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A dendroecological reconstruction of use by Saami of Scots Pine (*Pinus sylvestris* L.) inner bark over the last 350 years at Sädvajaure, N. Sweden

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Abstract. The historical use of Scots Pine (*Pinus sylvestris* L.) inner bark by the Saami near Lake Sädvajaure, N. Sweden was studied with dendro-ecological methods. Damming of the lake for hydroelectric power enabled destructive sampling of all pines with scars from bark peeling in an area of 870 ha. A total of 111 dead and live pines with 136 bark peelings were found. Stem-sections were taken for cross-dating to determine the precise peeling year and season. The oldest peeling was dated to 1618, which is the oldest reported evidence of Saami use of inner bark. No bark peelings were made after 1870 in the studied area which coincides with a shift to more extensive reindeer herding, and with colonization by Swedish farmers in the area. The regular use of inner bark over time and the absence of peeling peaks in known agrarian famine years support the hypothesis that inner bark was used regularly, and not only as an emergency food. Changes in spatial peeling activity around the lake is interpreted as temporal changes in nomadic fishing activity. We conclude that tree ring studies can provide valuable information about former mobile use of natural resources by Saami in boreal forest landscapes.

Key words: Boreal forest – Forest history – Bark peeling – Mobile land-use – Saami

Introduction

Inner bark of trees has been widely used for a variety of reasons within the boreal zone (Eidlitz 1969; Erichsen-Brown 1979). In northern Europe, farmers gathered inner bark for food from several tree species (*Pinus sylvestris* L., *Ulmus* spp, *Betula* spp, *Picea abies* L. Karst, *Fagus sylvatica* L.) in times of famine (Keyland 1919; Høeg 1975; Vuorela 1975). In these cases the trees were usually felled and the inner bark from the whole tree was utilized. The native inhabitants of northern America used several tree species, preferably pines, and peeled off the inner bark from the stem, leaving the trees alive with a datable scar (White 1954; Swetnam 1984). Similar use of inner bark in the past by the Saami people of northern Fennoscandia has been documented from oral sources, ethnologists and early explorers (Högström 1747; Leem 1767; Drake 1918; Itkonen 1948). Also, observations of scars from bark peeling in old Scots Pine trees (*Pinus sylvestris* L.) found in northern Sweden show that the use of pine inner bark was common among the Saami people (Zackrisson 1979). In the present study of a Scots Pine dominated area in northern Sweden previously occupied by the Saami, we used dendro-chronological cross-dating techniques to test the hypothesis that inner bark was used as an important regular food resource and not as a famine food in the traditional Saami society. The spatial and temporal pattern of the record of

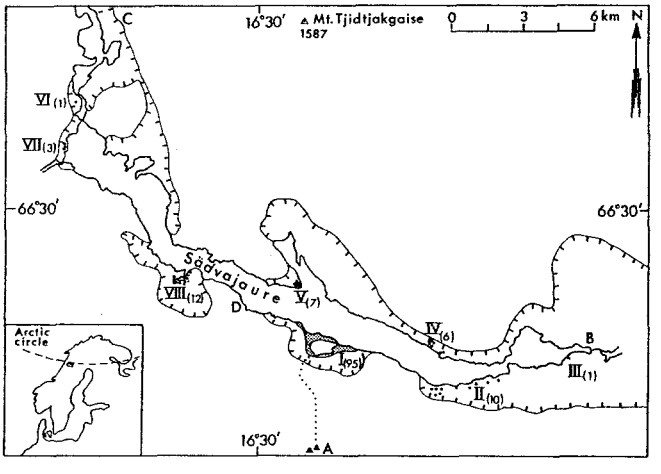

Fig. 1. Map of the investigated area. Roman figures denote sub-areas where peeled pines were found and sampled in the damming area. Numbers in brackets show the number of peelings for each sub-area. A: Tjallas: the nearest recent Saami dwelling. B: Location of the dam. C: Vuoggatjålme climate station. D: The ruins of the *Silbojokk* smelter. The hatched line marks the present distribution limit of pine in the area

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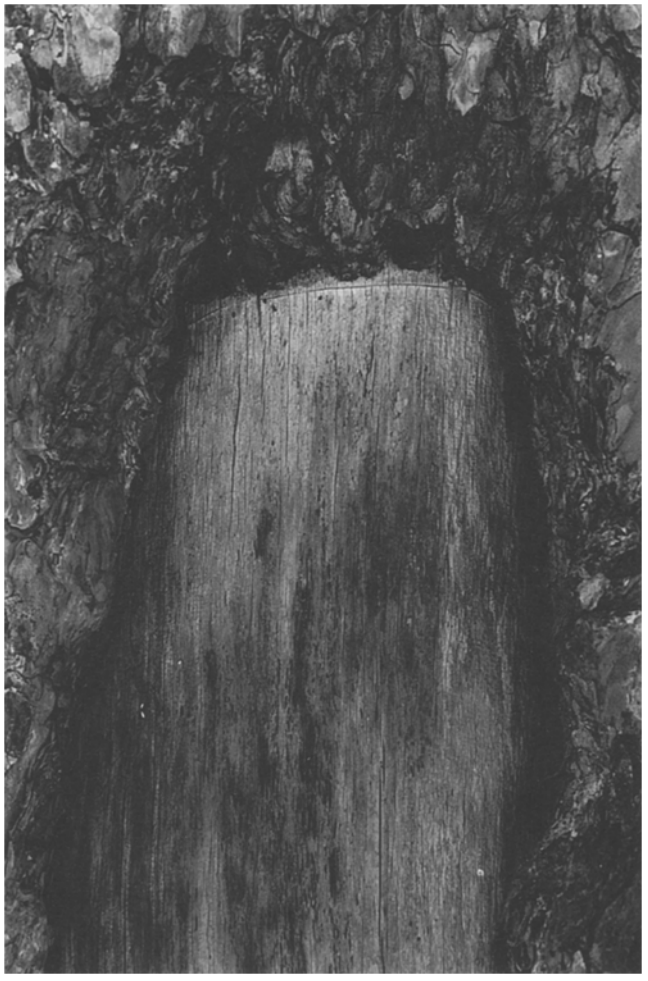

Fig. 2. Slow growing pine with well preserved upper knife cut

Fig. 3. Pine with typical peeling scar, the lower knife cut still intact. Only a narrow strip of living bark was left at the time of peeling. The top and bottom of the scar are typically v-shaped caused by the cambium's inability to heal over in the vertical direction. Note the smooth exposed dead wood without axe marks and the low cut well above ground level

peeling scars found are also discussed in relation to cultural changes over the studied period of 350 years. We also dated the season of peeling and described the shape and orientation of all peeling scars.

Materials and methods

Study area and historical background

We studied an area of 870 ha situated near Lake Sädvajaure in northern Sweden (Fig. 1). The lake belongs to the uppermost parts of the river Skellefteälven and is located within the eastern part of the Caledonian mountains. The lake was about to be dammed for hydroelectric power production, so the area within the damming zone could be used for destructive sampling. The water level of the lake fluctuates today between 461-477 m above sea level. The bedrock in the area is dominated by mica schists (SGU 1958) and the Quaternary deposits are dominated by moraines. The lake is situated on the border between the subalpine birch belt and the northern boreal forest zone (Sjörs 1965). The forest around the eastern part of the lake is dominated by Scots Pine (*Pinus sylvestris* L.) while the western part is dominated by subalpine polycormic birch (*Betula pubescens* ssp. *tortuosa* Ehrh.). Ground vegetation is dominated by blueberry (*Vaccinium myrtillus* L.) and crowberry (*Empetrum hermaphroditum* Hagerup) (Lundquist and Wistrand 1976). The vegetation growth period is 110 - 120 days (Odin et al 1983). The mean annual temperature is -1.7°C and mean annual precipitation is 512 mm (Vuoggatjålme climate station, C in Fig. 4) (Alexandersson et al. 1991). Snow-cover lasts for 220-240 days (Ångström 1958) or from mid October to late May/early June.

History of the area

The historical land use in the area is characterized by short periods of Swedish influence interrupting long periods of traditional Saami culture (Swedish is hereafter referred as being of non-Saami origin). In the years 1636-1659 a silver smelter, *Silbojokk*, was in operation (D in Fig. 1), where ore from the mine in Nasafjäll mountain (30 km to the west) was refined

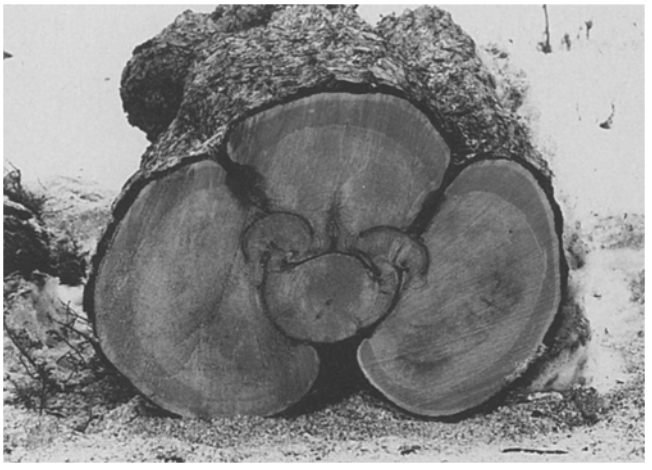

Fig. 4. Pine (70cm diameter) was found in area I, Kålmåsjaure. First peeled in 1694, secondly in 1709, and for the last time in 1734. Although almost all bark was peeled on the two last occasions, the pine survived and successfully healed over the scars

(Bromé 1923). Apart from this period, there were no Swedes permanently living in the area until the 1870s when Swedish colonization began in the area (SCB 1870, SCB 1880). Traditional Saami culture was characterized by a high degree of self-sustainability, mobility and consisted of two different ethnic groups. First, the nomadic mountain Saami, who migrated with large reindeer herds from summer pastures in the mountains to winter grounds in the eastern forests (Manker 1947). Second, the forest Saami, who were semi-nomadic and stayed for longer periods at one place with small herds. Dairy products from the reindeer played a substantial role in their economy (Ruong 1945; Aronsson 1991). Fishing Saami with dwellings situated by lakes in the forest landscape exhibited a variety of nomadic life forms found in both ethnic groups. Fishing was often merely considered to be an activity for poor or old mountain or forest Saami (Laestadius 1831), yet in certain areas, as in northern Finland, fishing was the main economy (Tanner 1929). There was not always a clear distinction between these ethnic groups in their use of resources. In different regions one life-style could dominate over another. Hunting also previously played an important role in all groups. In the studied area both mountain and fishing Saami were present in the time period which was studied (Laestadius 1831).

Sampling

We systematically searched for pines with scars from bark peeling within the 870 ha damming zone. Outside the damming area peeling scars were found but not sampled. All living and dead Scots Pines with scars of bark-peeling were located and positioned on maps. Bark peeling damage was separated from trail blazes, fire scars and other cambial damages (data not presented). Descriptions by Sandberg (1898), Rosberg (1912), Itkonen (1948), and local oral traditions helped in the identification of Saami bark peeling damage. In the field the following variables were recorded: shape, size,

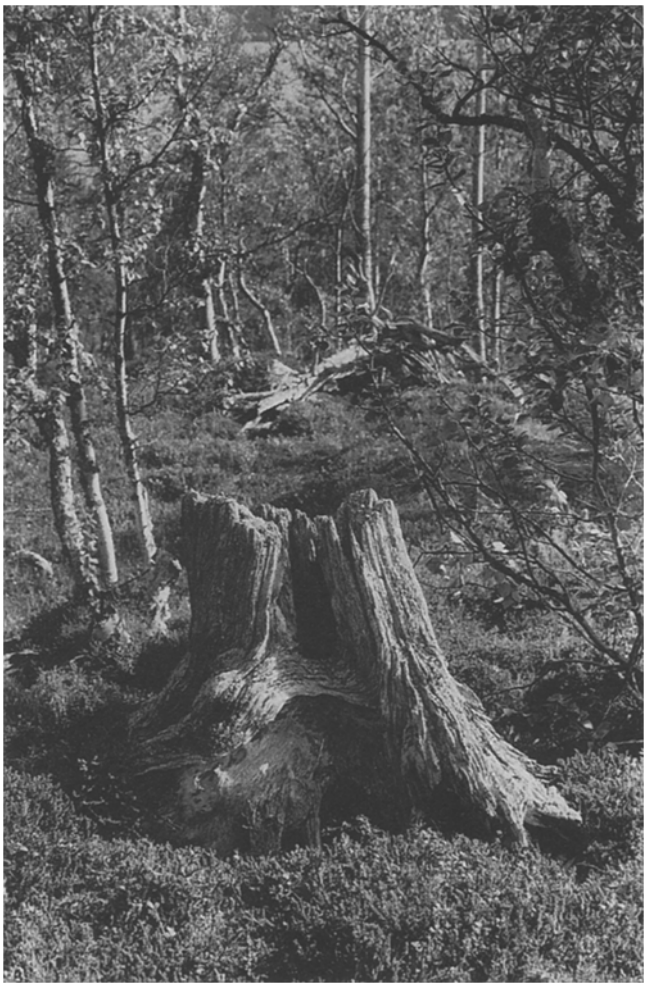

Fig. 5. Large pine stump from the 17th century cut for the silver smelter in *Silbojokk* (D in fig. 1.) The lower part of a pre-1600 peeling scar is still visible. In the cold and dry climate these stumps decompose slowly and can still be found scattered around lake Sädvajaure

position and orientation of the peeling scar. The pines were felled with a chain-saw and cross-sections were cut across the scars and taken to the laboratory for dating.

In the laboratory, the diameter (under bark) of the trees at the time of peeling was measured on the discs. To improve tree-ring visibility, the discs were sanded and grooves were cut in the wood with a scalpel. Zinc paste was applied to enhance the contrast of the cell walls and tree rings. For the cross-dating procedure, a local pointer year chronology was first established by examining 30 randomly sampled discs for common event years (Schweingruber et al. 1990). Three main types of pointer years were consistent in the majority part of the samples: (1) Very dense and dark late wood, (2) very light late wood or light rings (Filion et al. 1986) and (3) abrupt growth changes (Schweingruber et al. 1990). Many pointer years coincided with climatically extreme years reported in the literature (Table 1). The remaining discs were cross-dated on basis of the pointer year chronology (Stokes and Smiley 1968; Douglass 1941) and the exact years of the peelings were determined. The season of cambial damage was determined in the following fashion: 1. The number of undisturbed cells developed before the damage occurred were counted. 2. The total number of cells

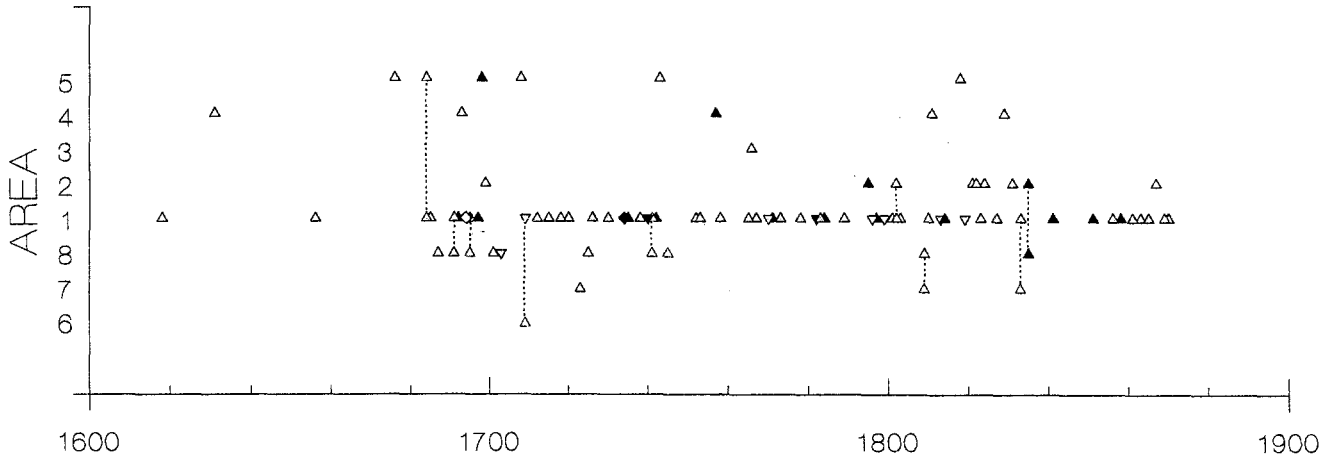

Fig. 6. Cross-dated peeling years from the sub-areas marked in Fig. 1. Peelings done the same year in two different sub-areas are connected with a vertical line. Number of peelings: Δ =1; ▲ =2; ∇ =3; ▼ =4; ◇ =5; ◆ =6

developed in an undisturbed portion of the same ring were then counted. 3. The number of cells from the first count was then divided by the number of cells from the second count. The relation (%) was used as a measure of season of peel. Based on phenological observations (Romell 1925) from somewhat lower altitudes, values from 0 - 10 % were interpreted as peeling in May/June; 10 -70 % as June/July; more than 70 % as July/August.

Results

A total of 106 living and 5 dead pines with peeling scars were found in the damming area around the lake. In pines with open scars, knifemarks from the peeling could still be seen (Figs 2, 3). Since some of the pines had been repeatedly peeled a total of 136 peeling scars were identified. Seventeen pines had peeling scars from two different occasions and four pines had scars from three different peeling occasions (Fig. 4). The cross-dating was facilitated by the great age of the trees, since most of the peeled pines had germinated during or just after the *Silbojokk* era in the 17th century (Zackrisson 1985). The dating failed in only one case; when the year and position of peeling coincided with a period of very narrow and partly absent tree-rings. A total of 135 peelings were thus dated. The five dead trees with peeling scars had died between the years 1920 and 1976. The oldest peeling scar was found in a dead standing tree in area 1. It was dated to 1618, which predates the earliest historical records of Saami pine bark use in Fennoscandia (Rheen 1897; Itkonen 1948). This particular tree was peeled a second time in 1656. The pine was at a seedling stage around the year 1500 and died in 1920. In large pine stumps cut during the *Silbojokk* mining era we found peeling scars which could not be precisely dated due to decay (Fig. 5). We estimated that some of these peeling scars could have been made as early as the 15th century. No peelings were made after 1870. For the period 1684-1870 an average of 0.7 peelings per year were made, with a maximum six peelings in 1734.

The peeled trees were concentrated to areas with stands of denser forest. Most peelings by far were found in sub-area 1, Kålmåsjaure (Fig. 1). When combining

Table 1. Major pointer years used when cross-dating the peeling scars. Types: (1) Very dense and dark late wood; (2) very light late wood or light rings; (3) abrupt growth changes.

Year	Type	Remarks
1601	2	Noted as a negative pointer year in Abisko by Bartholin and Karlén (1983)
1641	3,2	Very cold summer at lake Sädvajaur, mountain lakes still frozen in July (Bromé 1923). In Abisko noted as negative pointer year (Bartholin and Karlén 1983).
1680	2	Narrow ring in a period of fast growth without any negative lag effect in the following years.
1703	1	Unusually warm summer in reconstruction by Briffa et al. (1990). The subsequent year, 1704 usually has very light late wood.
1766	2	A single ring with very dense and dark late wood within a long period of complacent rings
1790	2	Often very narrow or partly absent ring with very light late wood.
1831	1	Warm and dry summer (Briffa et al. 1990) with many forest fires (Laestadius 1833).
1868	1	Warm summer in N. Sweden (Alexandersson and Eriksson 1989).
1901/2	1,2,3	Extremely warm summer followed by a very rainy and cold summer (Alexandersson and Eriksson 1989).
1934	1	Wide ring, wide and dark late wood.
1937	1	Warmest summer in northern Sweden for the period 1860-1987 (Alexandersson and Eriksson 1989)

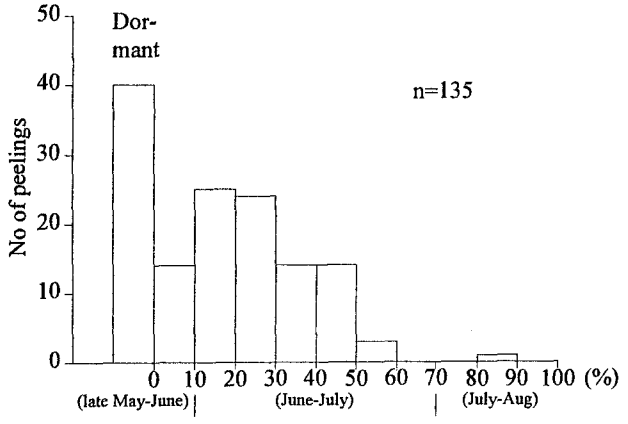

Fig. 7. Season when the pines were peeled. Note that the samples dated to generic early wood are equally distributed in the classes from 0 - 50% tree-ring development

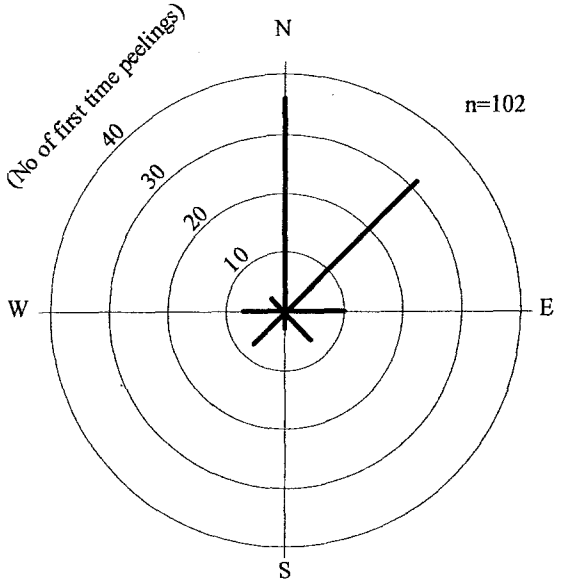

Fig. 8. Directions of the peelings. Only the first peeling in each stem included

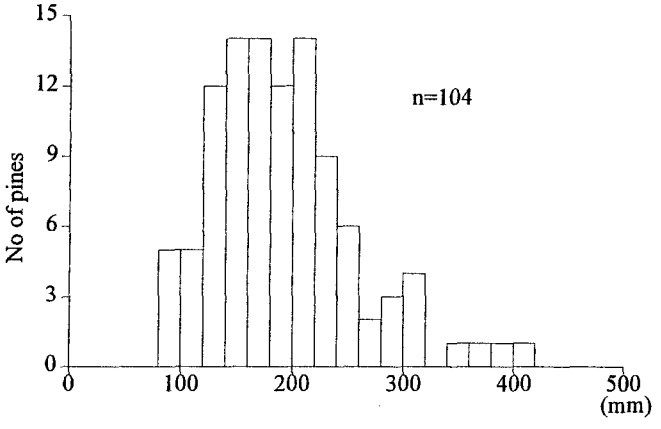

Fig. 9. Diameter of the pine (measured under bark) when first peeled

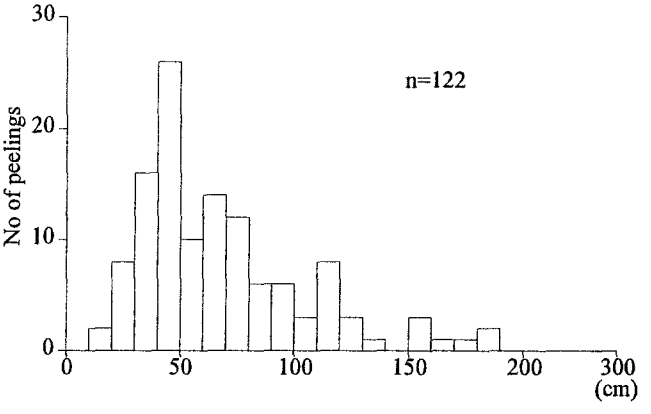

Fig. 10. Length of the peelings

peeling years and location of the peeled trees some patterns emerged (Fig. 6). On only one occasion (1684) were peelings made on both sides of the lake during the same year. Gaps of 5 to 10 years in the peeling record of area 1 often coincided with peelings in other areas. The periods 1698-1708, 1721-25, and 1743-51 are good examples of this. Long periods with peelings found only in area 1 were typical, such are: 1726-1740, 1767-1789 and 1841-1865.

The majority (95 of 135) of the peelings were made during the growing season (Fig. 7). In 55 of these peelings it was possible to count the exact number of developed cells before the bark had been peeled. In 40 peelings the damage had occurred in generic early wood (Baisan and Swetnam 1990), that is somewhere inside the early wood part of the tree-ring without the possibility of finer determination. The remaining 40 peelings were made during the dormant season, so that the damage appeared between two rings.

A majority (67 of 102 analyzed) of the pines had been peeled on the north and northeast side of the tree (Fig. 8). The size of the trees when used for bark (Fig. 9) and the size of the peel itself showed great variations (Fig. 10). The length of the peelings varied between 35 and 186 cm (mean 66 cm). Pines with diameters between 120 to 250 mm were preferred (mean 184 mm). No trees were found to have been killed by peeling.

Discussion

Our results clearly show that pine inner bark was used regularly for over 250 years in the area. No peaks in peeling activity can be seen during the well-known agricultural famine years 1695-1697, 1828-1832 and 1866-68 (Laestadius 1831; Tirén 1937; Wallqvist 1968). According to historical sources, the Saami used pine inner bark as a thickening agent and/or mixed it in other food, such as fish, meat and reindeer milk (Fellman 1906; Friis 1872; Drake 1918). For this use, rather small quantities of inner bark were needed. This is also reflected in our record as a low but steady number of peelings over the years. Thus, our results strongly support the hypothesis that the Saami did not use pine inner bark as an emergency food. The earliest peelings, including undatable old peelings, suggest that the habit of peeling pines for the inner bark was not brought by the Swedes. The cessation of the peeling in 1870 coincides with fundamental cultural changes in the area; the onset of free, more extensive reindeer herding beginning in the 1870s (Wallqvist 1968) and the increasing contacts with colonizing Swedish farmers. As the inner bark was used in small quantities it was readily substituted by flour that became easily available with the Swedes arrival in the area. The farmers generally negative attitude towards pine inner bark as a food source (Eidlitz 1969) could also have contributed to the rapid disappearance of the traditional use of inner bark by Saami living nearby.

The peeling activity is also an excellent indirect record of past Saami activity around lake Sädvajaure. From the fragmentary written records of the area (CA:a1, CA:a2) it is known that a fishing Saami group occupied an area south of Lake Sädvajaure at the turn of the 19th century. It is likely that this group peeled most of the studied trees during seasonal fishing at Kålmåsjaure and Sädvajaure. Lake Kålmåsjaure is still recognized by the local population as having better fishing than the main lake Sädvajaure. Possibly the spatial and temporal variation in bark peeling activity might reflect shifting between fishing places. Such a mobile pattern was described by Laestadius (1831) from a Saami population 20 km northeast of the studied area. In that area, fishing Saami moved between lakes depending on seasonal and more long-term variations in the catch of fish.

The dated season of the peelings agrees very well with records of bark peeling. Swedish farmers usually gathered pine inner bark in the first half of the summer (Levander 1914; Keyland 1919; Laestadius 1833) and the few observations of Saami bark use also confirm this (Drake 1918). We also assume that the dormant season peelings were made in the spring/early summer, since bark is easily removed when the sap is rising, before growth has started (White 1954).

The absence of pines killed by bark peeling and the bark strip left behind on peeled pines (Figs. 3,4) suggest that the damage to pines was deliberately limited. According to Drake (1918) the habit of leaving a bark strip when peeling pines had superstitious or religious origins. Children sent out to gather pine inner bark were told to leave „the back" of the pine, otherwise their father would get a sore back. As a small proportion of all pines were peeled and pollen production is not reduced even when severely girdled (Wheeler and Bramlett 1991) we also conclude that pine pollen production recorded in peat or mor humus profiles of closed canopy sites cannot be used to trace Saami bark peeling.

The prevalence of peeling on the north and northeast sides of the trees (Fig. 10) is more difficult to interpret. There might be either superstitious reasons behind this or simply differences in taste between the sides of the tree due to (for example) differences in sun exposure. White (1954) reported that Kutenai native Americans tried the taste of Ponderosa pine inner bark before completing the peel. To our knowledge, no sources mention the Saami tasting the bark before peeling. However, Rosberg (1912) mentions a small island in a lake in northern Finland, „Njalgispecessuolui" which means „the island with the delicious pines".

The average length of the peelings is somewhat shorter than is mentioned in the literature. Rheen (1897) mentions peelings of 1.2 m and Sandberg (1898) 1-1.5 m. We suggest that the length of the peelings was largely dependant on usage and individual size and strength of peelers, and possibly also how easily the bark came off. It is known that peeling was mainly carried out by women and children (Friis 1872; Rosberg 1912; Drake 1918). Very few large diameter (over 30 cm) pines were peeled, and as already noted, pine inner bark was not gathered in large quantities. Instead, the preference for smaller pines seems to be another intentional choice. We think that bark thickness, which increases with age and size of the tree, might have been an important selection factor. For Swedish farmers the bark thickness was often a determining factor when choosing pines. (Levander 1914; Pettersson 1941). Thin bark was probably also easier to clean and easier to carry than thick and coarse bark. Practical experiments could probably add substantial information to the questions concerning Saami bark use, for example selection criteria, variations in taste and techniques applied in the process.

Conclusions

We conclude that tree-ring studies can provide valuable information about previous mobile use of natural resources by Saami living in the boreal forest. The technique we used can provide data on annual as well as seasonal usage of bark over wide geographical areas thereby indirectly describing seasonal mobility within Saami ethnic groups. Future studies focusing on areas with stands of very old pines (Scots pines can attain ages up to 800 years [Sirén 1961]) and sub-fossil dead trees (a 1400 year-chronology has been established [Bartholin and Karlén 1983; Briffa et al 1990]), could possibly help to solve some of the questions raised about Saami colonization and their usage of natural resources in northern Fennoscandia (Aronsson 1991).

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