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Animal remains from Saami offering places: Glimpses of human-animal relations from Finnish Lapland AD 1000-1900

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Abstract

We present the results of 41 AMS and 49 stable isotope determinations of animal bones retrieved at seven Saami offering places or *sieiddit* from Finnish Lapland. The offered remains are dominated by reindeer, but other wild and domesticated species were also present. AMS dates and artefacts suggest that six of the studied *sieiddit* were being utilized as offering places by the 13th century, and that votive activity continued with varying intensity until around 1900. The AMS dates and stable isotope analyses of the *sieidi* bones produced interesting, somewhat unexpected, results that reflect various aspects of human-animal interaction in Finnish Lapland. In addition to information about Finland's *sieidi* sites in terms of utilization chronology and the species offered at them, the study provides a major body of new data from animal species that lived in Finnish Lapland during AD 1000–1900.

Keywords: AMS dates, Finnish Lapland, human-animal relations, Saami offering places, stable isotopes

4.1. Introduction

During 2006-2007, Oulu university researchers participated in a pilot project, the Ukko Project, involving the archaeological investigations of Saami sacred places (*sieidi*) in the vicinities of Inari, northern Lapland (Harlin 2007; Okkonen 2007; Harlin & Ojanlatva 2008). The results led to a major Finnish Academy project, *Human-animal relations among the Finnish Sámi 1000–1800 AD* in 2009–2011. Its aim was to study the sacral meanings of the *sieiddit*, their spatial and chronological distribution, the species offered at them as well as to gain information about the origin and domestication status of the offered sheep and reindeer remains through DNA and stable isotope (SIA) analyses. Much of the work on the *sieiddit* has been published (Äikäs 2009, 2011, 2015; Äikäs et al. 2009;

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Salmi 2012; Salmi et al. 2018). The complex aDNA determinations are currently in progress at the Oulu Biology department, but the AMD and SIA results have not been published. The main purpose of this paper is therefore to make those results known for the benefit of other researchers.

4.2 The *sieiddit* and their contents

Much has been written about the little that is known about the Saami sacrificial places or *sieiddit*, which the ancient Saami regarded as the abode of spirits/deities and made votive offerings to them (e.g. Rhen 1897 [1671]; Schefferus 1673; Fellman 1906 [1820s]; Holmberg 1915; Qvigstad 1926; Paulaharju 1932; Itkonen 1946, 1948, 1962; Serning 1956; Manker 1957; Mebius 1968; Vorren and Eriksen 1993; Rydving and Kristofersson 1993; Halinen 2010; Äikäs 2011, 2015). They have been briefly described as follows:

> *The Saami worshipped stones, made them as gods, and anointed them with the grease of fish and reindeer* (said an old Saami according to Paulaharju 1932: 5, M. Núñez's translation).
>
> *Seides had not been fashioned by human hands, but were natural stones, often hollowed out by water, having, as such, often peculiar form, resembling human beings or animals. Those regarded as most valuable were the stones resembling human beings* (Holmberg 1964: 100).
>
> *Big stones and peculiar boulders were also used as sacrificial altars. Sacrifices could also be made in grottoes or rocky caves on cliffs, beneath or, on the summit of fjells, in fens, beside waterfalls, in lakes and springs or at a tree* (Manker 1968: 86).

A few *sieiddit* have been investigated archaeologically (Hallström 1921, 1922, 1932; Itkonen 1948 II: 315; Erä-Esko 1957; Manker 1957; Sarvas 1971; Halinen 2006), including those involved in Oulu University projects during 2006-2011 (Okkonen 2007; Harlin & Ojanlatva 2008; Äikäs 2011, 2015). The Oulu projects carried out fieldwork at several *sieidi* sites (Äikäs 2011, 2015), but the AMS and SIA determinations involved only the seven sites that produced viable bone samples (Figure 4.1).

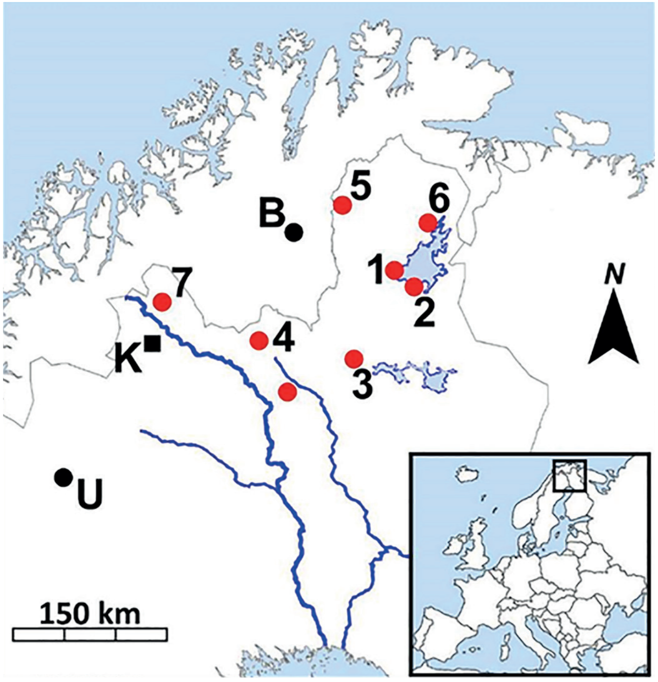

Figure 4.1: Location of the investigated sieidi sites of Ukonsaari (1), Ukko (2), Taatsi (3), Näkkälä (4), Seitala [Sieiddakeädgi] (5), Nitsijärvi [Koskikaltiojoen suu] (6) and Dierpmesvárri (7), and some localities mentioned in the text: Beajalgŋai (B), Könkämä (K) and Unna-Saiva (U).

Due to the sensitive sacral nature of *sieidi* sites and their contents, our investigations followed a procedure developed in consultation with the Inari Saami community . The archaeological fieldwork consisted of opening the ground in areas adjacent to the presumed *sieidi* core, which generally consisted of a large boulder, or of rock cavities in the case of the Ukonsaari site. The excavations were small (4–16 m^2) and rather shallow, since artefacts and bones generally occurred immediately below the turf. A few of the additional test pits made within 20 m from the Ukonsaari *sieidi* cavities yielded also bones, which had probably ended up there through taphonomic processes and/or human intervention. (Okkonen 2007; Harlin 2007; Harlin and Ojanlatva 2008; Äikäs 2009, 2011, 2015; Äikäs et al. 2009; Äikäs and Núñez 2009a, 2009b, 2009c, 2010, 2011).

As agreed with the Saami community, the bones found at the *sieidi* sites were analyzed in situ. The determination of species was carried out by the osteologists Eeva-Kristina Harlin (Harlin 2007; Harlin and Ojanlatva 2008) in the case of the two Inari *sieiddit*, and by Anna-Kaisa Salmi (Puputti 2008a, 2008b, 2008c, 2009; Salmi 2011) at the other five *sieidi* sites (Table 4.1). Those bones identified to species and which were well-preserved enough for yielding laboratory results were bagged as samples for AMS, DNA, and SIA determinations. Bones of the less frequent fish and bird species were also chosen as samples despite their poor preservation state, but many lacked enough collagen for AMS and SIA analyses. Those bones not chosen as samples were left at the site in accordance with the mentioned agreement. For the same reason, after all the material needed for laboratory determinations had been utilized, what remained of the bone samples was reburied at their respective *sieidi* sites in August 2011 (Äikäs and Núñez 2012).

Table 4.1: NISP and MNI of fauna remains found at the studied sieidi sites: (1) Ukonsaari, (2) Ukko, (3) Taatsi, (4) Näkkälä (4), (5) Seitala [Sieiddakeädgi], (6) Nitsijärvi [Koskikaltiojoen suu] and (7) Dierpmesvárri. When possible, the earliest AMS dates of each species have been included. (Harlin 2007; Harlin and Ojanlatva 2008; Puputti 2008a, 2008b, 2008c, 2009, 2010; Salmi 2011.)

Species	Sites	NISP	%	MNI	%	Cal. AD
Reindeer	1–7	573	32.5	43	52.5	1165–1260
Sheep	1, 2	139	7.9	15	18.3	1300–1420
Bear	4	4	0.2	1	1.2	1165–1260
Mammals (prob. reindeer)	1–7	662	37.5			
Gallinaceous birds (grouses)	1,2,3,6	81	4.6	16	19.5	1270–1400
Waterfowl	2,3	7	0.4	3	3.7	1040–1230
Birds	1,2,3,6	46	2.6			
Pike	2,3	5	0.3	2	2.4	1040–1220
Perch	3	225	12.7	1	1.2	
Trout	3	12	0.7	1	1.2	
Fish	2,3,4	11	0.6			
Totals		1765	100	82	100	

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1. The procedure was developed in 2006 in connection with the pilot project fieldwork on Ukonsaari island by the involved Oulu University archaeologists, some of whom live in Inari, and the staff of the Sámi Museum and Nature Centre Siida in Inari. Subsequently, the same procedures were also applied in the larger follow-up project, which had also the green light of the Sámediggi (Finnish Sámi Parliament).

The extraction of collagen and the subsequent measurement of carbon ($\delta^{13}C$), nitrogen ($\delta^{15}N$) and sulphur ($\delta^{34}S$) stable isotope ratios were carried out on 32 bone samples at the Archaeological Research Laboratory and the Stable Isotope Laboratory of Stockholm University (cf. Eriksson et al. 2009 for laboratory procedures). Furthermore, the 41 samples submitted for AMS dating were also complimentarily measured at the Helsinki Laboratory of Chronology, 32 for $\delta^{13}C$ and 27 for $\delta^{13}C$ and $\delta^{15}N$ (cf. Bläuer et al. 2016 for laboratory procedures). Altogether, a total 49 samples underwent $\delta^{13}C$ and $\delta^{15}N$ analyses, some of them by duplicate (Appendix 4.1). All the analyzed bones were from adult individuals. The C/N ratios of the samples analyzed at Stockholm fell within 3.2-3.5. The Helsinki laboratory also reported good collagen quality from the samples but did not provide the actual figures.

It is difficult to assess the representability of the identified species. Their presence was initially influenced by choices determined by individuals and cultural traditions and, later on, by taphonomic factors and the archaeologists' decisions. The more fragile bones of fish and birds are probably under-represented. The only thing that can be said at this point, is that the presence of the recorded species indicates that they were suitable for offering, at least at some point in time and place. Nevertheless, the numerous reindeer bones (52% MNI) should make a fairly representative sample of reindeer populations, and the same probably applies also to the sheep remains, which are fairly common at Inari, with a 29% MNI in the two Inari *sieiddit*.

4.3 Human-reindeer interaction in northern Fennoscandia

Reindeer have been part of Fennoscandia's fauna tens of thousands of years (Siivonen 1975; Núñez 1991, 2019). They returned after being exiled by the last glaciation, reaching Fennoscandia around the same time as the first pioneer Mesolithic groups 10 000–12 000 years ago (Rankama and Ukkonen 2001; Bergman et al. 2004; Rankama and Kankaapää 2008). The subsequent millennia probably saw a gradual increase of human-reindeer interaction in northern Fennoscandia, as suggested by hunting pits and the so-called 'corral' engravings from the 5th millennium BC (Spång 1991; Furset 1995, 1996; Halinen 2005; Helskog 2011, 2012). The use of those specialized devices probably led to reindeer domestication and, eventually, to the adoption of the herding practices[2].

The origins of Fennoscandian reindeer herding practices is a long-debated topic that goes back to the early 20th century and still preoccupies the minds of many Scandinavian researchers. In contrast, the subject is seldom touched by Finnish archaeologists (cf. however Carpelan 1979, 1993), possibly because herding practices had already developed in northern Scandinavia before spreading into Finland. The various estimates for the antiquity of reindeer herding practices in northern Fennoscandia fall within AD 200–1700, with most scholars placing the event in either the Viking period or the beginning of the Early Modern period. There is no room to go into this here, but useful outlines have been presented by several authors (e.g. Forsberg 1995; Storli 1996; Sommerseth 2011; Bjørklund 2013; Hansen & Olsen 2014).

With the possible exception of an intriguing passage in the Old English version of Orosius, Ohtheres' account (Bately & Englert 2007: 45–46), there are no reliable sources on the subject before the 16th or 17th century, when reindeer herding practices already existed in some parts of northern Fennoscandia. Olaus Magnus describes some sort of sedentary pastoralism in Norrbotten with people owning from 10 to 500 reindeer (Magnus 1555: 596), but he has been criticized for his exaggerated numbers and inaccurate reindeer descriptions (Núñez 2019). Olaus' numbers are repeated by others one century later (Rheen 1907 [1667]: 23; Negri 1750 [1660s]: 20); but by then, as pointed out by Rheen, herd sizes had been rapidly increasing. In any event, it seems clear that fairly developed forms of reindeer herding practices were established in some parts of northern Scandinavia by the mid-17th

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[2] By "herding practices" is meant one or more individuals claiming ownership and controlling a group (herd) of semi-wild domesticated reindeer for various possible purposes: insuring food in lean times, prestige and/or wealth, identity, marriage/alliance transactions, etc.

century (Rheen 1907 [1667]; Negri 1750 [1660s]; Schefferus 1673; Hultbald 1968; Lundmark 1982; Hansen 1990; Hansen and Olsen 2006, 2014; Bjørklund 2013).

However, although the reindeer inventories of Karl IX indicate that the pastoralization process was under way west of the Tornio river by 1605, present Sweden (Figure 4.1), they show that it had barely begun to the east of it, on the Finnish side (Hultblad 1968). There are also several sources praising the abundance of wild reindeer and their hunting in Finland during the 1700s, but by the late 1800s they had become extinct and reindeer herding practices were fully established (Castrén 1754: 59; Wegelius 1754: 17; Aurén 1894; Melander 1920: 29–33; Tegengren 1952; Storå 1971; Pulliainen and Leinonen 1990; Nieminen 2013).

4.4 AMS determinations and chronology of the *sieidi* sites

The utilization chronology of the seven studied *sieiddit* is illustrated in the diagrams of Figures 4.2–4.3. It appears that at least six of the *sieiddit* were in use by AD 1300, as suggested by five AMS ages (Appendix 4.1) and the 13th-century silver ornament found by young, pre-Knossos Arthur Evans at the Ukonsaari *sieidi* in 1873 (Nordman 1922; Carpelan 2003; Okkonen 2007). The 41 AMS dates from the studied *sieiddit* suggest continuous use from the 12th or 13th century with a clear drop in votive activities in the 17th century, which may be connected with the increasing influences from Church and Crown (Itkonen 1945; Rydving 1993; Hansen and Olsen 2014; Westman Kuhmunen 2016). A similar pattern can be observed at a few *sieidi* sites from Norway and Sweden (Vorren and Eriksen 1993; Mulk 2009; Salmi et al. 2015). A lesser disturbance around the 14th century could be linked to the Black Death (Figure 4.3). Artefact finds and ethnohistorical sources suggest a reduced but nevertheless continuous utilization of some *sieidi* sites into the 18th and 19th-centuries (Fellman 1906 [1820s] I; Paulaharju 1927, 1932; Itkonen 1948, 1962; Carpelan 2003, Äikäs 2011, 2015).

The AMS results would imply that, despite its dominance, reindeer may not have been the first species offered at some *sieidi* sites. However, at least the slightly earlier dates of swan and pike could

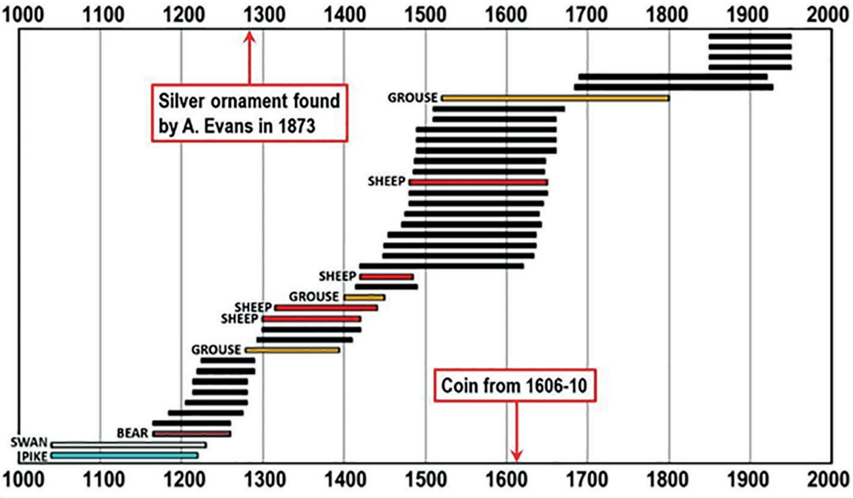

Figure 4.2: Ranges (2σ) of 41 calibrated AMS dates of bones from the studied *sieiddit*. The black bars represent reindeer, the other species are in different colors and labelled accordingly (see also Appendix 4.1).

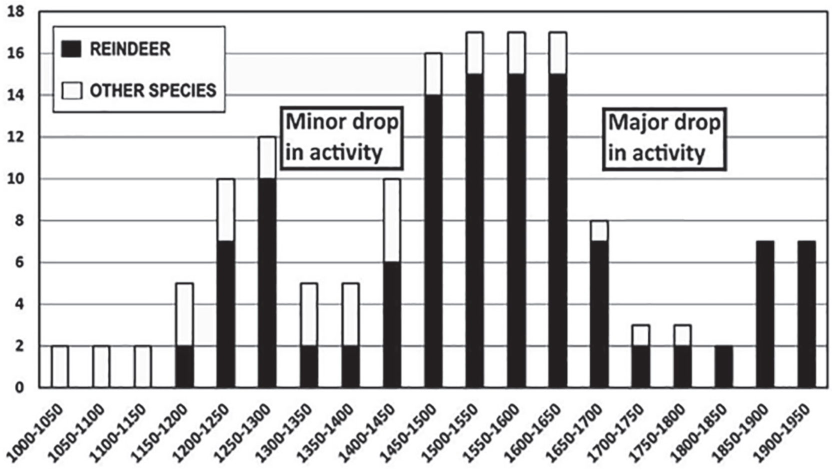

Figure 4.3: Histogram of the ranges (2σ) of the dates in Figure 2, grouped according to their spread in 50-year intervals between 1000 and 1950.

be due to reservoir effects. The swan has a very strong marine $\delta^{13}C$ signal (-11.9‰) and the pike could come from a small carbonate-rich basin. On the other hand, a similar situation involving the early occurrence of bear was observed at the Unna Saiva *sieidi* (Salmi et al. 2015). At this point it is difficult to say whether these early dates constitute a true reflection of Saami-animal interaction or not.

4.5 Stable isotope analyses

The SIA results of the *sieidi* samples are presented in Figure 4.4 and Appendix 4.1. With the exception of the swan, which is obviously a migratory marine visitor, all the analyzed species show clear terrestrial signals in their $\delta^{13}C$ (mean±s.d. –20.4 ±1.4), which reflect the inland location. The relative positions of the $\delta^{15}N$ values of the different species agree with their respective diets. Trophically lowest are the seed/needle eating grouses with $\delta^{15}N$ values within 0-1‰, highest are the pike and the bear around

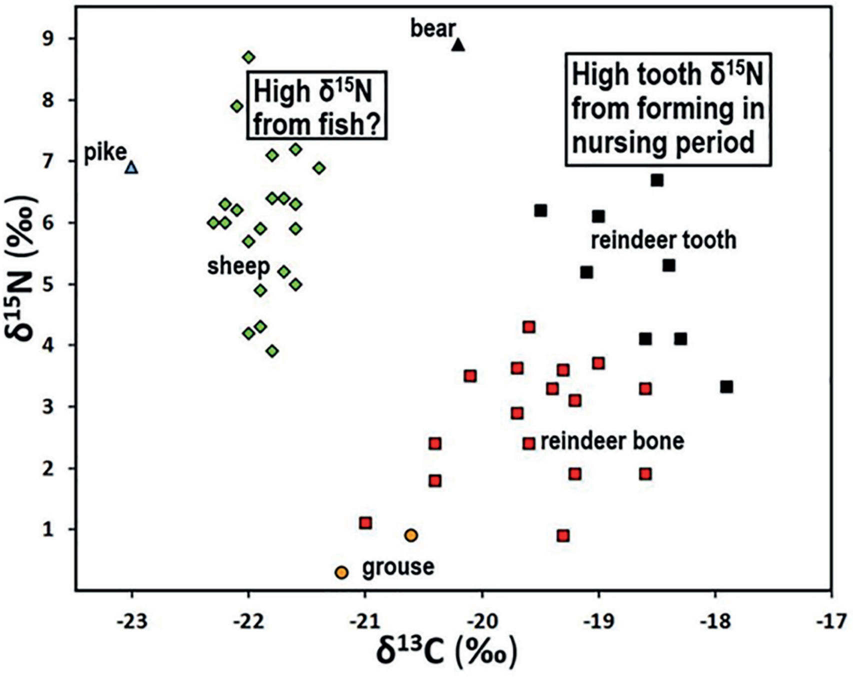

Figure 4.4: Plot of the SIA results from the studied sieiddit.

7-9‰. The δ^{15}N of the herbivores, 21 sheep and 23 reindeer, fall between the mentioned trophically highest and lowest taxa with rather broad ranges. The results fit well with the expected values from this geographic area (Table 4.2; cf. also Lidén and Nelson 1994; Etu-Sihvola et al. 2019). As is to be expected, T-tests showed that the sheep δ^{13}C and δ^{15}N values differ significantly from those of reindeer (p=.00001 for both isotopes), but the geology-related δ34S values do not (Appendix 4.1).

Table 4.2: Comparative δ^{13}C and δ^{15}N values of ovicaprids and reindeer as well as some baseline figures from elk and cod and their sources: (1) Naumann et al. 2014b; (2) Naumann et al. 2014a; (3) Salmi et al 2015; (4) Spangen and Fjellström 2018; (5) Lahtinen and Salmi 2018; (6) Linderholm et al. 2008; (7) Sayle et al. 2013; (8) Fjellström 2011; (9) Etu-Sihvola et al. 2019; (10) Barret et al. 2008. LIA = Late Iron Age.

Species	Site / Region	Period	N	δ^{13}C	δ^{15}N	Ref.
Sheep	Bodø, Arctic Norway	LIA	1	–22.2	3.6	1
Sheep	Flakstad, Arctic Norway	LIA	1	–22.3	3.6	2
Ovicaprid	Flakstad, Arctic Norway	LIA	1	–21.6	3.7	2
Ovicaprid	Unna-Saiva, Swed. Lapland	1270–1400	1	–21.9	5.4	3
Ovicaprid	Beajalgŋai, Swed. Lapland	1400–1520	1	–18.6	11.3	4
Ovicaprid	Oulu, North Finland	1600–1900	1	–22.0	5.0	5
Ovicaprid	Oulu, North Finland	1600–1900	1	–21.7	7.4	5
Ovicaprid	Björned, North Sweden	LIA	1	–21.3	3.3	6
Ovicaprid	Björned, North Sweden	LIA	1	–21.6	7.8	6
Ovicaprid	Skútustaðir, Iceland	LIA	48	–21.2±0.4	2.5±1.1	7
Reindeer	Unna-Saiva, Swed. Lapland	1270–1640	6	–19.3±0.4	4.7±0.7	3
Reindeer	Könkämä, Swed. Lapland	c.1900	5	–20.5±0.3	2.6±0.6	8
Reindeer	Rovaniemi, Central Lapland	Modern	1	–20.1	3.9	5
Reindeer	Tornio, coastal Lapland	1500–1800	1	–19.0	4.1	5
Reindeer	Tornio, coastal Lapland	1500–1800	1	–21.2	3.0	5
Reindeer	Oulu, coastal Ostrobothnia	1600–1900	1	–19.6	5.5	5
Elk	Finland	Modern	5	–22.1±0.4	3.3±1.2	9
Elk	Sweden	Modern	20	–22.0±1.0	3.3±1.0	9
Cod	Arctic Norway	Medieval	4	–14.9±0.5	14.3±0.3	10

4.5.1 Sheep

The 21 sheep samples come from a single site and show a tight δ^{13}C range (–21.9 ±0.2‰) and a wide δ^{15}N range (6.0 ±1.2‰). The large standard deviation (1.2‰) implies high variability in the Inari sheep diet.

One could expect some variability in the Inari sheep due to different feeding practices in the various households where the sheep were raised, also taking into account the six centuries involved. Sheep are not an arctic species and depend on their keepers to survive in winter. Early 19th-century sources indicate that, to compensate for hay shortage, sheep and cattle were winter-fed with a gruel (*moska*) made of grasses, horsetails, birch/pine shoots, lichens and fish waste gathered during summer (Fellman 1906 [1820s]: 36,55; Paulaharju 1921: 97–98, 1927: 93–94; Itkonen 1948 II: 186–188).

The proportion of the gruel components would have varied from household to household and year to year, leading to the observed wide δ^{15}N range. Those individuals with lowest δ^{15}N values would have received more lichen, those with highest values more fish. It is unclear if these feeding practices go back to the 14th century, but sheep winter fodder consisting of fish and seaweed was recorded in northern Norway in the late 1500s (Bratrein 1974), and an even greater antiquity is suggested by the recently described 15th-century ovicaprid from the Beajalgŋai *sieidi*, c.100 km from Inari (Spangen and Fjellström 2018). The Beajalgŋai sheep has higher δ^{13}C and δ^{15}N values (–18.6‰ and 11.3‰) than the Inari maxima (–21.4‰ and 8.7‰) and is compatible with the consumption of marine fish and seaweed described by Bratrein (1974). The Inari sheep values, on the other hand, reflect the local freshwater fish and lichens described in Finnish sources. See Table 2 for comparative sheep/ovicaprids isotopic values.

The continuous occurrence of sheep from the 14th through 17th century and their strong terrestrial values suggest that they were locally raised in the Inari area. The non-nomadic, fishing-oriented lifeways of the Inari Saami (Itkonen 1948) would have been compatible with keeping a couple of sheep per family.

4.5.2 Reindeer

One would be tempted to attribute the wide spread of reindeer isotope values to their extremely variable diet and the large territory and long period involved, but the observed δ^{15}N wide range is obviously caused by the few tooth samples, which have higher values than those of bone (Figure 4.4, Appendix 4.1). The reason for higher δ^{15}N values in teeth has to do with having been formed, at least partly, during the suckling period. Similar elevated isotopic values of molars with respect to bone were also observed in North American caribou (Drucker et al. 2001, 2012). T-tests showed significant differences between the isotope values of the tooth and bone samples (p=.00121 for δ^{13}C and p=.000016 for δ^{15}N).

Although the reindeer samples come from four sites, T-tests showed no significant differences in the δ^{13}C and δ^{15}N values. However, there are significant differences between the δ^{13}C values of those reindeer samples AMS-dated before AD 1600 and those with more recent dates (p=.002044), which may be a reflection of the human-reindeer interaction processes that took place in Finnish Lapland during 1200-1900. For comparative reindeer isotope values see Table 2.

4.6 Isotopes and human-reindeer relations in Finnish Lapland 1200–1900 AD

The lack of interest in the origins of reindeer herding practices among Finnish archaeologists may be blamed on being introduced as a 'ready package', but that does not make the event any less interesting. The conditions in Finnish Lapland in 1650–1900 may hold similarities to the earlier farmer-forager contact scenarios and the processes of adopting reindeer herding practices that took place in Norway and Sweden during the preceding centuries.

This brings us to the questions of whether changes in the proportions of different reindeer categories (wild, herded, household) may be represented in the *sieidi* material and, if so, whether the differences can be detected isotopically. The latter is not so farfetched. Household reindeer were valuable and lived in close contact with their owners, who made sure that they were well fed year-round. Herded reindeer were semi-wild. Their diet may have been more varied than that of household animals, but was nonetheless human-controlled to some degree. They represented both livelihood and wealth, and their well-being was insured by guiding them to suitable grazing grounds and, most importantly, providing them with the necessary food in winter. Wild reindeer, on the other hand, were free to roam and browse opportunistically. Even if they consumed the same plant taxa as their herded counterparts, they had to cope by themselves with natural food fluctuations, particularly during bad winters. One would therefore expect wild reindeer to be associated with more heterogeneous diets than herded and household reindeer. Based on these premises and on what is known from written sources, one can expect the proportions between the three reindeer categories in Finnish Lapland to have evolved in the following manner:

> 1200: There are no written sources from this time, but we can safely assume that the reindeer population of Finnish Lapland was dominated by wild reindeer, which were hunted, and a very small percentage of household animals used for transport/hunting purposes.
>
> 1200–1600: Wild reindeer continued to dominate. There may have been a slight influx of herded reindeer from the west at the very end of the period, but the reindeer inventories show that the number of tame reindeer was still rather modest in 1605: no more than 4 reindeer per household (Hultblad 1968; Nieminen 2013).
>
> 1600–1900: The proportion of herded reindeer increased gradually during the 1600s and 1700s, and at an even faster rate in the 1800s as wild reindeer populations declined and collapsed. Around 1800 many Saami families in Finnish Lapland owned over 200 reindeer, the richest of them 1000-2000. By the end of the 19th century, wild reindeer had become extinct in Finnish Lapland, which means that all the reindeer were either herded or household animals. (Aurén 1894; Itkonen 1948; Tegengren 1952; Storå 1971; Pulliainen and Leinonen 1990).
>
> 1900: Only herded reindeer and a small percentage of household animals.

On this basis, we should expect a greater variability in the isotope values among the reindeer offered at the *sieiddit* before 1600, when most reindeer were wild and herding practices had not begun to spread into Finnish Lapland. After 1600, the variability of isotopic values should decrease as the proportion of herded reindeer increases, first gradually and later faster, culminating with the disappearance of wild reindeer. Around 1900, only tame reindeer would be offered at the *sieiddit*.

The diagram of Figure 4.5 seems to reflects these developments. When reindeer $\delta^{13}C$ values are plotted against the medians of their calibrated AMS-dates, one can observe a greater variability before 1600 than after. The difference is particularly obvious around 1900, when wild reindeer had become

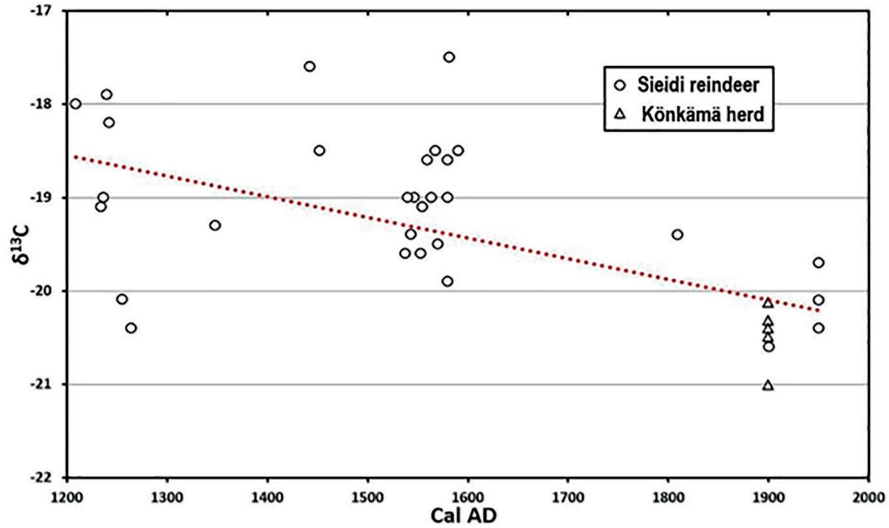

Figure 4.5: Plot of all the reindeer $\delta^{13}C$ values (circles) against the median of their AMS calibration ranges. Fjellström's (2011) results of five modern herded reindeer (c. 1900) from the Könkämä Saami village in Sweden (triangles) were added for comparison. Trend line: y= -0.002x -16.192.

extinct. Moreover, the somewhat lower $\delta^{13}C$ values around 1900 suggest a diet with less lichens than in earlier periods (see the trendline in Figure 5), which also agrees with herding practices. A similar treatment of the $\delta^{15}N$ shows the expected opposite trend, suggesting again less lichens; but the $\delta^{15}N$ data are badly disturbed by the high tooth values.

Summing up, the distribution of reindeer carbon and nitrogen isotopic values through time seems to reflect the historical facts: Reindeer herding spread into Finnish Lapland after 1600, becoming fully established by 1900. The correlations shown here may be useful in future research, but it must be borne in mind that stable isotopes can only provide indications. They will not determine whether one reindeer is wild or domesticated (cf. Balasse et al. 2018), but may be useful in certain cases. By far the best potential for determining the introduction of reindeer herding practices in the various parts of northern Fennoscandia would be aDNA analyses, but that still requires technique improvements and lots of analyses. Recent research seems to be moving in that direction (Røed et al. 2008, 2018; Bjørnstad et al. 2012; Heino et al. forthcoming).

4.7 Final remarks

After describing and briefly discussing the laboratory results of animal bone samples from seven sieidi sites in Finnish Lapland, we present the following summarizing remarks:

- The utilization of at least six of the seven studied *sieiddit* had begun by AD 1300 and continued with varying intensity throughout the 19th century. A clear drop in votive activity seems to have taken place in the 17th-century.
- The *sieidi* fauna was dominated by reindeer (52% MNI), followed by grouse (19% MNI) and sheep (18% MNI). Fish and bird bones were less common, but they may be taphonomically affected.
- The Inari Saami were apparently raising sheep 300–400 years earlier than previously thought. Their abundance and chronological distribution suggest that they were being raised in Inari by AD 1400.
- The stable carbon and nitrogen isotope results of the *sieidi* species and are in agreement with other results from northern Fennoscandia.
- The high $\delta^{15}N$ values of some sheep suggest the consumption of animal protein, which could be explained if they had been fed freshwater fish in winter. Such practices were recorded in Inari in the 1820s and in northern Norway in the late 16th century. Similar SIA results were observed in a 15th-century ovicaprid sample from Swedish Lapland.
- When the $\delta^{13}C$ values of the reindeer samples are plotted against their AMS dates, they show correspondence to what is known about the history of Saami-reindeer interaction in Finnish Lapland during AD 1200–1900.
- The reindeer offered before 1600 appear to have had more variable diets than those offered later, which is compatible with wild reindeer. This contrasts with the more uniform diets after 1600, particularly, around 1900, when wild reindeer were extinct and all the offered reindeer would have been herded or household animals.
- The lower $\delta^{13}C$ values of the reindeer offered around 1900 suggests a diet with less lichens than in earlier centuries, which may also reflect herding practices.
- By far the most important contribution of the project and this paper are the generated data, which can be used by others in future research: a total of 41 AMS dates and 49 stable isotope determinations from the remains of animals offered at seven *sieidi* sites in Finnish Lapland during AD 1100–1900.

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Appendix 4.1: AMS and SIA results from the studied sieidi sites with their numbers (cf. Fig.1), species and materials involved, the AMS lab numbers and dates (BP and cal AD), and the SIA results from Helsinki and Stockholm. Whenever possible we preferentially used the Stockholm δ^{13}C and δ^{15}N results for the diagram of Figure 4 because they also involve the sheep samples; otherwise we used the Helsinki Batch 2 results. For the diagram of Figure 5 we used the same δ^{13}C results from Stockholm and Helsinki used for Figure 4, but also included the seven single δ^{13}C from Helsinki Batch 1. All the results employed in Figures 4 and 5 have been enhanced in bold. The AMS dates have been corrected for isotopic fractionation to correspond to a δ^{13}C of -25‰. The SIA were done with a Finnigan MAT52 at Helsinki (both batches) and a Finnigan MAT Delta+ at Stockholm.

Site	Species	Material	Lab number	Date BP	Date cal AD	HELSINKI			STOCKHOLM		
						Batch 1	Batch 2				
						δ^{13}C	δ^{13}C	δ^{15}N	δ^{13}C	δ^{15}N	δ^{34}S
3	pike	bone	Hela-1878	900±25	1040–1220	–23.5	–23.0	6.92			
2	swan	bone	Hela-1755	875±30	1040–1230	–11.9					
4	bear	tooth	Hela-1885	830±25	1165–1260	–19.9	–19.6	8.90	–20.2	8.9	9.9
5	reindeer	tooth	Hela-1896	830±25	1165–1260	–18.0					
5	reindeer	bone	Hela-1890	800±25	1185–1275	–19.5	–19.1	2.06	–19.2	1.9	12.8
4	reindeer	bone	Hela-1882	795±25	1205–1280	–19.6	–19.0	3.32	–19.3	3.6	10.9
4	reindeer	tooth	Hela-1883	785±25	1215–1280	–18.7	–17.9	3.32			
4	reindeer	tooth	Hela-1884	780±25	1215–1280	–18.9	–18.2	3.44	–18.4	5.3	11.0
4	reindeer	bone	Hela-1886	740±30	1220–1290	–20.5			–20.1	3.5	12.0
5	reindeer	bone	Hela-1892	740±25	1225–1290	–20.9	–20.4	1.05	–21.0	1.1	15.2
6	grouse	bone	Hela-2195	655±30	1279–1393		–21.2	0.31			
2	reindeer	bone	Hela-1756	600±25	1290–1410	–19.3					
2	sheep	bone	Hela-1754	570±25	1300–1420	–20.6					
5	reindeer	bone	Hela-1891	575±25	1300–1420	–19.7	–19.4	1.02	–19.3	0.9	13.1
1	sheep	bone	Hela-1257	540±30	1315–1440	–20.2					
1	grouse	bone	Hela-1221	490±30	1400–1450	–21.6					
1	reindeer	bone	Hela-1220	445±30	1415–1490	–17.6					
1	sheep	bone	Hela-1433	444±25	1420–1485	–19.6					
5	reindeer	bone	Hela-1894	425±25	1420–1620	–18.9	–18.5	2.00	–18.6	1.9	11.4
6	reindeer	bone	Hela-2200	367±30	1448–1634		–19.6	4.32			
6	reindeer	tooth	Hela-2198	362±30	1450–1634		–19.0	6.07			
1	reindeer	bone	Hela-1219	350±30	1455–1635	–19.0					
6	reindeer	bone	Hela-2199	338±30	1472–1640		–19.6	2.35			
6	reindeer	tooth	Hela-2194	333±30	1475–1641		–19.1	5.18			
6	reindeer	tooth	Hela-2196	325±30	1480–1644		–18.6	4.11			
1	sheep	bone	Hela-1432	330±25	1480–1650	–21.2					
5	reindeer	bone	Hela-1893	325±25	1480–1650	–19.4	–19.0	3.33	–19.2	3.1	10.6
6	reindeer	tooth	Hela-2197	313±30	1486–1648		–18.5	6.67			
6	reindeer	tooth	Hela-2201	309±30	1487–1649		–19.5	6.21			
5	reindeer	bone	Hela-1895	295±30	1490–1660	–19.5	–19.0	3.65			
5	reindeer	bone	Hela-1897	295±25	1490–1660	–20.2	–19.9	2.21	–19.7	2.9	12.8
5	reindeer	bone	Hela-1898	295±25	1490–1660	–19.0	–18.6	3.31			
5	reindeer	tooth	Hela-1889	290±25	1510–1660	–18.2	–17.5	3.40			
1	reindeer	bone	Hela-2494	276±30	1513–1667	–18.5					
6	grouse	bone	Hela-2202	259±30	1520–1799		–20.6	0.94			
7	reindeer	antler	Hela-2514	90±30	1685–1928	–21.7					

3	reindeer	bone	Hela-1880	80±25	1690-1920	–20.1	–19.4	3.33			
3	reindeer	bone	Hela-1879	modern	modern	–21.1	–20.4	2.43			
4	reindeer	bone	Hela-1881	modern	modern	–20.7	–20.1	1.76	–20.4	1.8	11.6
4	reindeer	bone	Hela-1887	modern	modern	–20.0	–19.7	3.63			
7	reindeer	antler	Hela-2513	modern	modern	–20.6					
1	sheep	bone							–22.2	6.3	3.8
1	sheep	bone							–21.6	7.2	5.8
1	sheep	bone							–22.0	4.2	5.9
1	sheep	bone							–21.9	4.9	8.0
1	sheep	bone							–21.7	5.2	4.0
1	sheep	bone							–21.9	5.9	6.0
1	sheep	bone							–22.3	6.0	6.8
1	sheep	bone							–21.6	5.0	5.0
1	sheep	bone							–21.4	6.9	10.8
1	sheep	bone							–21.8	3.9	2.0
1	sheep	bone							–22.2	6.0	0.4
1	sheep	bone							–21.8	6.4	6.3
1	sheep	bone							–21.9	4.3	3.1
1	sheep	bone							–22.0	8.7	0.0
1	sheep	bone							–21.8	7.1	4.4
1	sheep	bone							–22.1	6.2	2.7
1	sheep	bone							–22.1	7.9	3.9
1	sheep	bone							–22.0	5.7	7.5
1	sheep	bone							–21.6	5.9	3.5
1	sheep	bone							–21.6	6.3	11.5
1	sheep	bone							–21.7	6.4	4.7

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