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Content

MATTI ROUSI: Susceptibility of pine to mammalian herbivores in northern Finland

Seloste: Männyn altius niikkäyttöisille Pohjoinen-Suomessa

SIMO POŠO: Kuviaaraisen arviointimethodin perusteita

Summary: Basic features of forest inventory by compartments

KARI HELIÖVAARA, EERO TERHO & ERKKI ANNILA: Effect of nitrogen fertilization and insecticides on the population density of the pine bark bug, Aradus cinnamomeus (Heteroptera, Aradidae)

Seloste: Tyypillisuohtujen ja eräiden hyönteismykkyjen ongelmia punaatikkan esiintymisvkoisista

LEO HEIKURAINEN, JUKKA LAINÉ & JARMO LEPOLA: Lannoitus- ja sarkakevyyskokeita karujen rämeiden uudistamisessa ja taimikoiden kasvatuksesta

Summary: Fertilization and ditch spacing experiments concerned with regeneration and growing of young Scots pine stands in nutrient poor pine bogs

PEKKA SARANPÄÄ: Puunaineen tiheyden ja vuosilaston leveyden vaikutus kuusen isoksiivituntuvuusasteen Etelä- ja Pohjoinen-Suomessa

Summary: The influence of base density and growth ring width on the impact strength of spruce wood from South and North Finland

SEPPÖ KELLOMÄKI & TIMO NEVALAINEN: Nääköhtia puuston tiheyden ja puiden koon välisestä suhteesta

Summary: On relationship between stand density and tree size

JUSSI KUUSIPALO: Distribution of vegetation on mechanic forest sites in relation to some characteristics of the tree stand and soil fertility

Seloste: Kuusistkuistetun kasvillisuuden jakautuminen suhteessa eräisiin paikoittueisiin ja mäkielin tutkimuksesta

KARI LÖYTTYNIEMI: Flight periods of some birch timber insects

Seloste: Kasvikumpaisten lentäjöiden luontokartoitus

Käsikirjoitusten tarkastus vuonna 1983

Appraisal of manuscripts in 1983

SUOMEN METSÄTIEETEELLINEN SEURA
SOCIETY OF FORESTRY IN FINLAND
SUSCEPTIBILITY OF PINE TO MAMMALIAN HERBIVORES IN NORTHERN FINLAND

Matti Rousi

Sulite

MÄNNY ALTTIUS NISÄKÄSTUHOILLE POHJOIS-SUOMESSA

Näissä tapahtuneen 1981 (vol. 17, no 4: 301–312)


An inventory of pine graft collection in Kolari (67°15′ N, 23°45′ E) showed that severe damage by the arctic hare, root and bank vole and mouse was done to grafts small in size and in rather poor condition. Furthermore, the damage by the arctic hare was dependent on the dry matter content of the needles. Another inventory in a fertilization experiment in a pine pole-stage forest showed that nitrogen fertilization increased the damage by the arctic hare.

On the base of the present results an assumption was made that the formation of repellent substances against herbivorous mammals is connected with the wintering process of northern pines.

1. INTRODUCTION

The arctic hare (Lepus timidus L.) and the mouse (Aloës aëtes L.) had browsed several of the grafts in a collection of Pinus sylvestris L. at the Kolari Research Station Turavuoma experimental area (67°15′ N, 23°45′ E) in the winter of 1982. In the spring, after the thaw, traces of the vole were also seen in the same collection. The damage drew special attention as the grafts were in the middle of a vast region full of the deciduous species usually preferred by rodents in winter.

Birch and willow are regarded as the most important winter food of the hare (Kangas 1935, Brander 1934, Seiskari 1954, 1956). The importance of these deciduous species is further enhanced, particularly in northern Finland (Lindelöf et al. 1974, Nyholm 1968, Pulliainen 1971, 1972). In southern Finland the hare browses on pine only occasionally as emergency food (Brander 1954). Similarly, the browsing of pine by the hare had no serious consequences in Kuusamo (Nyholm 1968) or northeastern Lapland (Pulliainen 1971 and 1972), although it is known to have occasionally caused extensive damage to pine in northern Finland (Granit 1900). Pulliainen (1972) points out, however, that the hare does not seriously affect pine or spruce (Picea abies (L.) Karst) in northeastern Lapland.

Information on vole damage has been collected in Kolari since 1934, when the field vole (Microtus agrestis L.) and the bank vole (Clethrionomys glareolus Schreb.) were recorded to “have damaged rathed badly” a spruce plantation set up on a drained area (Kangas 1935). Some vole species (the root vole and field vole) have benefitted from human activity since the turn of the century; e.g. clearing natural habitats for hay-fields and modern forestry has created a lot of suitable habitats for these herbivorous vole species. Thus, the damage to forestry during microtine peaks has probably increased (Christiansen 1975, Korhonen 1982, Teivainen 1982).

Today the moose is the greatest cause of damage in mature plantations of pine and deciduous species in Finland (Löytyniemi 1981); pine is the most important winter food of the moose because of its high nutritive value and easy availability (Löytyniemi

Tilauksiin ja julkaisuihin koskevat tiedotetut osotetaan seuran toimistolle. Silva Fennicaan tilaushinta on 100 m. kotimaisissa, ulkomailla 150 m.
2. MATERIAL

In 1968 a graft collection of plus trees originating from an area with a temperature sum of 700–850 d.d. (see e.g. Solandt 1976) was set up on a peatland plantation at Teura-vuoma (800 d.d.). In 1975 12 pine grafts originating from Alta in Norway were added to the collection. Originally, six grafts of each of the 475 clones were planted. In 1978 56 grafts were planted to replace the dead ones. The grafting point was at about 10–30 cm, above which scaly bark begins. At the spring inventory in 1982, 891 grafts were alive, of which 90 had been protected against the vole by wire nets. The protected saplings were omitted from the inventory. The study area is c. 500 ha, and is dotted with small conifer and hardwood stands and protective forest zones. Various experiments occupy parts of the area, and part of the area has been left to regenerate naturally. The graft collection is surrounded by willows, which cover c. 50 % of the area. In the graft collection itself the willows covered c. 30 % of the area in the winter of 1981/82. About 90 % of the willows were Salix phylicifolia L., and less than 10 % are Salix lapponum L. and some Salix caprea L. A naturally regenerated stand of weeping birch (Betula papyrifera Ehrh.) covered 2–3 % of the area. The height of the willow bushes and weeping birch varied, reaching three metres. Apart from the Scots pine and Norway spruce the field is also stocked with black spruce (Picea mariana (Mill) B.S.P.) and white spruce (Picea glauca (Moench) Voss) provenances originating from Canada and Alaska and with black larch (Larix laricina (Dur) K. Koch). The black and white spruces come from the vicinity of Fairbanks in Alaska, from the river valleys of the upper reaches of the River Yukon and the outlet of the river Mackenzie in western Canada. All the black larches come from the vicinity of Fairbanks. The plantations were also surveyed in the spring of 1982.

No estimates of the density of the hare population at Teuravuoma can be given, but on the basis of tracks in the snow, pellets and visual observations the population was very dense in 1981/82. The density of neither the vole or the hare population at Mustivinsa (see page 303) was recorded. When the vole had gnawed the graft above the snow, at needles, buds or branches, the bank vole was considered the culprit. If the parts below the snow had been damaged, the root vole (Microtus oeconomus Pallas) was to blame.

The graft collection was surveyed throughout the winter of 1981–82. However, the browsing by the hare was not discovered until early March. All the trees were measured for height, breast-height diameter and average browsing level. As the trees were still dormant, their prebrowsing condition could also be estimated.

The major vole species in both the areas of reclaimed bog and the areas with willow and grassy vegetation in Teuravuoma is the root vole. The bank vole is common in the small shelterwoods. The field vole and grey-sided vole ( Clethrionomys rufocanus Sund.) were also found in more shady biotopes, although they were very rare. As a matter of fact only root and bank voles were responsible for the damage in the experimental area. In autumn 1981 both species had reached their cyclic population peak and in the spring of 1982 the voles were still numerous.

The density of the mouse population is 0.3–3 mouse per 1000 hectare in Lapland and about one mouse/1000 ha in Koları. Damage by the root vole and hare was divided into five classes: 0 = intact, 1 = nibbled, 2 = slightly eaten, 3 = over half the tree girth eaten and 4 = the whole stem at the lower branches eaten. The damage classes for the bank vole and mouse corresponded to these classes so that class 4 consisted of trees that were not expected to recover from the damage. A needle sample (previous-year needles) was taken from the uppermost, southern branch where of nine grafts severely damaged by the hare in April 1982. Control samples were taken from nine grafts which were not eaten by the hare but resembled as much as possible the eaten grafts. The needle samples were analyzed using conventional methods for the contents of dry matter, ash, N, P, K, Ca, Mg, Fe, Mn, Cu and B by Mr Pieläläinen at the Muhol Research Station. The samples were dried before determination. Student's t-test was used to compare the affected and unaffected trees.

The same measuring method was used for the fertilization experiment at Mustivinsa, Muonio, close to the border of Koları, in spring 1981. The experiment was set up in a pole-stage pine stand of Empetrum-Vaccinium site-type which originated after a forest fire. The experimental area has 4802 pines whose average height is 7.5 m and average breast-height diameter 8.5 cm. The experiment consists of seven treatments with four replications in early spring 1981. A nine-month plot for each treatment was fertilized according to the following scheme:

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Calcium ammonium nitrate</th>
<th>Rock phosphate</th>
<th>Potassium chloride</th>
</tr>
</thead>
<tbody>
<tr>
<td>kg/ha</td>
<td>kg/ha</td>
<td>kg/ha</td>
<td>kg/ha</td>
</tr>
<tr>
<td>1</td>
<td>400</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>2</td>
<td>800</td>
<td>200</td>
<td>200</td>
</tr>
<tr>
<td>3</td>
<td>1600</td>
<td>400</td>
<td>400</td>
</tr>
<tr>
<td>4</td>
<td>400</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>5</td>
<td>800</td>
<td>200</td>
<td>200</td>
</tr>
<tr>
<td>6</td>
<td>1600</td>
<td>400</td>
<td>400</td>
</tr>
</tbody>
</table>

Mammal damage was observed not only in pine plantations but also in other plantations of pine, spruce, black spruce, white spruce and black larch at Teuravuoma.

3. RESULTS

The mouse had browsed on over 50 % of the pine grafts in the Teuravuoma clone collection. The root vole and hare had damaged almost 30 % of the grafts and the bank vole about 15 %. The number of severely dam-aged saplings (classes 3 and 4) only reflects the magnitude of mammal damage. The mouse had severely damaged 13 % of the grafts, the root vole 22 %, the hare 14 % and the bank vole 1 % (Fig. 1, Table 1).
The mean height of the trees in the Teura-
vauma graft collection was about 3 m and the
average breast-height diameter about 4 cm. The
prebrowning condition of the 801 live
trees in the graft collection was estimated
very good in 7 %, good in 51 % and poor in 42 % of the cases. Mammals primarily badly
damaged the poor grafts and usually caused
less damage to those in slightly better condi-
tion than average (Tables 1 and 2). If all the
grafts browsed by mammals are combined, it
can be seen that their condition class dis-
tribution does not deviate from that of the
whole material (x² = 2.23). The severely
damaged grafts were usually smaller in size
than those of the whole material and the
"only slightly damaged" grafts (Fig. 2). This
can be particularly clearly seen in grafts eaten
by the moose and bank vole. It should be
pointed out that the poor condition of grafts
usually resulted from abiotic factors. In some
cases the cause was previous moose or vole
damage. Thus the condition of grafts was not
considered to have been affected by being
eaten during the inventory winter.

The root vole had eaten 47 % of the pines
in the graft collection. The hare had eaten 46
% of the grafts, 43 % of which had also been
eaten by the root vole. As the percentages are
almost the same, the vole and hare clearly
started eating the grafts independently of
each other. Trees with severe hare damage
(classes 3 and 4) numbered 110. Severe vole
damage was observed in 163 grafts. Both the
vole and hare had badly damaged 52 grafts.
In comparison to the entire material, the
hare had often more damaged the trees that had
also been badly affected by the vole; the
difference was highly statistically significant
(Z = 5.7; P < 0.001). The other mammals did
not show a similar correspondence.

The results from Mustivinsa fertilization
experiment showed that nitrogen fertilization
increases the palatability of pines to hares to
a statistically significant degree (P = 0.004).
Mineral nutrients did not show any effect
(Figure 3). The needle analysis shows that the
dry matter content of grafts severely dam-
aged by the hare at Teuraamoa was lower
than in the needles of grafts untouched by
the hare (Table 3).

In the plantation of black and white spruce
or black larch were no sign of damage by
mammals.

### Table 1. Teuraavauma in Kolari: The effect of the condition of grafts on mammal damage.

<table>
<thead>
<tr>
<th>Damage class</th>
<th>Condition class</th>
<th>Moose</th>
<th>Hare</th>
<th>Root vole</th>
<th>Bank vole</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>l/p</td>
<td>%</td>
<td>l/p</td>
<td>%</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0</td>
<td>1</td>
<td>34</td>
<td>9</td>
<td>32</td>
<td>7</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>203</td>
<td>52</td>
<td>232</td>
<td>54</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>150</td>
<td>39</td>
<td>167</td>
<td>39</td>
</tr>
<tr>
<td></td>
<td></td>
<td>387</td>
<td>43</td>
<td>420</td>
<td>47</td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>9</td>
<td>8</td>
</tr>
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<td></td>
<td>2</td>
<td>16</td>
<td>17</td>
<td>28</td>
<td>43</td>
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<td></td>
<td>3</td>
<td>80</td>
<td>83</td>
<td>56</td>
<td>55</td>
</tr>
<tr>
<td></td>
<td></td>
<td>96</td>
<td>65</td>
<td>94</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>10</td>
<td>100</td>
<td>31</td>
<td>69</td>
</tr>
<tr>
<td></td>
<td></td>
<td>10</td>
<td>45</td>
<td>79</td>
<td></td>
</tr>
</tbody>
</table>

### 4. DISCUSSION

Several reports have been published about
the food selection in winter by the arctic hare.
In Finland the hare prefers the weeping birch
and shuns the silver birch (Sulkinoja 1983).
According to Hewson (1977) the hare does
not care for the weeping birch in Scotland.
The proportion of willow in the winter food
of the hare is particularly accentuated in north-
ern Finland (Nyholm 1968, Pulliainen 1971,
1972). Although the area in Kolari where the
grafts grew abounded in willow and weeping
birch, the pines had been damaged to a con-
siderable extent. If log pines are felled during
winter hares seem to eat quite often phloem
and cambium from the crown parts. Main
reason to this may be scaly bark or and the
chemical composition, lack of phenolic com-
pounds, of crowns (see also Rhoades and
Cates 1976). When grated from old trees the
crown parts maintain their characteristics
(topophysis and cyclophysis) and because of that
may be attractive to hare. In ordinate pine
plantations near the graft collection pine bark
Table 2. Condition class distribution of grafts badly and slightly eaten by different mammal species as compared to the condition class distribution of the entire material, according to Table 1.

<table>
<thead>
<tr>
<th>Material</th>
<th>Badly eaten - Paljon syötä (damage classes 3 and 4)</th>
<th>Slightly eaten - Vähän syötä (damage classes 1 and 2)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$u_1^2$ P-value</td>
<td>$u_1^2$ P-value</td>
</tr>
<tr>
<td>Moose</td>
<td>80.82 P&lt;0.001</td>
<td>15.88 P&lt;0.001</td>
</tr>
<tr>
<td>Hare</td>
<td>18.69 P&lt;0.001</td>
<td>2.29 P&lt;0.1</td>
</tr>
<tr>
<td>Root vole</td>
<td>6.0 0.05&gt;P&gt;</td>
<td>5.60 0.10&gt;P&gt;</td>
</tr>
<tr>
<td>Bank vole</td>
<td>0.01</td>
<td>0.05</td>
</tr>
<tr>
<td>Mammals combined</td>
<td>80.6 P&lt;0.001</td>
<td>18.0 P&lt;0.001</td>
</tr>
</tbody>
</table>

Table 3. Results from the needle analyses of badly eaten (hare) and intact grafts. Significances $* = 0.05 > P > 0.01; 0 = 0.1 > P > 0.05.$

<table>
<thead>
<tr>
<th>Eaten - syötä</th>
<th>t-value</th>
<th>t-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moose</td>
<td>1.34</td>
<td>1.39</td>
</tr>
<tr>
<td>Hare</td>
<td>1.26</td>
<td>1.70</td>
</tr>
<tr>
<td>Root vole</td>
<td>1.60</td>
<td>1.00</td>
</tr>
<tr>
<td>Bank vole</td>
<td>1.40</td>
<td>0.90</td>
</tr>
</tbody>
</table>

Fig. 2. Severity of mammal damage in relation to the height curve of grafts. (Kuva 2. Niäkkäiden syöminen ongelmassa suhteessa varttiiden pituuslämmitettä. Kolari, Teurumaa.)

Fig. 3. Effect of nitrogen fertilization on browsing by the hare. (Kuva 3. Typpilamnettöjen vaikutus jäkaneen syöntiin. Muonio, Mustivaara. (Kuva 3. Typpilamnettöjen vaikutus jäkaneen syöntiin. Muonio, Mustivaara.)

```latex
\textbf{Classes - Luokat}

- 1 = nibbled - mestinen
- 2 = slightly eaten - syötä vähän
- 3 = badly eaten - syötä paljon
- 4 = severely eaten, graft likely to die - kaasu syöminen suraava

1) Only one graft belonged to Class 4 in the case of the bank vole. Not included in the figure.

\textbf{Damage classes:}

- 1 = nibbled
- 2 = slightly eaten
- 3 = badly eaten
- 4 = severely eaten, graft likely to die

\textbf{Table 2.}

\begin{tabular}{|c|c|c|}
\hline
Material & Badly eaten & Slightly eaten \tabularnewline & (damage classes 3 and 4) & (damage classes 1 and 2) \tabularnewline \hline
Moose & 80.82 P<0.001 & 15.88 P<0.001 \tabularnewline Hare & 18.69 P<0.001 & 2.29 P<0.1 \tabularnewline Root vole & 6.0 0.05>P> & 5.60 0.10>P> \tabularnewline Bank vole & 0.01 & 0.05 \tabularnewline Mammals combined & 80.6 P<0.001 & 18.0 P<0.001 \tabularnewline \hline
\end{tabular}

\textbf{Table 3.}

\begin{tabular}{|c|c|c|}
\hline
Material & Eaten syötä & t-value \tabularnewline & & t-value \tabularnewline \hline
Moose & 1.34 1.39 & 1.39 1.70 \tabularnewline Hare & 1.26 1.70 & 1.60 1.00 \tabularnewline Root vole & 1.40 0.90 & 0.90 0.70 \tabularnewline Bank vole & 1.40 0.90 & 1.07 0.24 \tabularnewline Mammals combined & 80.6 P<0.001 & 18.0 P<0.001 \tabularnewline \hline
\end{tabular}

\textbf{Fig. 2.}

\textbf{Fig. 3.}


\textbf{Kuva 3.} Typpilamnettöjen vaikutus jäkaneen syöntiin. Muonio, Mustivaara. (Kuva 3. Typpilamnettöjen vaikutus jäkaneen syöntiin. Muonio, Mustivaara.)
was left completely untouched by the hare. Here and there, however, the hare had broken leaders in small pines (see also Bryant and Kuropat 1980). The size of grafts eaten by the hare did not deviate much from the mean of the material. Most of the severely damaged saplings had been in poor condition.

Both the snowshoe hare (Lepus americanus Erx.) and the mule deer (Odocoileus hemionus columbianus Richardson) select certain genotypes of Douglas fir (Pseudotsuga menziesii (Mirb.) Franco). Dimock et al. (1976) showed that the relative palatability of needles in the genotypes of Douglas fir was a strongly heritable, additive characteristic. It was also possible to predict the most preferred genotypes of Douglas fir by a mathematical model based on the availability and digestibility of needles (Dimock and Silen 1978, cf. Rawdan 1972). Investigations have shown that voles reattack the same lodgepole pine they had earlier damaged (Rousi 1983a), which might be at least partly attributable to the genetic difference between lodgepole individuals. About 500 clones in the Teuvaruuma graft collection there are genotypes that had not been touched by the root vole or hare, whereas each graft in some clones had been badly damaged. As only three fourths of genotypes that have survived, more specific analyses on the differences between clones cannot be carried out.

The chief winter food of the snowshoe hare in the interior of Alaska is black and white spruce needles (Wolff 1978). In the 4.5 ha plantation of black and white spruce and the c. 0.5 ha plantation of black larch near the Teuvaruuma graft collection plenty of hare and vole tracks were seen in the snow. Mammals were not, however, found to have eaten these introduced species in the winter of 1981/82. The root vole had caused damage not far from the graft collection, particularly in pine plantations, but also spruce had been severely damaged over large areas (cf. Teijumrinen 1982). The root vole had usually gnawed the roots and the damage was not seen until trees started to fall in several plantations in Teuvaruuma in the summer of 1982. It has previously been suggested that the bank and root vole select their food according to some external factors between tree species.

Thus the vole does not taste the sapling before selecting a particular tree species. The amount eaten depends on the palatability of different individuals of the same species (Rousi 1983a and b). The present results also indicate that the hare and root vole at least partially select their food on the same basis. Furthermore the palatability of the tree chosen by the hare and root vole seems to depend on the same chemical factors. The condition class distribution of the damaged trees in the Teuvaruuma graft collection does not, according to this investigation, deviate from the entire material. However, the grafts severely damaged by mammals were usually in poor condition (Tables 1 and 2). This would suggest that mammals start eating trees randomly. The most palatable trees those in poor condition are then further eaten a great deal, while those in good condition are only slightly damaged.

Attempts have been made to find reasons for the choice of winter food by the moose in the nutrient contents of plants (e.g. Kubota et al. 1970, Andersson and Markkula 1974, Salonen 1980). The results obtained differ what varied (e.g. Laine and Mannerkoski 1980, Löyttyniemi 1981, Salonen 1982, Haukioja et al. 1983). The moose prefers pine saplings that have become weakened for various reasons (Saarnio 1956, Yli-Vakkuri 1956, Westman 1958), although contradictory views also exist (Kangas 1949, Etelilähti 1950, Laine and Mannerkoski 1980, Löyttyniemi 1982). Every other tree in this graft collection had been browsed by the moose (Fig. 1). This limited material suggests that the moose selects the pines on the basis of their condition (Table 1). Over 80% of the severely damaged saplings had been in poor condition before browsing (Table 2). The badly damaged grafts were also among the smallest trees in the material (Fig. 2). The present result agrees with Sainio’s findings (1956) dealing with saplings browsed by the moose in the far north. The moose eats some crude protein contents, in particular, have proved to affect the food selection of the hare (Lindelöf et al. 1974). In Scotland the nitrogen and phosphorus contents in heather (Calluna vulgaris L.) were not found to have any effect on the eating habits of the hare (Hewson 1974). It has been argued (Bryant and Kuropat 1980) that the food selection of neither the hare nor moose correlates with the nutrient content. Instead, there is a negative correlation between the food selection and gross energy content of the food. The hare and moose seem to prefer the same easily digestible species (e.g. willow and aspen). Those with a higher energy content but which are less digestible (birch, alder and conifers) are less palatable (e.g. Seiskari 1954, 1956, Sainio 1956, Yli-Vakkuri 1956, Dodds 1960, Nyholm 1968, Pullaainen 1971, 1972, Teller 1974, Bryant and Kuropat 1980, Salonen 1982). It appears that the content of the secondary substances in plant tissue affect the food selection of the hare and moose (Bryant and Kuropat 1980, Haukioja et al. 1983, see also Löyttyniemi and Hiitonen 1978). The secondary metabolites of these plants or their compounds do not affect the feeding habits of the moose and hare in the same way; the moose prefers silver birch and pine, which usually remain untouched by the hare. Similarly, the palatability of Douglas fir to the snowshoe hare and deer are probably caused by slightly different combinations of factors (Dimock et al. 1976). The classification of different resin types seems to explain the food selection of the hare as far as the same tree species is concerned, while the qualitative variation explains the difference between different tree species (Bryant and Kuropat 1980). According to earlier studies, the field vole prefers the more southern provenances of spruce (Kangas 1935 and Heinkinheimo 1958 p. 23, Hagman 1973, Christiansen 1975). Investigations in northern Finland have also shown that the root vole damages the southern lodgepole pine (Pinus contorta var. latifolia S. Watts.) provenances significantly more than the northern ones (Rousi 1983a). The pine grafts in this investigation come from such a small area (150 d.d.) that it is unlikely that there are any differences in the susceptibility due to the transfer of different provenances. In this respect the nitrogen fertilization experiment with the hares has proved to be successful. The nitrogen fertilization increased the browsing of pine by the hare. The same kind of results have been obtained also in the case of moose in southern Finland (Laine and Mannerkoski 1980, Löyttyniemi 1981). The nitrogen fertilization and the transfer of provenances from the south to the north are known to affect the growth rhythm of trees by delaying the physiological processes related to wintering in the autumn (see e.g. Gusta et al. 1982). Thus experiments in northern Finland, including the present one, have revealed frost damage to the tops of nitrogen fertilized trees.

In a pine graft collection in central Finland the moose browsed pine whose needles had a (to a highly significant degree) lower dry matter content than the pine needles shunned by the moose (Haukioja et al. 1983). In the present experiment the hare browsed the bark of those grafts whose needles had a lower dry matter content than the pine untouched by the hare. The dry matter content in pine needles is reportedly a reliable sign of wintering. The foliar dry matter content is used to estimate, among other things, the susceptibility of pine to snow blight (Phacidium infestans Karst.) (Langlet 1934, 1936). It might be that the palatability of conifers to mammals depends on the success of wintering.

There is now more evidence for the fact that the secondary metabolites have an ecological significance and their absence in plants. Plenty of evidence has lately been produced about the antagonistic effect of particularly phenolic substances such as tannins and lignins on herbivores (e.g. Swain 1979, 1980). The functional significance of this repellent substances in different plant species is determined by their availability to herbivores, and it has been assumed that the different concentrations of repellent substances found in different species is due to the importance of that particular plant part to the survival of the species (Rhoades and Gates 1976). The contents of repellent substances have proved to explain the food selection of the moose and some within northern herbivores better than the positive factors in food (Bryant and Kuropat 1980, Haukioja et al. 1983.).

Conifers are among the easily available sources of winter food for mammals. As the function of the phloem and cambium is vital in the survival of trees, the conifers have had to develop protection against the vole and hare in the course of their evolution. The hare does not usually browse pine, whereas e.g. the root vole gnaws the base of pine during its peak years. As the vole damage usually occurs before or during the decline of the popu-
lution, pine bark may be unsuitable for it. The vole, hare and mouse use conifers only for winter food. The lignin and tannin contents in plants correlate with winter endurance, and the tannin content has, in fact, been found to increase during the winter (Levitt 1956, 1972). Secondary metabolites that prevent the breakdown of proteins in the intestines of herbivores and other substances that disturb the digestion of herbivores are also known to disturb the metabolism of the plant cell. Hence the plants have to use a lot of energy to isolate these antagonistic substances from the function of the cell (Rhoades and Cates 1976). The present results indicate that, in particular, the green coniferous saplings which do not have sufficient energy to form repellent agents are very susceptible to severe mammal damage (see also Rhoades 1979, cf. Hansson and Larsson 1980). Conifers need the repellent agents that disturb the digestion or physiology of mammals only in the winter when the tree tissue is dormant, the isolation of repellent agents from the metabolism of the cell then probably being far simpler than when the cells are active. There is reason to believe that mammals use poorly wintering conifers food forest. The assumption is based on the earlier observations on the low foliar dry matter content in pine preferred by the mouse (Haukioja et al. 1983), the present similar results in the case of the hare, the present observation on the hare focusing on nitrogen fertilized pines and the earlier findings that the root vole prefers the southern provenances of spruce and larchpole pine. This assumption which links the wintering of conifers and the formation of repellent substances, would make it possible for the conifers to protect themselves against mammals at the right time without needing much energy. 

KIRJALLISUUS


MÄNNIN ALTITUS NISÄKÄSTUHOILLE POHJOIS-SUOMESSA


Varttukokeman läheisyydessä kasvavia musta- ja val- kokukuisė sekä kanadanlehikuvussivuiljeystä nisäkkäät ei- vät olleet vahingoittaneet. Sen sijaan mänty- ja kuusii- istutuksissa havaittiin runsaasti metsän syöınıksi.


KUVIOITTAISEN ARVIOIMISMENETELMÄN PERUSTEITA

SIMO POSO

Summary

BASIC FEATURES OF FOREST INVENTORY BY COMPARTMENTS

Saapunut toimitusillalle 3. 11. 1983

Tutkimuksessa on kuvattu kuvioittaisssa arvioinnissa vaihtoehtoisilla tavalla saatujen kuvion omissuutena sekä metsätalouden yhteydessä että kuviooksahtaisten arvioidon kannalta. Loottattavat tiedot kuvioita keskiarvoi- neen ja sisäisine hajontointeet saatii systemaattisella 40 m x 40 m tai 50 m x 50 m välein mitata relaskappokopira- lastolla. Tutkimusaineiston suuruus oli yhteensä 1129 kohtaa jakaantuneena 16 eri puolilta Etelä-Suomea valittuun alueeseen. Tutkimusaineet valittiin sieltä, mistä piirimetsäalutaukomman toimesta juri oli tehty tai oli tekeillä käytännön kuvioitattavan arviontia. Tämän lisäksi alueilla 1–11 kuvioitusta arviointa teki 2 koheenhildä. Heidän työmässä on kohdistettu tietojen kerou myös aikatutkimuksia varten. Erityisesti henkilö 1:a kohdalla pyritti soveltaamaan ilmankuvita suoritettavaa suhteellisen tarkkaan maastotytön ennakoosuunnitelun perustuvaa kuvioitattava arvioimismenetelyä, jonka etuna on maastotytön pinta-alalla mitatun tuottavuuden paraneminen samalla kun liikkuminen kuvion ja kuvion rajojen tarkistaminen vähenevät. Alueilla 12–16 muodostettiin piirimetsäalutaukon kuvioimin rinnalle koaloiottaiseen maastotyöhön perustuva mahdollisimman hyvä kuviointi.


1. JOHDANTO

1.1. Kuvioittaiss sa arviointin käsittä

Inventoinnilla ymmärretään metsätalous- dessa tiedon keruu, jonka tulee voidaan käyttää hyväksi metsätalousliikenteessä suunnit- telussa. Tietoja metsävaroista ja niiden ja- kaantumisesta voidaan hankkia esimerkiksi systemaattisella koelautannalla.

Kuvioitattainen arviointi on enemmän kuin pelkästään metsän inventointimenetelmä. Siinä kohteena oleva metsäala jaetaan ku- vioihin, jotka toimivat sekä inventointi- että toimenpidekysikköihin. Nämä kahdenlaisten tavoitteiden samanaikainen huomioon otta- minen asetaa arvioijan ammattitaitolle suur- ria vaatimuksia. Nämä erityisesti silloin, kun...