| Åsele 4           | Åsele       | Åsele 125:1         | Site    | Castor fiber  | Humerus 1     | 1.8          |
| Sävar 1           | Sävar       | Sävar 330:1         | Site    | Phoca sp.     | Metatarsus II | 1.6          |
| Västerdal 1       | Västerdal   | Umeå 510:1          | Site    | Phoca hispida | Calcanus 4    | 4.4          |
| Västerdal 2       | Västerdal   | Umeå 510:1          | Site    | Phoca hispida | Phalanx II    | 1.0          |
| Garaselet A20     | Garaselet   | Jörn 79:1           | Hearth  | Alces alces   | Talus 1       | 1.2          |
| Garaselet A2      | Garaselet   | Jörn 79:1           | Cooking pit | Castor fiber | Femur 1      | 1.5          |
| Garaselet B1      | Garaselet   | Jörn 79:1           | Bone feature | Castor fiber | Tibia 2      | 2.2          |
| Västernorrland    | Fagerviken 1| Fagerviken Holm 174:2| Cooking pit | Alces alces | Phalanx I     | 3.2          |
| Västernorrland    | Fagerviken 2| Fagerviken Holm 174:2| Cooking pit | Alces alces | Phalanx II    | 1.3          |
| Västernorrland    | Fagerviken 3| Fagerviken Holm 174:2| Cooking pit | Castor fiber | Radius 0.8    |
| Gävleborg         | Snickerstensmon | Adals-Liden 194 | Site    | Castor fiber  | Talus 0.7     |
| Gårdjösundet 1    | Gårdjösundet | Skog 170:1          | Site    | Alces alces   | Phalanx I     | 1.1          |
| Gårdjösundet 2    | Gårdjösundet | Skog 170:1          | Feature of fire | Phoca sp. | Metatarsus V  | 2.9          |
| Gårdjösundet 3    | Gårdjösundet | Skog 170:1          | Hearth  | Phoca sp.     | Humerus 2     | 2.0          |
| Gårdjösundet 4    | Gårdjösundet | Skog 170:1          | Cooking pit | Phoca sp. | Tarsus 3      | 1.1          |
originated from coastal areas or from an inland tundra/taiga envi-
ronment by studying the composition of species on different sites
in inland and coast. Different hunting strategies and different con-
sumption patterns make marks in the zooarchaeological record
(Sørensen et al., 2013). This is best done by analysing data from
radiocarbon dated sites, and it is even better if those dates derive
from faunal remains that have been identified to the species level;
which species can be correlated to environmental and climate
changes. Even if hunting strategy and cultural preference plays an
important role in the forming of faunal remains on site, environ-
mental and climate changes necessarily also affect the composi-
tion of prey on site.
In this paper, new data on dates and faunal assemblages,
together with previously published results, illustrates the settle-
ment process as a consequence of the deglaciation and also the
use of different animal species during the Mesolithic. This forms
a base from which to discuss economic strategies as new lands
became accessible and environmental change altered the ecologi-
cal setting of these different groups. When the economy and the
lithic technology are connected to this new chronology, similari-
ties and differences can perhaps become visible, helping to
answer questions pertaining to the origin of the first settlers and
the processes by which they adapted to new environments.

Chronology
Northern Fennoscandian Mesolithic research has previously been
performed within each nation state, each with its own scientific
traditions determining the definition of prehistoric cultures. These
different archaeological research traditions have thus created
seemingly isolated groups of people in Scandinavia with different
cultural practices. In fact, these groups and their lifestyles might
be more related to each other, judging from similarities in their
reconstructed movement patterns and networks of contact span-
ning areas that transcend modern national borders, than assumed.
This has actually been suggested in previous research (Manninen
and Knutsson, 2011; 2013; Sørensen et al., 2013).
Apart from the problem of a slightly different classification
system for material culture creating artificial borders between
groups, another major problem is the construction of a reliable
cultural chronology in the prehistory of Norrland. This relates to
the problem of dating artefact assemblages due to a lack of stra-
tigraphy. The assemblages often represent palimpsests of material
from several periods making the relation of dates, features and
artefacts difficult. Furthermore, due to the decomposition of
organic materials in the acidic soils, artefacts made of wood and
unburnt bones are rarely found, not even in sunken features
(Andersson, 1898: 142; Borg et al., 1994: 97f; Björdal, 1999:
120f; Christensson, 1999: 172f). From the point of view of this
paper, a general chronological frame focusing on the general
trends over time is being relied upon.
As the situation stands now a Middle Mesolithic macro blade
industry (ca 8300-7000 cal BC) with semi-conical cores reminis-
cent of the Butovo/Vereteye tradition defines the southern part of
Norrland, at the same time defining the northern border of the
suture-zone (Knutsson et al., 2016). In the north, north of the
assumed suture-zone, the Middle Mesolithic is characterised by a
lithic tradition of simple quartz industry and of slate tools. The
late Mesolithic, 7000-4500 cal BC, there is an expansion of a tra-
dition foremost identified by a microblade production of insets
for slotted bone tools based on handle cores stretching from
northern Germany to northernmost Sweden. Raw materials are
varied depending on local variation in access to suitable raw
materials. From this period sites with oblique arrow points based
on a simple flake industry characterise the late Mesolithic stretch-
ning over a vast area of northernmost Sweden, Northern Norway
and most of Finland. Most, if not all, sites from the period typi-
cally have hearths and cooking pits filled with a burnt fossil
fauna. This is also where the work on this paper begins. These
calcined bones from hearths and cooking pits will provide valu-
able data pertinent to the discussion of hunter-gatherer adaption
during the early Holocene in northern Sweden in this paper.

The ecology of the last pioneers
of northernmost Europe, a
Mesolithic fauna history of
Northern Sweden
The new chronological and contextual data sketched above can
now tentatively be used as a starting point for a discussion of the
ecology and adaptive strategies of the two hunter/gatherer popu-
lations settling the area south and north of the Weichselian ice in
the early Holocene. The problem archaeologists have faced in
previous years was the lack of proper dating of the faunal remains
and their relation to the general cultural process. Based on recent
developments in 14C dating of burnt bones, the strategy followed
for this paper has been to date different Mesolithic contexts with
burnt animal bones from the supposedly early Stone Age settle-
ments in northern Sweden. In doing so it became possible to
explore the adaption of the two hunter-gatherer populations to the
new ice-free area (Ekholm, 2015a, 2016). Furthermore, advances
in dating allow for a better understanding of how their ecology
changed as they adapted to the environment in the area and, event-
ually, due to their hypothesised encounter with each other in cen-
tral Norrland.
The purpose of this study was thus to:
• Select already known, and potentially, Mesolithic sites
  in Norrland and Dalarna with zooarchaeological
  assemblages.
• Radiocarbon date selected faunal species from these
  contexts.
• Merge and expand dataset by using the tested charcoal
dates with the data from bones to build the reconstructed
  population history.
One specific focus will thus be to investigate and compare over
the long durée the identified fauna and relate this to the ecology of
the two populations who presumably settled the area simultane-
ously in the early Holocene (Knutsson and Knutsson, 2012).
However, the possibility that the absence of a certain species in
the archaeological record reflects a shift in human adaptation pat-
tern unrelated to the availability of this species cannot be ruled
out.

Databases and samples
To accomplish the goal of this study, a survey of known Meso-
lithic sites in Norrland and the county of Dalarna in Svealand
was carried out (Figure 1). To do so ADIN 1950-1995 (Ramqvist,
2000), a database of all archaeological sites excavated between
1950 and 1995 in the region of Norrland was used. Since the data-
base only contains excavations from Norrland, the sites in Dalarna
were not present in the database. Therefore, a database made by
PhD student Michel Guinard, Uppsala University, was also con-
sulted, as the sites from Dalarna and more recent excavations in
Norrland were listed there. Also, a recent compilation of all the
excavated sites in the county of Västernorrland (Persson, 2015)
were used. The databases used for the study are organised accord-
ing to: county, parish, RAÄ-number (site ID number) and site.
Selected sites for the study are represented in Figure 4.
The osteological assemblages were housed at their respective
county museums as well as the Swedish History Museum in
Stockholm (http://mis.historiska.se/mis/sok/start.asp). All the
osteological assemblages that derived from the selected sites were
The bone samples were selected from small assemblages and the bones were very fragmented (Figure 5). The general fragmentation rate of north Swedish bone materials are 0.1–0.2 g per fragment. Some of the zooarchaeological assemblages did not contain even one bone sample large enough for radiocarbon dating (e.g. Rasklippan, Hästboberget (Figure 4)). The samples were mainly phalanges from hoofs and paws. As beaver paw bones are too small for radiocarbon dating, proximal and distal segments of the long bones were chosen.

The amount of zooarchaeological analysis from Norrland is fairly meagre. So far the most extensive work has been the analysis of, and a review of, the analysis of the zooarchaeological assemblages from the NTB (Norrlands tidiga bebyggelse) project made by Elisabet Iregren and Jan Ekman in the Early Norrland series no.8. It was a research project sprung out of the excavations from the major building project of the power plants (Iregren and Ekman, 1984). Besides that, there are some more recent osteological analysis of bones from Mesolithic contexts made in connection to archaeological excavations, for instance; Iregren (1984), Jonsen (2004, 2010), Sjöling (2009) and Ekholm (2013, 2014, 2015b) which all have been included or, at least, considered for this study.

In addition to the osteological research discussed above, Taberlett et al. (1998) also examined Scandinavian fauna in the study Comparative phylogeography and postglacial colonization routes in Europe, which detailed the introduction of animals and plants into Europe during the Quaternary. Their work shows a number of suture-zones in Europe where different species met after dispersed into Europe from different directions. One of them are situated in the centre of Scandinavia (Taberlett et al., 1998; Figure 6) reminiscent of the special structure of archaeological sites with different lithic technology (Knutsson and Knutsson, 2012).

**Method**

The first step in finding the information about possible Mesolithic sites with zooarchaeological assemblages in Norrland was to search the ADIN 1950-1995 (Ramqvist, 2000), together with a database made by PhD student Michel Guinard, Uppsala University, and a recent compilation of all the excavated sites in the county of Västernorrland (Persson, 2015).

The second step was to identify representative sealed contexts with samples of burnt bone for radiocarbon measurements from the sites chosen for the study. It was accomplished by:

1. Searching for zooarchaeological assemblages from sealed contexts on the site.
2. Through reports and articles surveying and clarifying the lithic technologies connected to the site.

The third step was to search for good bone samples for radiocarbon dating and to determine or confirm the species and bone element. Most of the osteological assemblages were already analysed, but for the purpose of this study the present author confirmed the previous analysis of the bone sample. In instances where the bone assemblages were not analysed, an analysis of the sample to be dated was made by the present author. When the decision of permission for 14C-dating had been made by each museum, the samples were sent to Angström Laboratory, Uppsala University, for AMS radiocarbon dating.

already dated to the Mesolithic based on charcoal samples, other bone samples or artefact typology. The osteological references used included the present author’s private collection of Eurasian elk (Alces alces) and domesticated reindeer (Rangifer tarandus) and the collection at the Osteoarchaeological Research Laboratory at Stockholm University containing Eurasian beaver (Castor fiber) and Ringed seal (Phoca hispida). The calibrations of the dates were performed with the program OxCal v4.3.2 (Bronk Ramsey, 2013) using IntCal13 (Reimer et al., 2013) and the diagrams of the total sum of the dates of every species and the diagrams of the total sum of the dates were performed in the program rcarbon (Brevan and Crema, 2020).

In this study bones from Eurasian elk, reindeer, Eurasian beaver and seal (Phocidae) were selected for dating (Table 1), as all other species in the assemblages were very few and/or their bones were too small for radiocarbon dating. To be sure at least one gram was used but two exceptions were made on beaver bones; 0.7 g and 0.8 g. Details pertaining to the bone element, species, context, site, Raa (site ID-number) and county of each sample are listed in Table 1.

Two of the assemblages were not found; Haverö 12:1 in Västernorrland and Fors 12:1 in Jämtland. Apart from that, Ramsele 113:1; 128:1 and Holm 174:2 had not gone through the appropriate antiquarian procedures and thus it was not possible to get permission to radiocarbon date them.

The database made for this study contains both archaeological and zooarchaeological information about every sample dated for the study. It also contains information about the new radiocarbon dates and bone samples and charcoal samples dated previously. Together they constitute the foundation of this study. (See supplementary file.)

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Table 2. The results from the radiocarbon dated samples.

| Sample          | Lab. No. | δ¹³C ‰ VPDB | Species          | Context               | ¹⁴C Age BP | Cal. BC  |
|-----------------|----------|-------------|------------------|-----------------------|------------|---------|
| Vojmsjön A6:1   | Ua-53978 | −16.4       | Alces alces      | –                     | 7555 ± 47  | 6481–6261 |
| Vojmsjön A6:2   | Ua-53975 | −21.5       | Alces alces      | –                     | 7588 ± 39  | 6499–6393 |
| Vojmsjön A1:1   | Ua-53977 | −26.9       | Alces alces      | Hearth               | 5830 ± 36  | 4789–4586 |
| Vojmsjön A1:2   | Ua-54123 | −25.6       | Castor fiber     | Hearth               | 5898 ± 28  | 4836–4712 |
| Vojmsjön A1:3   | Ua-54124 | −25.2       | Castor fiber     | Hearth               | 5885 ± 28  | 4829–4705 |
| Tärna 1         | Ua-53973 | −23.5       | Rangifer tarandus | Cooking pit           | 6905 ± 38  | 5877–5721 |
| Tärna 2         | Ua-53974 | −19.9       | Rangifer tarandus | Cooking pit           | 6841 ± 37  | 5801–5646 |
| Åsele 1         | Ua-53979 | −24.1       | Alces alces      | Site                  | 5913 ± 36  | 4896–4709 |
| Åsele 2         | Ua-53980 | −21.0       | Alces alces      | Site                  | 6844 ± 38  | 5809–5646 |
| Åsele 3         | Ua-53981 | −21.9       | Alces alces      | Site                  | 6733 ± 37  | 5716–5569 |
| Åsele 4         | Ua-54125 | −26.8       | Castor fiber     | Site                  | 5066 ± 27  | 3952–3796 |
| Sävar 1         | Ua-54126 | −23.4       | Phoca sp.        | Site                  | 5887 ± 30  | 4833–4702 |
| Västerdal 1     | –        | –           | Phoca hispida    | Site                  | –          | –       |
| Västerdal 2     | Ua-54129 | −21.1       | Phoca hispida    | Site                  | 6071 ± 29  | 5057–4853 |
| Garaselet A20   | Ua-53972 | −22.2       | Alces alces      | Hearth               | 8034 ± 42  | 7079–6778 |
| Garaselet A2    | Ua-54127 | −26.6       | Castor fiber     | Cooking pit           | 4668 ± 28  | 3521–3367 |
| Garaselet B1    | Ua-54128 | −22.8       | Castor fiber     | Bone feature          | 4620 ± 28  | 3506–3349 |
| Fagervik 1      | Ua-53970 | −24.6       | Alces alces      | Cooking pit           | 5894 ± 35  | 4842–4696 |
| Fagervik 2      | Ua-53971 | −26.6       | Alces alces      | Cooking pit           | 5960 ± 36  | 4941–4730 |
| Fagervik 3      | Ua-54119 | −26.1       | Castor fiber     | Cooking pit           | 7346 ± 50  | 6361–6076 |
| Snickerstensmon | Ua-54120 | −25.9       | Castor fiber     | Site                  | 4371 ± 34  | 3090–2907 |
| Gårdsjösundet 1 | Ua-53976 | −23.9       | Alces alces      | Site                  | 7879 ± 40  | 7024–6635 |
| Gårdsjösundet 2 | Ua-54121 | −27.2       | Phoca sp.        | Feature of fire cracked rocks | 7856 ± 46 | 7021–6593 |
| Gårdsjösundet 3 | Ua-54122 | −26.7       | Phoca sp.        | Phoca sp.             | 7671 ± 33  | 6591–6456 |
| Gårdsjösundet 4 | –        | –           | Phoca sp.        | Cooking pit           | –          | –       |

In OxCal v4.3.2 the radiocarbon dates have been calculated and each species has been arranged in sequences in carbon to show the duration and the density of certain species on archaeological sites in the northern region and in the southern region of the study area, separated by the previously mentioned suture-zone. Also, the total sum of the radiocarbon dates from bone samples, supported by the total sum of the radiocarbon dates from the charcoal samples, have been arranged in sequences north and south of the suture-zone. The collected samples for ¹⁴C-dating were carefully chosen to make sure that the sample represented the activities at the site and to avoid errors caused by contamination. When burnt bone is dated the sample has to be of solid, white bone, burnt in a high temperature. Since there are two different ways of dating bones, whether they are burnt or unburnt, a suggestion is never to use partially charred bones for the reason that they are neither entirely burnt nor unburnt (Olsen et al., 2008: 795f). Another complicating factor could be the presence of tree roots which can contaminate samples, and thus where possible samples with roots were avoided (Borg et al., 1994: 97).

It has also been discussed whether burning old wood together with bones would affect the radiocarbon dates of the bones. Olsen et al. (2008, 2013), Snoeck et al. (2014), Zazzo et al. (2012) coin the phenomenon as ‘old wood effect’, when the bones are dated older than the actual date of burning as a result of them being burnt together with old wood. Challenging are bones from animals that live in the sea or feed on animals from marine habitats, as they may yield dates exceeding their actual age, due to the so-called reservoir effect. It is therefore important to take this into account when marine animals are analysed, as well as when dating animals that may have been feeding on marine resources (Hedman, 2009: 5; Lanting and van der Plicht, 1998: 151; Lanting et al., 2001: 249–250). This does not, however, affect burnt bones as much as it does unburnt bones. Structural carbonate, which is used when dating burnt bones, originates from the whole diet rather than just animal protein. Thus while burnt bone samples from predators that feed entirely on marine animals are impacted by the reservoir effect, this impact is minimised amongst animals that do not consume marine based animal proteins (Lanting and Brindley, 1998: 6). It is not possible to tell from burnt bones what percentage of the diet of the animal whose remains are being sampled was either marine or terrestrially based. One can however assume that the elks and reindeers had entirely terrestrial diets and that seals had entirely marine diets. Although the beaver bones sampled are almost surely impacted by the reservoir effect, because of their freshwater living environment, and waterplant diet (Jensen, 2004: 110), for the purposes of this study their diets could be said to be terrestrial. Thus during radiocarbon data curve calibrations, seal samples were calculated as having had 100% marine diets, while elk,
The radiocarbon dates are listed in Table 2 in the same order as in Table 1. Out of 25 samples, 23 resulted in new dates, and out of them 19 were Mesolithic. The ones that were not dated to Mesolithic were dated to Early or Middle Neolithic and they were all samples of beaver bones. All together in the database there are 13 samples of reindeer, 35 samples of elk, 9 samples of beaver, 13 samples of ringed seal and 5 samples of undetermined seal. There are also 39 bone samples of undetermined species and 132 samples of charcoal in the database. Elk and reindeer are the most reliable species since beaver and seal might be affected by the reservoir effect. But due to the long time span in the study and to the overall geographical perspective, the reservoir effect does not seriously affect the outcome of the study. Besides the radiocarbon dated species collected from specific contexts there were, in most cases, more species in the same feature and on the same site, especially fish but also birds. These species can in some cases connect to the dated

Faunal population history

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Figure 6. The total amount of radiocarbon dates for each species (reindeer, elk and seal) divided into the regions north and south of the suture-zone.
species, if they were found in the same sealed context as the bone sample. This also goes for sites, although, it is important that the samples are connected to the activity on site and that the site is from a single occasion. Some features are more complex and seem to have contextual contemporaneity, which means that they have been used several times or reused after some time (Ahlbeck, 1995: 42; Ekholm, 2015a, 2016). It is possible to transfer the date to other species from the same context and the same site as long as one is aware of the errors that can occur. In Table 2, all known radiocarbon dated species from the sites are listed.

The dates cover the whole Mesolithic period in Norrland with reindeer being the earliest species to be hunted both south and north of the ice (Figure 7). The known data from reindeer bones on Mesolithic sites are from Norrbotten, Täna in north-western Västerbotten and Limsjön in Dalarna, with a huge gap in between where the ice sheet remained longest.

When the ice sheet was completely gone, at around 7000-8000 cal BC, Eurasian elk entered rapidly together with the taiga vegetation of bushes and trees. The elk reached the whole study area basically at the same time, only slightly later in the north, and the population was quite stable through time, apart from a peak around 6500 cal BC. Looking closer, it seems like the appearance of elk, or to be more precise, the use of elk, is dated earlier in the southern counties and later in the northern area. In southern Scandinavia elk was present already at 11800-11400 cal BC in Denmark and 11300-11200 cal BC in southern Sweden (Aarss-Sorensen, 2009: 27).

Most of the beaver remains sampled date to the Neolithic, and the Late Mesolithic dates are very late and somehow connected to the Neolithic. One sample however suggests that beaver were present in Västernorrland by as early as 6361-6076 cal BC. The lack of Mesolithic beaver bones are the reason why beaver is left out of Figure 6.

One important result is that there is a difference in hunting of seal. North of Gävleborg the hunting of seal began much later than in southern Norrland (Figure 6) even if the seals probably was present in the entire Baltic Bay at the time (Ukkonen, 2001: 192). In southern Norrland, the oldest radiocarbon dates from seal bones show up at the same time as the first known radiocarbon dates from elk bones. Not until around 5300 cal BC are seal bones found on the northern sites, at the same time as reindeer disappeared from the archaeological record. At that time the handle core tradition also appears as a new lithic technology (Forsberg and Knutsson, 1996).

Figure 6 show that the first dates of all three species in the south are the same but in the north the first dates of each species differ a lot.

Population history, all dated sites

Figure 8 is based on all samples in the database with dates older than 5200 uncal. BP. The total amount of radiocarbon dates of bones are shown in black and the total amount of radiocarbon dates of both charcoal and bones are shown in grey. The diagrams are divided into two areas; one with the results north of the suture-zone and one with the results south of the suture-zone, after Taberlet et al. (1998; see also Figure 7). Since the amount of dated bones are sparse, the results from the charcoal samples have been used to strengthen the picture of the population history in Norrland and Dalarna. In an earlier study (Ekholm, 2015a), mentioned earlier, samples from the analysed zooarchaeological record from the same features and contexts as previous radiocarbon dated charcoal were dated and showed the same results as the previous results. The results from the charcoal samples indicated that they were reliable and useful for the study of long-term processes, but only as long as they were sampled correctly from contexts and not only connected to the sites.
that could disperse northwards on the land bridge between present-day Sweden and Denmark in the Late Glacial/Early Holocene. The oldest date of reindeer in Scania, situated in southernmost Sweden, is 9700 cal BC and the population seems to have become established around 9500 cal BC, which coincides with the period of the land bridge. It has previously been stated that the southern reindeer population spread northward as the ice sheet melted (Ekman, 1922; Liljegren and Lagerås, 1993: 10) but disappeared around 7100 cal BC (Aaris-Sørensen et al., 2007: 91f) before reaching the area of Svealand (Figure 1b). Recent data show that reindeer have been present in the area later than that (Ekholm, 2014; Boethius, 2018).

The results also show that reindeer disappeared from the archaeological records from Norrbotten after 5300 cal BC. This disappearance may be representative of a declining reindeer population triggered by changing climate and vegetation patterns that may have ‘pushed out’ reindeer from the area (Lepiksaar, 1986: 61). However, we cannot rule out the possibility that the absence of reindeer in the archaeological record reflects a shift in human consumption unrelated to the availability of this species. However, we find this unlikely.

The oldest known radiocarbon dates from elk bones in southern Norrland, and the few available dates from reindeer in Dalarna, are concurrent with radiocarbon dates from seal bones. All along the southern and eastern Scandinavian coast (Boethius et al., 2017; Lepiksaar, 1986: 55; Storå, 2001), as far north as to the suture-zone (Figure 7), people were hunting seal during this time. The ringed seal probably entered the Baltic Sea at the time of Yoldia Sea stage (Storå, 2001: 2; Ukkonen, 2001: 17) and the early groups of Ahrensburgian ancestry living along the coast in southern and western Scandinavia were already used to the marine fauna from before they inhabited the Scandinavian peninsula. In southern

Norrland, on the sites in Gävleborg, the lithic technology seems to be the same as in Dalarna and probably derives from western Scandinavia. There are no seals in the archaeological Mesolithic records north of Gävleborg before 5300 cal BC. It is not possible to argue for the seals not to be able to live in the northern Baltic Sea because most of the seal samples are interpreted to be Ringed seal and they live and keep their pups in pockets in the land fast ice during winter (Jensen, 2004: 263). Also, in Finland there are no findings of seal bones from the earliest settlements, including the coastal ones (Sørensen et al., 2013: 34; Ukkonen, 2001; Ukkonen et al., 2014; Ukkonen and Mannermaa, 2017).

It is thus probable that the groups of pioneering hunter-gatherers entering northern Norrland hunted reindeer and they may not have been adapted to hunting aquatic big game. Therefore the hunting of seal was introduced much later. As mentioned earlier in the text, the first recognisable culture to settle in northern Norrbotten were assumed to have derived from the inland taiga zone of Russia and were presumably adapted to hunting terrestrial rather than marine based fauna.

Whatever the case, this study has showed that the earliest evidence for seal hunting coincides with a disappearance in evidence of reindeer hunting in northern Norrland around 5300 cal BC. The lack of seal bones in this area prior to this period suggests a cultural change occurred ca 5300 cal BC that might be linked to following factors:

- There might be another group of people settling northern Norrland from the south. Such a colonisation event could correlate with the introduction of the handle/core lithic tradition, which might indicate another group of people settling the area replacing or cohabiting the area alongside an earlier population.
- Perhaps climate ‘pushed out’ the reindeers and the humans needed to look for another source. At this time forests had spread and the environment suited elks more than reindeers and the elkss were already established long before.
- Perhaps there was a cultural change within the group. A change in hunting or in handling the prey.

According to earlier interpretations of beaver hunting the beaver was connected to the elk and the eastern pressure blade lithic technology groups originating from inland (Sørensen et al., 2013). The beaver lives in the same environment as the elk and is therefore available at the same place. But beavers do not move as good on land as in water and therefore they tend to stay in the same water system. They rarely move to another water system (Jensen, 2004: 109). The elk, on the other hand, can move as far as 100 km between winter and summer pasture (Jensen, 2004: 294f). Perhaps people did not hunt beavers in a large amount until later even if it was available. In Scania, the earliest known remains of beaver is from archaeological sites date to 8818-8487 cal BC (Hansson et al., 2017; Table 1), but these culture groups are certainly not the same as the ones in Norrland.

The general human migration/hunting pattern seems to be different north and south of the suture-zone (Figures 6 and 8). In the southern part, the earliest dates of all recorded animal species and charcoal are from the same time, at around 7500 cal BC and the amount increased fast. The lithic technology from those sites indicates a migration from the west. It seems like it took a while until humans entered Dalarna and Gävleborg after the ice sheet melted. A suggestion is that they came from the west and were used to hunt reindeer, elk and seal. There might, of course, also have been people coming from the south but there are no traces of that.

In the northern area it seems like the humans entered earlier, together with the reindeer, or slightly after, but before the elk. The migration was slower and increased over a longer period of time.
The sites in northern Norrland were most likely inhabited by the quartz using Butovo/Veretye descendants (Riede and Tallavaara, 2014) that had moved in from Finland and Russia (Ekholm, 2016; Knutsson et al., 2016; Sørensen et al., 2013), thus the site Aareavara might have been occupied by another population entering earlier, perhaps from the north Norwegian coast (Östlund, 2017).

The lithic technology on the sites of Orsand and Limsjön in Dalarna seems to be connected to the eastern pressure blade technology probably originating in western Sweden and eastern Norway but originally from northern Norway. Since the technology might have been transferred by social learning it is impossible to tell where the actual individuals originated. According to recent aDNA investigations (Günther et al., 2017) they may represent an admixture between western (WHG) and eastern (EHG) hunter-gatherers defined as Scandinavian hunter-gatherers (SHG). Unfortunately there are no preserved aDNA from the pioneer phase in the study area.

Conclusions

This study has shown that the first settlers in both north of and south of the melting Weichsel ice sheet hunted reindeer. Originating from the south, hunter-gatherer groups of Ahrensburgian ancestry entered and spread northward along the Norwegian coast and also established in settlements in southern Scandinavia. Their lithic technology was characterised by a direct percussion blade production strategy, based on one-sided cores with opposed platforms. Along the Norwegian coast the preservation of bones are very bad but the first groups with the same origin settled in southern Scandinavia hunted reindeer and seal. The interpretation is that the groups which travelled north did the same.

In the northeast there were at first hunter-gatherer groups of unknown descendant, not very similar to the later groups. These earlier groups might have arrived either from the north Norwegian coast or from Finland/Russia in the east, and there are not many traces of the people from the first phase. Soon after, groups of hunter-gatherers of Butovo/Veretye ancestry arrived, mainly from the Russian inland, bringing their pressure blade technology, which produced conical cores with faceted platforms. The first groups of Butovo/Veretye ancestry also hunted reindeer.

When the tundra vegetation changed to taiga vegetation, at around 7000-8000 cal BC, Eurasian elk seems to enter rapidly from the south. Since only archaeological records are studied, there might also be a question of this pattern only being representative of human hunting of elk, a cultural trend perhaps with origins to the south. No cultural changes are visible in the lithic technology in connection with this change, though.

The southern population of reindeer reached the study area slightly before its extinction in southern Scandinavia. At that time the southern groups and the northern groups had already met and mixed, (at least the lithic technologies) and spread south along the Norwegian coast and then east into the region of Dalarna and Gävleborg.

The hunting of beaver seems to go hand in hand with the hunting of elk but became more common on archaeological sites during the Late Mesolithic period. The beaver lives in the same environment as the elk but beavers tend to stay in the same water system while elks can move as far as 100 km between winter and summer pasture.

The hunting of seal began in south Scandinavia immediately after the Yoldia Sea became ice-free and the seals could swim into it. But north of the suture-zone the hunting of seal began much later even if the seal was present in the Gulf of Bothnia. Not until around 5300 cal BC are seal bones found on the northern sites, at the same time as reindeer disappeared from the archaeological record and the handle core tradition appears as a new lithic technology.

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Supplemental material
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