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# BARK-PEELING, FOOD STRESS AND TREE SPIRITS – THE USE OF PINE INNER BARK FOR FOOD IN SCANDINAVIA AND NORTH AMERICA

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ABSTRACT.—The Sami people of northern Scandinavia and many indigenous peoples of North America have used pine (*Pinus* spp.) inner bark for food, medicine and other purposes. This study compares bark-peeling and subsequent uses of pine inner bark in Scandinavia and western North America, focusing on traditional practices. Pine inner bark contains substances – mainly carbohydrates, dietary fiber, vitamin C, and minerals – that were important complements to the protein-rich food of the indigenous peoples living in northern regions of both continents. The climate in these regions was (and is) sharply seasonal, and the stored carbohydrates in pine inner bark were particularly important during late winter. On both continents, a strip of live cambium was commonly left to show respect to the tree and the tree spirits and to ensure the tree's survival. The uses of pine inner bark and associated traditions have long time depths, and trees with old, or even ancient, bark-peeling scars are still common in old-growth pine forests on both continents. We conclude that forests with such trees should be regarded as relicts of traditional landscapes and protected for their cultural historical value.

Key words: Bark-peeling, forest history, sharply seasonal climate, pine (*Pinus* sp.), plant food, CMT.

RESUMEN.—Los Sami del norte de Escandinavia y muchos nativos de Norte América han utilizado la corteza interna del pino (*Pinus* spp.) como alimento, medicina y con otros fines. En este estudio se comparan los modos tradicionales de pelar y usar la corteza en Escandinavia y Norte América. Como muestra de respeto hacia los árboles y su espíritu, en ambos continentes era muy común dejar una franja de cambium vivo en un lado del árbol para que así pudiese sobrevivir después de ser pelado. La corteza interna de pino contiene sustancias que eran importantes complementos proteícos para los grupos que vivían en las regiones del norte. La tradición de utilizar la corteza interna del pino es muy antigua y los árboles con viejas e incluso viejas marcas de pelado todavía son comunes en antiguos bosques de pinos en ambos continentes. Se concluye que los bosques con este tipo de árboles deberían considerarse reliquias de los paisajes tradicionales y deberían estar protegidos por su valor histórico cultural.

RÉSUMÉ.—Le peuple Sami du nord de la Scandinavie et plusieurs Premières Nations de l'Amérique du Nord ont utilisé l'écorce interne du pin (*Pinus* sp.)

comme nourriture, médecine et autres utilisations. Dans cette étude basée sur les pratiques traditionnelles, nous comparons l'écorçage et l'utilisation subséquente de l'écorce interne en Scandinavie et dans l'ouest de l'Amérique du Nord. Dans un geste de respect pour les arbres et l'esprit de l'arbre, il était commun sur les deux continents de laisser une bande de cambium vivant sur un côté de l'arbre, ce qui assurait la survie des arbres. L'écorce interne du pin contient des substances (glucides, fibres, vitamine C, minéraux) qui étaient d'importants compléments à la nourriture riche en protéine des Premières Nations vivant dans les régions nordiques des deux continents. L'utilisation de l'écorce interne du pin, ainsi que les traditions qui lui sont associées, remonte loin dans le temps et les arbres avec de vieilles, voire d'anciennes, cicatrices liées à l'écorçage sont encore fréquents dans les forêts anciennes des deux continents. Nous concluons que les forêts ayant de tels arbres devraient être considérées comme des vestiges de paysages traditionnels et être protégées pour leur valeur culturelle historique.

## INTRODUCTION

*Old Man [the sun] showed them the roots and the berries, and showed how to gather these, and certain times of the year they should peel the bark of some trees and eat it…* Blackfeet creation (Grinell 1913)

*They [the Sami] also use pine bark for food, which they take from Pine trees and subtly cut from the innermost part of the bark which is sweetest…* From a description of the Sami people of northern Sweden in 1672 (Graan 1899)

Indigenous peoples in northern Scandinavia and the northern temperate and boreal zones of North America have utilized the nutritious inner bark from pine trees (*Pinus* sp.) for a long time as food, for medicine, and as wrapping material. When indigenous peoples removed bark, they did not kill or seriously injure the trees, but left a characteristic imprint on them in the form of bark-peeling scars. Although many animals, including large ungulates and bears, also eat the inner bark of pine trees (Bergqvist et al. 2003; Zeigltrum 2004), scars made by people are distinguishable in shape, size, and location of the modified trees across the landscape (Mobley & Eldridge 1992; Zackrisson et al. 2000). These scars can be identified and dated using dendrochronology several hundred years after they were made, so culturally modified trees (CMTs) provide an important source of information about people's use of the forest in the past (Andersson 2005; Mobley and Eldrige 1992; Östlund et al. 2002). Examinations of CMTs can document similarities and differences in the nature and frequency of tree use, and in peeling methods, both through time and across space. CMT studies can also be combined with investigations of other kinds of archaeological sites to document changes in settlement, population movements and populations over time (Östlund et al. 2004; Stryd and Eldridge 1993). A proper understanding of past utilization of forests is essential for future protection of cultural heritage in forest ecosystems that were mainly used by indigenous peoples (Zackrisson et al. 2000). Accordingly, there is a growing awareness in Scandinavia and North America that CMTs have high interpretative value for both scientists and the public (Mobley and Eldridge 1992).

Some of the most abundant, and perhaps the most common, CMTs in the northern hemisphere are various species of pine (*Pinus ponderosa* Laws., *P. sylvestris* L., *P. contorta* Dougl. Ex Loud., *P. banksiana* Lamb., and *P. monticola* Dougl. Ex D. Don) with bark-peeling scars. Bark-peeling scars can be found in forested areas that have been traditionally used by indigenous peoples and still have remnants of old-growth forest. However, there are major variations in the sizes of the scars, number of trees with scars within harvest areas and their spatial distribution in forest landscapes. Due to the long lifespan of pine trees and the persistence of dead wood, they can show distinct patterns of indigenous people's forest use and resource extraction including settlement patterns and seasonal occupation of certain areas (cf. Östlund et al. 2004; Turner et al. 2000). Further, they provide unique indications of past people's lives and activities, since traditional plant use by the indigenous peoples generally left little evidence and is thus difficult for archaeologists and historical ecologists to interpret.

This paper presents a comparative review and synthesis of knowledge pertaining to the inner bark harvest from pine trees (and resulting CMTs) by indigenous peoples in northern Scandinavia and western North America. The following specific questions are addressed. Are there temporal, spatial and social patterns related to the bark-peeling of pine trees in these two regions? If so, when was the inner bark harvested, why was it sometimes heat-treated, and how was it harvested? What nutritional and medicinal benefits did indigenous people obtain from bark, and what traditions were associated with pine inner-bark harvest and use?

## PINE BARK-PEELING – SPATIAL AND TEMPORAL PATTERNS

*Northern Scandinavia*.—The bark-peeling of Scots pine trees for food and wrapping material by the indigenous Sami people is one of the most common sources of CMTs in boreal Scandinavia (Andersson 2005; Östlund et al. 2003; Zackrisson et al. 2000; Figure 1). The pine species used for bark-peeling in Scandinavia, Scots pine, is the only native pine, and one of two dominant coniferous species in Scandinavian boreal forests, the other being Norway spruce (*Picea abies* Karst.). Scots pine prefers sites with poor fertility and can reach up to 800 years in age. The ground vegetation in the pine-dominated boreal forest is, in general, dominated by dwarf shrubs, mosses and lichens with relatively low nutritional value. Scots pine is well adapted to surviving and re-establishing after frequent forest fires and often occurs naturally in multi-storied stands with trees that have regenerated after successive fire events.

The Sami ate the inner bark of Scots pine fresh, roasted, or dried and ground into flour, which could be mixed with reindeer milk, fat, blood or other food. The trees chosen for food were of medium age (on average 90 years old) when first peeled (Zackrisson et al. 2000), and the same tree could be peeled several times (Bergman et al. 2004). Most studies of Sami bark-peeling have concluded that Scots pine inner bark was not an emergency food, but rather a regularly collected and valued staple food (see Bergman et al. 2004; Niklasson et al. 1994; Zackrisson et al. 2000). This use contrasts with Swedish and Finnish farmers who only ate Scots pine inner bark as an emergency food during years of famine (Bergman et

FIGURE 1.—Bark-peeling on live Scots pine in Tjeggelvas nature reserve, Northern Sweden, dated to AD 1777 and located in an area with more than 20,000 bark-peeled trees. Note the characteristic square/oval shape of the scar and the knife-cut in the upper part (insert). Trees with Sami bark-peeling scars are commonly located around traditional Sami wooden huts in old growth Scots pine forest. Photograph by Lars Östlund.

al. 2004). Although bark-peeling was commonly practiced by the Sami people, as witnessed by large numbers of bark-peeled trees in old forests, we have little information on the quantities they used. Some estimates indicate that each Sami household required between 100 and 200 trees per year (Bergman et al. 2004). Bark-peeled trees are often found in proximity to former semi-permanent settlements and good water sources in northwestern Sweden (Östlund et al. 2003). Typically, many Scots pine trees around older Sami settlements have bark-peeling scars and the density of such trees decreases with distance from the settlements (Östlund et al. 2003). It is difficult to verify if Scots pine trees suitable for bark-peeling occasionally became scarce in some areas, but the absence of court records regarding bark-peeling rights suggests that this was not the case (Bergman et al. 2004).

Several authors have attempted to gauge the time-depth of Sami bark-peeling. In a study using dendrochronology to date more than 300 bark-peeling scars, Zackrisson et al. (2000) showed that the Sami people of Sweden collected pine inner bark from as early as 1450 AD. Östlund et al. (2004) subsequently traced the practice back considerably further, to 2800 BP, using both dendrochronology and $^{14}C$ dating of bark-peeled trees that were preserved as fallen logs in forests and peatland. However, there are indications that the

practice is far more ancient, with some scholars proposing that Neanderthals in Europe used inner bark for food. Tools found at Paleolithic sites in northwestern Europe may have been used for bark-peeling since they are similar in shape and size and to historic period tools described in ethnographies (Sandgathe and Hayden 2003). The practice of peeling trees declined and eventually ended during the 19th century for several reasons (Andersson et al. 2005; Niklasson et al. 1994; Östlund et al. 2003; Zackrissson et al. 2000). One was that the Swedish authorities forcefully tried to stop the use of inner bark for food; for example, in 1870 it became illegal to strip bark from standing trees on crown land (Zackrisson et al. 2000). In addition, at that time, access to alternative foods such as sugar, salt, wheat and dried fruit, as well as pharmaceutical products and fibers, greatly improved. Consequently, inner bark lost its role in the Sami diet (Drake 1918; Eidlitz 1969; von Duben 1873).

There have been no comprehensive inventories of the remaining bark-peeled trees in Scandinavia; however, based on both published studies and unpublished data we estimate that somewhere between 30,000 and 100,000 trees with bark-peeling scars exist in the northern region (north of ca. 65° N). Most of these trees are found in Scots pine-dominated forest reserves along the Fennoscandian mountain range. Today there are very few bark-peeled trees outside forest reserves, and data on old trees from historical records show that only a very small proportion of the original bark peeled trees still remain (Andersson and Östlund 2004). The Sami abandoned this practice more than 100 years ago, and nearly all old-growth pines in boreal Sweden have been cut for timber since then (Andersson and Östlund 2004; Östlund et al. 1997). Furthermore, forest commissions and laws passed during the early 20th century emphasized the importance of removing damaged trees. Bark-peeled trees were considered ''damaged'' and thus were logged to an even greater extent than undamaged ones during the last part of the 19th and early part of the 20th centuries. When trying to explain temporal and spatial patterns of bark-peeled trees in Scandinavia, it is important to note that previous cutting operations have strongly influenced today's forests. In addition, logging was not random and may have affected certain areas more strongly than others (Östlund et al. 1997).

*Western North America*.—The collection of inner bark from pine trees in the Americas was first recorded in 1792 by the trader and explorer Alexander MacKenzie, who described this practice among the Carrier people in western Canada (Lamb 1970). A decade later, members of the Lewis and Clark Expedition recorded indigenous peoples' collection of inner bark collection (Moulton 1988), and early North American ethnologists noted that trees were used for food (see Boas 1910). However, systematic field observations have been provided primarily by archaeologists and historical ecologists (Douglas 1929; Marshall 2002; Martorano 1981; Prince 2001; Swetnam 1984).

Several pine species were used as sources of bark. One that was commonly peeled was lodgepole pine (*Pinus contorta* var. *latifolia*), as illustrated in Figure 2 (Marshall 2002; Turner 1997; Turner and Davis 1993). The Gitskan people used its inner bark for food, as a blood purifier, and a purgative, while the Kootenais

FIGURE 2.—Characteristic rectangular bark-peeling scar on a lodge pole pine tree, Site HbSs-04 at the Sustut River, Birdflat Crossing, British Columbia, Canada. The scar is dated to AD 1846 and is part of a larger site of 704 CMTs. Photograph by Amanda Marshall.

recommended eating it as a remedy for tuberculosis (Hart 1992). In general, very young bark was eaten, while older bark was used medicinally (Johnson 1997). Lodgepole pine is a pioneering species with a large geographic and elevational distribution, extending from the Yukon Territory in northwestern Canada to southern California and east to South Dakota. It usually lives only 150–200 years (Arno and Hammerly 2007). Ponderosa pine (*Pinus ponderosa*) inner bark was used food by various groups, especially in the Rocky Mountains (Moerman 1998; Turner and Davis 1993; Figures 3 and 4). Ponderosa pines often attain ages of 400 to 500 years and are found on mountain slopes, high plateaus and valleys from British Columbia to southern California, Mexico, and eastward to Nebraska (Arno and Hammerly 2007).

Ethnographic accounts note that bark from Jack pine (*Pinus banksiana*), western white pine (*Pinus monticola*), and whitebark pine (*Pinus albicaulis*) was eaten (Moerman 1998). Jack pine is similar to lodgepole pine in general appearance (Arno and Hammerly 2007) and is abundant in the Great Lake states and across Canada westward to central Alberta. Western white pine commonly grows at elevations of 600–1800 m in southwestern British Columbia and the Olympic Peninsula, generally outgrowing other species on nutrient-poor sites. Peoples' perceptions of inner bark flavor and their species preferences varied among groups (Turner and Davis 1993). According to Cushing (1920) and Standley (1912), inner bark was difficult to digest, while Ferries (1940) noted that

FIGURE 3.—Large open bark-peeling scar on a live ponderosa pine in Bob Marshall wilderness (Murphys Flats site), western Montana, USA. The scar is dated to AD 1824 and the site has 33 more bark-peeled trees. Photograph by Lars Östlund.

it had a sweet acid taste. According to White (1954), ponderosa pine, lodgepole pine, and western white pine have more pleasant tasting inner bark than other species. Documentation, although scarce, shows that a few other pine species were exploited (see Moerman 1998), but according to Kuhnlein and Turner (1991), bark was also peeled from western larch (*Larix occidentalis* Nutt.), balsam fir (*Abies balsamea* (L.) P. Mill.), spruce (*Picea* spp.) and western hemlock (*Tsuga heterophylla* (Raf.) Sarg.).

Several studies have analyzed the time depth of pine bark-peeling in North America. White (1954) studied bark-peeled pine trees near Flathead Lake in Montana, dated a limited number of them, and found that many were peeled during World War I. This was a time of sugar shortages and rationing when bark was used as an alternative ''sweet'' since it has a high sugar content. In perhaps the first scientific study of bark-peeled trees, Swetnam (1984) cored and cross-dated 20 ponderosa pines in New Mexico, and obtained peeling dates ranging between 1818 and 1872. A study of bark-peeled trees in northern British Columbia found that most had been peeled in the 19th century (Eldridge 1982), and scars examined in the Lolo and Bitterroot National Forests of Montana and Idaho by McLeod and Melton (1986) mainly originated from the late 18th to early 19th century. In the Kootenai National Forest in northwest Montana, 204 bark-peeled trees were registered in a forest-wide survey, and 14% were cored. The resulting peeling dates ranged from 1756 to 1944 with most peels dating to the 19th century (Alldredge 1995). In an innovative study, Kaye and Swetnam (1999)

FIGURE 4.—Large bark-peeling scar on a dead ponderosa pine (Murphy Flats site) Bob Marshall Wilderness, western Montana, USA. Photograph by Lars Östlund.

analyzed the relationship between fire history and peeling dates in New Mexico in an attempt to determine whether late spring forest fires in areas with peeled trees were anthropogenic. They dated 45 bark-peeling scars and found scar dates ranging from 1772 to 1879 (Kaye and Swetnam 1999). Marshall (2002) registered a very large number of bark-peeled lodgepole pines (689) at two sites on the Nechako Plateau in British Columbia. She dated 177 scars and found that dates ranged from 1885 to 1931. Finally, in the most recent investigation to be cited here, Östlund et al. (2005) studied 138 bark-peeled ponderosa pine trees at four sites in the Bob Marshall Wilderness in northwestern Montana and obtained peeling dates ranging from 1665 (most likely the oldest bark-peeling scar on a pine tree in North America recorded so far) to 1938. It is important to note that so far only very few studies have been undertaken to analyze the real time-depth and temporal patterns of bark-peeling in North America (as well as in other places). Only a small fraction of the existing bark-peelings have been dated and only at a limited number of sites.

Researchers have examined the locations of bark-peeled trees to gain information on past harvesting. White (1954) reported that peeled trees could be found along nearly every valley in western Montana and northern Idaho, and that this area seemed to be the center of inner bark utilization in the West. Bark-peeled trees are commonly clustered along major streams and rivers; however, the highest concentrations are found in open, south-facing areas, with gentle

topography and close to water, areas that were probably near camp sites (McLeod and Melton 1986). Alldredge (1995) theorized that since inner bark was gathered during springtime, most bark-peeled trees would be found near the locations of camps used in the spring. In addition, Eldridge (1982) states that bark-stripped trees are associated with a variety of sites, including temporary camps, camps established for exploiting other resources, occasional hearths, rock-lined circular depressions (a possible processing sign), and trail corridors. Ethnographic accounts record that generally, young trees with as few lower branches as possible were chosen first for stripping (People of 'Ksan 1980; Spier 1930; Turner and Bell 1973). Good areas for bark-stripping were often known, and camps were established in these areas for a week or more during harvests (People of 'Ksan 1980).

Among Northwest Coast peoples in Canada, inner bark was an important source of carbohydrates in areas where there was a dearth of other nutritious roots, grains and sources of sweeteners (Johnson 1997). In parts of northern British Columbia with low plant food reserves and long distances between watercourses, a large number of scarred trees have been registered. In contrast, there are relatively few scarred trees to the south where watercourses are numerous and the supplies of salmon and nutritious plants are good. Of course logging and other disturbances have altered the distribution of bark-peeled trees in many parts of North America, as they have in Scandinavia. Consequently, our understanding of the number and distribution of peeled trees, as well as peeling dates, may reflect this bias (Stewart 1984).

## BARK HARVESTING AND PROCESSING

The cambium of pine trees, also called the inner bark, sap layer or cambial zone, is the soft whitish inner part of the bark. When the sap is running in the spring or early summer, the bark can be removed from the tree easily and the nutritious inner bark can be separated from the coarse outer bark. Cambial activity is generally dependent on both temperature and moisture (Mikola 1962), so the ''right'' time for harvesting cambium is limited and varies by only a few weeks in spring when the sap of the new phloem contains substantially higher levels of translocated sugars and other nutrients (Eidlitz 1969).

Inner bark harvesting among the Samis in northern Scandinavia was typically performed by women and children during spring when the sap was rising and the bark (both outer and inner) was easily removed from the tree. The inner bark was then separated from the outer bark with a knife (Lundius 1905). The inner bark sheets used of food by the Samis were of a specific size (ca. 1 m long). Smaller bark sheets used for other purposes such as storage of sinews (Zackrisson et al. 2000). Therefore the resulting bark-peeling scars on live and dead trees can give direct evidence of how the bark was used. In western North America the bark-stripping was also done primarily by women and children in springtime. For example, among the Kootenai and Flathead groups it was a spring ritual, combined with the harvest of bitterroots (White 1954). The Thompson group peeled lodgepole pine in springtime, May or June, depending on elevation (Turner et al. 1990), first removing the outer bark and then scraping

the inner bark (sap layer) from the stem (Marshall 2002). The bark of ponderosa pine, like Scots pine, requires a different technique and toolkit because the inner and outer bark adhere to each other. Hart (1992) states that women peeled off the outer and inner bark together and then separated them from each other. According to Turner and Efrat (1982), the bark harvesting among the Hesquiats on Vancouver Island was a task for either families or inhabitants of entire villages that had the sole right to harvest certain areas. The annual bark-peeling event was obviously of great importance. The Okanagan-Colville were one of several indigenous groups that held ceremonies every spring to celebrate the coming harvest of food plants and tree inner bark. As evidenced from ethnographic information, inner bark harvest on pine species in North America was primarily aimed at obtaining food, and scar sizes vary considerably compared to Sami bark-peeling scars in Scandinavia (Östlund et al. 2005).

Indigenous groups paid close attention to the optimal time for peeling bark. The Coeur d'Alene people called May the ''bark loose on tree month'' (Teit 1930). This is a clear analogue to the Sami term for June, ''the pine-month'' (Zackrisson et al. 2000). Cambial activity differs among species, but pine cambium is preferable slightly after bud break (Busgen 1929), and ponderosa pine cambium is usually ready to harvest two or three weeks before lodgepole pine cambium (Malouf 1974; Turner 1978). If the inner bark is peeled too late, the cambium becomes increasingly woody (lignifies) and inedible. After the time when the bark is ''sweet and tender,'' it matures and accumulates secondary compounds, which drastically reduce its nutritional value. The site conditions where the trees grow are also important. Trees growing on well-drained, south-facing slopes have a longer peeling season than trees in other environments (Wilcox 1962).

Ethnographic accounts describe numerous traditions connected to harvesting techniques. In western North America the bark on the northern side of the stem was penetrated to gauge the thickness of the new tissue between the bark and wood and to determine if the cambium was harvestable (Johnson 1997). A satisfactory cambium layer on the north side implied that the whole tree was good. Furthermore, some groups removed a vertical strip and sampled the sap to test its flow and sweetness (Hart 1992; People of 'Ksan 1980; Turner 1978). Östlund et al. (2005) interpreted very small bark-peeling scars as ''taste-scars,'' peeled to test the quality of the inner-bark before harvesting.

On both continents, inner bark could be eaten fresh just after harvest (Marshall 2002; Zakrisson et al. 2000) or dried and stored for future use (Ahlberg 2001; Bergman et al. 2004). Although only collected during a limited period of time each year, many native people ate the inner bark year round clearly showing that it was stored. To increase the nutritional value of the inner bark it could also be processed further. Cooking in earthen oven pits was an ancient technique in both Scandinavia and North America as evidenced by their remains (Bergman 1995). According to ethnographic and archaeological information, ovens were mainly used for processing roots in North America but also were used to process inner bark in both Scandinavia and North America (Graan 1899; Jones 1914; Knapp and Childe 1896; Peacock 1998; Smith 1997). Graan (1899:43) described the methods that Sami people used for preparing pine bark in the 17th century:

> They take the pine bark from large and thick pine trees, preferably as close to the ground as possible… They hang it on racks a day or two to dry, and then they rip it into small slices and put it in a big, well-wrapped bushel made of birch bark. They place the bushel into a pit in the ground, cover it with soil and peat, over which they make a huge fire of logs. The fire burns for a day, then they unearth the bushel again, and the bark is red and sweet.

Accounts describe similar construction and use of cooking pits on both continents. Pits were basin-shaped, and their size depended on the amount of food to be cooked (Malouf 1974). Heated rocks were placed in the bottom, and then vegetation was placed around the food to protect it, add moisture, and enhance the flavor. Generally, the food was covered by a layer of earth topped by a fire (Grinell 1962; Lundius 1905). Cooking time varied depending on the nature of the food, but fires burned up to four days. Cooking the inner bark made it more digestible in two main ways. First, it reduced the size of the carbohydrate polymers, making them easier for the small intestine to absorb (Konlande and Robson 1972; Wandsnider 1997). Second, it modified and reduced the toxicity of various secondary metabolites that can interfere with the absorption of nutrients when present in large amounts (Griffiths 1989). The inner bark of Scots pine contains secondary metabolites such as lignins, tannins, resins, terpenes, waxes and steroids (Airaksinen et al. 1986), and lodgepole pine inner bark contains a similar array of substances plus various flavonoids (Vercruysse et al. 1985). To make such food palatable, it must be detoxified by heat treatment or by other methods (Johns and Kubo 1988).

## INNER BARK AND SEASONAL FOOD STRESS

Researchers have debated whether inner bark was eaten only during times of famine or on a regular basis. Minnis (1991) argued that there were various types of food shortages, from hunger seasons to massive famines, and that different foods were eaten depending on the severity of the shortage. In ''regular hunger seasons'' people intensified their use of low preference foods that were part of the normal diet. In contrast, people might turn to toxic, foul-tasting substances that required substantial processing or had low nutritional value during severe famines. Which of these categories (if either) inner bark fell into seems to have varied both between continents and among groups of people.

According to Eidlitz (1969) inner bark was used both as a regular food and emergency food in Scandinavia. However, there is no indication that more bark than usual was peeled in well-documented famine years (Niklasson et al. 1994). Moreover, bark was consistently described as a normal staple food in the 17th and 18th centuries (Drake 1918; Graan 1899; Leem 1767; Lundius 1905; Rheen 1897; Schefferus 1674), and rich Sami families normally collected the largest quantities of Scots pine inner bark (Drake 1918). The high frequency of inner bark utilization among circumpolar peoples may reflect that annual use of inner bark was necessary because food was very limited during certain seasons (Swetnam 1984). Furthermore, Knut Leem (1767) asserts that the Sami in Norway ate bark

not to satisfy their hunger, but for delight. The Skolt Sami in Finland took pine inner bark as a special gift to relatives living in areas with no pine trees (Tanner 1929). In addition, Graan (1899) describes the taste of pine inner bark as delicious and points out that it was sometimes eaten as candy. In contrast, Nordic farmers used Scots pine for an emergency food. However, they mostly collected the bark after the growth season, when its quality was very poor. This gave inner bark a bad reputation, which has persisted to the present (Zackrisson et al. 2000).

References by explorers, ethnologists, and others indicate that some indigenous groups in western North America ate pine inner bark regularly, perhaps on an annual basis, whereas other groups may have used it primarily as an emergency food, such as during famine (Swetnam 1984; Turner and Davis 1993). Considering the reported abundance of surviving peeled trees in unlogged forests in Montana and statements by Kootenai informants, inner bark was probably a regular, seasonal resource in this area (Östlund et al. 2005; White 1954). Indeed, for some indigenous peoples, annual and emergency use of inner bark may have been essentially the same, since food was very scarce every year during certain seasons. According to Marshall (2002), the Carrier people in western Canada used inner bark as a staple food, famine food, medicine and delicacy, which was probably also true for many northern peoples.

Carbohydrates, vitamins, fiber, and minerals are the most important nutritional constituents in pine cambium. The carbohydrates helped balance the protein and fat from meat, fish, and reindeer milk, the primary source of calories in the Sami diet (Airaksinen et al. 1986; Hanson 1996). The relatively high vitamin C content of Scots pine inner bark probably prevented scurvy among the Sami; before the 19th century, scurvy was widespread among Swedish and Norwegian farmers living by the coast, but not among the Sami in the Interior (Fellman 1906; Urbye 1937). Furthermore, inner bark contains beneficial food fiber (Zackrisson et al. 2000) and high levels of iron and calcium, which was particularly important for healthy bone development and maintenance among children and pregnant women. Recent research shows that substances in Scots pine inner bark may reduce the risk of cardiovascular and cancer diseases (Östlund et al. 2004).

The nutritional qualities of inner bark make it particularly valuable in areas with significant seasonal variation in available plant foods. Inner bark contains a form of sugar in a fiber matrix, which reduces the rate of sugar absorption and keeps blood-sugar levels relatively steady for long periods. This makes it a good food for sustaining people during prolonged, high-energy activities, which may be why the Carrier ate pine bark during travels rather than carry stored food (Lamb 1970). Energy is the most essential nutritional need. Therefore, sources of digestible carbohydrates that can be transformed into glucose or other simple sugars have long been integral to hunter-gatherer diets, and according to Flannery (1986), should be the highest priority foods in regions with sufficient protein resources. Speth and Spielman (1983) agree suggesting that hunter-gatherers in sharply seasonal environments generally needed to gather supplies of storable carbohydrates during fall, because they periodically experienced food stress in late winter and early spring. During these periods, protein was more available, and hence the primary source of calories. But this diet was

metabolically inefficient because proteins require more calories to metabolize than carbohydrates or fats, and using protein for energy could reduce skeletal muscle. Consequently, stored carbohydrates, such as inner bark, were important even when protein supplies were plentiful.

In spite of these nutritional benefits, the practice of eating inner bark has largely disappeared. European missionaries and teachers believed that the diets of indigenous people in parts of North America were nutritionally unbalanced, and they tried to change these food preferences (Rivera 1949). In addition, the higher status associated with adopting European food traditions caused a shift in indigenous people's subsistence practices (Kuhnlein and Turner 1991). This interfered with the inner bark harvest scheduling, and a system that had persisted for thousands of years was nearly eradicated.

## THE SPIRIT AND THE TREE – SUSTAINABLE HARVEST

Animistic religions that evolved within hunter-gatherer frameworks were intimately tied to the natural environment. The relationship between people and their environment was characterized by spiritual affinity (Bergman et al. 2004), and was reflected in practices associated with the harvesting of plant materials (Boas 1930). The Sami people, according to tradition, always left some undamaged cambium to ensure the survival of the tree (Bergman et al. 2004). Failure to comply with this tradition would lead to illness in the person collecting inner bark (Drake 1918). Before felling a tree, its spirit had to be warned so it could safely leave the tree (Zackrisson et al. 2000). Some indigenous groups in western North America had similar customs. People expressed gratitude to all natural resources – plants, animals, birds or fish – understanding that the resources gave of themselves. Showing respect was essential for ensuring a good supply in future years (Turner et al. 2000).

The Sami generally peeled trees on the northern side (Manker 1938; Zackrisson et al. 2000), possibly because they preferred the taste of bark that had less sun exposure. They also took bark only from the north side for wrapping material. However, north and south were important directions for both cultural and religious reasons (Bergman et al. 2004), suggesting that cultural and religious traditions, rather than taste, may have been the main reasons for this bias (Zackrisson et al. 2000).

According to Kootenai informants in western Montana, their ancestors stripped bark from as much as three quarters of the circumference of the trunk for food. Nevertheless, the trees survived stripping and often look as vigorous as unpeeled trees. If enough cambium is left, the sap carries sufficient nutrients for continued growth (Stewart 1984). In addition, a pitch layer quickly develops over the scar, protecting the tree from insects and fungi, and healing lobes on each side of the scar slowly encroach and sometimes fully cover it. Investigations in western North America indicate that bark was most often peeled on the shaded northern side (Marshall 2002; Stafford 1999) or upslope side (Mobley and Eldridge 1992). However, the direction probably had no religious connotations. The shaded side usually had fewer branches, which provided a more continuous bark strip.

## CONCLUSION

We conclude that the indigenous Sami people of Scandinavia and indigenous peoples in the western parts of North America have used inner bark from various pine species on a large scale and for a long time. This tradition may be very old and may have been a crucial component of human subsistence in northern, sharply seasonal environments. On both continents, indigenous peoples' forest utilization, including bark-peeling, gradually diminished during the 19th century due to the growing forest industry and increased access to substitute foods and medicine. The high interpretative value of living and dead trees with bark-peeling scars has recently been recognized in both Scandinavia and western North America.

In recent decades research on CMTs in general, and bark-peeled trees in particular, have taken new qualitative steps and new interesting directions (Mobley and Eldridge 1992; Östlund et al. 2002). Several studies incorporate large-scale inventories of bark-peeled trees at specific sites (Marshall 2002; Östlund et al. 2003; Östlund et al. 2005) or across extensive landscapes (Zackrisson et al. 2000), dating many trees using dendrochronology. Some studies address more specific issues: the relationship between human presence, as interpreted by bark-peeling scars, and anthropogenic fires (Kaye and Swetnam 1999); the relationship between the use of inner bark and other available foods in a landscape perspective (Prince 2001); and the time depth of inner bark utilization as interpreted from archaeological evidence and ethnographic information (Sandgathe and Hayden 2003). Using several methods to investigate this practice is an effective approach. Perhaps the best example is Marshall's (2002) study, which not only examined a very large sample of registered trees and dated many of them, but also interviewed native elders of communities located near the study sites, thus providing valuable contextual information and better clues for interpreting the field observations. These examples show that this field of research can develop further and can provide answers to critical questions regarding human subsistence in the past in forested landscapes across the northern hemisphere.

However, several major problems limit the possibilities for future research on bark-peeling. The extensive scale and high intensity of logging, especially of pine forests, during the past 150 years has unfortunately removed many older trees in areas used by indigenous peoples of northern Europe and western North America. In addition, forest fires have killed and destroyed many trees with bark-peeling scars, especially in semi-arid areas in North America, and more recently, large-scale pine beetle outbreaks are reducing pine forests in western North America (Kurz et al. 2008). These non-random disturbances have reduced our ability to assess historic distributions of bark-peeled trees in many regions to small fragments of undisturbed old-growth forest. In contrast, the relatively few large areas with intact bark-peeled trees, such as unlogged forest reserves, often contain many of these trees and will be very important for more detailed studies in the future. They provide data on the original numbers of peeled trees and spatial patterns of past land use in forested areas. However, we need new methods to improve sampling efficiency, reduce the labor and financial costs of

data collection, and minimize the damage to culturally valuable trees (Andersson et al. 2008).

Pine inner bark was probably a regular staple food for the Sami of Scandinavia, but either a regular food or an emergency food in western North America. Most likely its use for any particular group fell along the gradient from staple to famine food, and its status may have shifted over time with short or long term changes in the natural and cultural environments. The climate was sharply seasonal in parts of both regions, with recurring periods (generally in late spring and early winter) when other vegetable foods were scarce. We most commonly find bark-peeled trees in these locations. At times of scarcity, inner bark could provide adequate energy supplies, a valuable complement to the predominantly protein-based diet, as well as fiber, vitamin C, and essential minerals. Inner bark was eaten fresh, dried, and roasted on both continents. Cooking pits, found in both Scandinavia and western North America, could have been used to process bark, but we have limited historic data on this. Heat treatment could have been important because it detoxifies the bark, kills bacteria, and breaks down complex carbohydrates, making the food more digestible.

In North America and Scandinavia indigenous people deeply respected nature, often believing that trees, plants, and animals had souls. They knew that girdling would kill a tree and thus generally left a strip of bark to preserve it. This sustainable use of the trees ensured a good future supply of inner bark, since an individual tree could be harvested several times. This pattern of peeling also distinguishes CMTs, both living and dead, allowing us to interpret past land-use in some old-growth forests.

The historical significance of pine inner bark for indigenous peoples across the northern hemisphere, and the exciting possibilities to study it today by examining old and ancient trees with bark-peeling scars, highlights the importance of protecting old-growth forests with traces of traditional land-use. Old and ancient forests in northern regions generally have high ecological value, but they are also remnants of past cultural landscapes carrying a legacy of historical land use. Therefore, traditional ecological knowledge of indigenous peoples and their historical land management practices need to be researched and incorporated into current land management models in both northern Europe and North America (Arno et al. 2008; Turner et al. 2000).

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