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# The use of birch tar in the prevention of moose damage in young Scots pine stands

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**Abstract.** Moose (*Alces alces* L.) browsing causes economically significant damage in young Scots pine (*Pinus sylvestris* L.) stands in Finland. Various methods and devices have been used in attempts to prevent moose damage to Scots pine in young sapling stands. Our aim was to test the effectiveness of birch tar, a new innovation as repellent, under controlled experiments in young Scots pine stands frequently browsed by moose. Experiments were conducted during winter 2007/2008. In experiment A, each of the four experimental stands was divided into two treatments: (1) a treated block where all the top shoots and current-year shoots in the first whorl were treated with birch tar, and (2) an untreated block, i.e. a control area. In experiment B, the effect of birch tar was tested as an odorous repellent, i.e. small sacks with wooden pellets were dipped in the repellent liquid and placed around and inside three young Scots pine stands. In experiment A, there were no differences in the measured stand characteristics and the damage variables between the treated and untreated blocks. In experiment B, no significant differences in the measured variables were found between the protected and control stands. In conclusion, it seems that birch tar does not have a sufficient repellent effect when used against moose browsing.

**Key words:** *Alces alces*, birch tar, damage, moose, *Pinus sylvestris*, repellent, Scots pine.

## INTRODUCTION

Moose (*Alces alces* L.) browsing causes economically significant damage in young Scots pine (*Pinus sylvestris* L.) stands in Finland (e.g. Lavsund, 1987; Löyttyniemi & Lääperi, 1988; Heikkilä & Härkönen, 1993). Although pine can be considered a medium-preferred browse species in the winter diet of moose (Bergström & Hjeljord, 1987), the major proportion of consumed browse consists of pine from late autumn to early spring owing to its high availability (Cederlund et al., 1980). Especially in recent decades, increasing moose damage on Scots pine has boosted concern amongst forest-owners and the associated industries, since, as a long-term consequence, moose browsing reduces the quality of butt logs (i.e. merchantable timber) as a result of broken main stems (Heikkilä & Löyttyniemi, 1992; Glöde et al., 2004; Ingemarson et al., 2007). In addition to the flaws in the stem form, pith discolorations and colour changes outside the pith

reduce the internal quality of the wood, and hence also the value of the logs, irrespective of their end use.

Various chemical repellents, visual and acoustic devices, and tree sheltering methods and devices have all been used in attempts to prevent moose damage to Scots pine in young sapling stands (e.g. Löyttyniemi & Lääperi, 1988; Löyttyniemi et al., 1992). Different silvicultural methods (Härkönen, 1998; Härkönen et al., 1998; Heikkilä & Härkönen, 2000) and game management practices (e.g. Heikkilä & Härkönen, 1998; Gundersen et al., 2004) have also been tested. The effects of the different methods have been variable, and in many cases the methods used have generally shown little promise for the reduction of moose damage on a large-scale or long-term basis.

In general, forest-owners prefer methods that are easy to perform and not too expensive and time-consuming. In consequence, forest-owners would like to make use of new products that would be cost-effective and also provide satisfactory protection. To this end, tests have been conducted with birch tar. Birch tar is a substance derived from the dry distillation of the wood of the birch (*Betula* spp.). In this process the wood is rapidly decomposed by the application of heat and pressure in a closed container. The primary resulting products are charcoal and birch tar. To our knowledge, there is no comprehensive information of the components of birch tar. Mainly diluted with water, birch tar has efficiently repelled slugs, snails, and pest insects from gardens and sites where a variety of vegetables and berries are grown (i.e. in horticulture) (see Lindqvist et al., 2006; Pasanen, 2006). Preliminary unpublished observations made by manufacturers and derived from young Scots pine stands have also proven promising when birch tar has been used in the prevention of moose damage.

The Finnish Forest Research Institute has a long tradition in conducting experiments to determine the usefulness and biological efficacy of the products (i.e. chemical repellents, visual and acoustic devices, and tree sheltering methods and devices) intended for use in the prevention of moose damage (e.g. Löyttyniemi et al., 1992). The assessment of efficacy is mainly based on the results of field trials. Our aim was, therefore, to test the effectiveness of birch tar, a new innovation as repellent, under controlled experiments in young Scots pine stands frequently browsed by moose.

## MATERIAL AND METHODS

### Experiment A

Field experiments were conducted in four young Scots pine stands suffering from moose damage in Joroinen and Pieksämäki, central Finland. Each of the experimental stands was divided into two treatments: (1) a treated block where all the top shoots and current-year shoots in the first whorl were treated, and (2) an untreated block, i.e., a control area. Birch tar was liquid distillate (i.e. not diluted with water) and it was sprayed with a hand-trigger pump sprayer in October

2007. There were no signs of fresh moose browsing on trees during the setting-up of the experiments.

The stands were checked with no measurements in December 2007. In spring 2008 the stands were inspected using a systematic line-plot method (see e.g. Heikkilä & Härkönen, 1993). The circular sample plots were 50 $m^2$ in size, and the distance between the lines and plots was 20–40 m, depending on the area of the stand. The density and height of all pines over 0.5 m were measured. Each measured Scots pine was investigated for signs of fresh moose browsing. Fresh browsing would indicate that browsing had occurred after the establishment of the experiments, and it would be distinguishable from older browsing by its white colour at the point of browsing. Moose browsing was divided into three damage categories: stem breakage, twig-browsing at the first whorl from the top, and twig-browsing below the first whorl from the top. In order to estimate the moose activity in the stands, the number of faecal pellet groups (1 group ≥ 20 pellets) was counted in each plot (see Neff, 1968). Only pellet groups deposited during the winter of 2007/2008 (i.e., those on top of the previous year's leaf litter) were counted.

### Experiment B

The effect of birch tar as an odorous repellent was studied at Kannonkoski, central Finland. In total, 25 small sacks (with a density of 6–10 sacks per ha) with wooden pellets were dipped in the repellent liquid and placed around and inside three young Scots pine stands of 0.5–1.0 hectares in November 2007. Adjacent young stands of similar size were used as controls.

The stands were checked in mid-February 2008. Final measurements were taken as in experiment A in early summer 2008. The density and height of all pines over 1.0 m were measured. The number of stem breakages and browsed lateral twigs was counted.

### Statistical analysis

All statistical analyses were performed with SPSS program (v. 16.0, SPSS Inc., Chicago, IL, USA). The parametric tests were employed because the variables had normal distributions.

## RESULTS

### Experiment A

The experimental stands were relatively dense and at a developmental stage where the pine trees were very susceptible to moose damage due to their height (Table 1). There were several moose tracks, bedding sites, and browsing signs in the three pairs of the experimental stands already at the preliminary checking in December 2007.

**Table 1.** Results of experiment A. Means were tested by a paired-sample *t*-test. Means are given with their standard errors

| | Treated $n = 4$ | Untreated $n = 4$ | *P*-value |
|---|---|---|---|
| Stem density, per ha | 6002 ± 595 | 5079 ± 668 | 0.08 |
| Height, cm | 161 ± 14 | 159 ± 12 | 0.86 |
| Pellet groups, per ha | 233 ± 129 | 131 ± 59 | 0.39 |
| Damaged, % | 18.6 ± 7.8 | 20.6 ± 11.6 | 0.85 |
| Stem breakage, % | 7.6 ± 3.5 | 7.7 ± 5.2 | 0.96 |
| First whorl, % | 13.6 ± 5.8 | 13.3 ± 8.7 | 0.98 |
| Other damage, % | 14.7 ± 6.2 | 16.1 ± 9.3 | 0.87 |

There were no differences in the measured stand characteristics (i.e. the density and height of the pines) and the damage variables (i.e. the proportions of damaged pines, stem breakages, twig-browsing at first whorl, and twig-browsing under the first whorl) between the treated and untreated blocks. In the treated blocks the moose activity proved to be almost double that found in the untreated blocks when measured by pellet groups, although the difference was not significant. As a whole, moose had used stands intensively as the number of faecal pellet groups was relatively high.

## Experiment B

Several moose tracks, bedding sites, and browsing were observed in stands preliminarily checked in mid-February 2008. No significant differences in the measured variables were found between the protected and control stands (Table 2).

## DISCUSSION

Birch tar has yielded promising results in the repulsion of slugs and snails (Lindqvist et al., 2006; Pasanen, 2006). In addition, the positive preliminary observations made by manufacturers from young Scots pine stands provided the basis and inspiration for these controlled experiments with free-ranging moose.

**Table 2.** Results of experiment B. Means were tested by a *t*-test. Means are given with their standard errors

| | Protected $n = 3$ | Control $n = 3$ | *P*-value |
|---|---|---|---|
| Stem density, per ha | 2480 ± 167 | 2367 ± 165 | 0.44 |
| Pellet groups, per ha | 74 ± 20 | 86 ± 21 | 0.32 |
| Stem breakage, per ha | 227 ± 63 | 249 ± 47 | 0.28 |
| Browsed twigs, per ha | 1821 ± 157 | 1880 ± 135 | 0.39 |

The results presented here, however, suggest that birch tar is not an effective repellent against moose browsing.

Tar-like substances have long been used in Europe to protect trees against deer damage. In Finland pine tar was shown to prevent moose damage satisfactorily in young Scots pine stands throughout the winter (Löyttyniemi et al., 1992). At present, different tar-like substances are no longer in common use due to their possible toxic effects, such as their possible impact on human health. In addition, registration procedures for new chemical repellent products are relatively slow and expensive due to strict EU rules. This also reduces the possibilities for marketing new products to end-users. In Finland, approvals for repellent registrations are made by Finnish Food Safety Authority according to EU Council Directive 91/414/EEC.

Our experiments were focused on implications what different birch tar treatments may have on moose damage to Scots pine. In this respect, it is also important to evaluate how our results may be connected to moose browsing ecology. Consequently, knowledge about factors steering the moose winter browsing is necessary in understanding what mechanisms may cause more or less damages in young Scots pine stands. In general, herbivore foraging decisions are dependent on different factors acting at different scales (Senft et al., 1987; Månsson et al., 2007). These scales may vary from bites to landscape level (e.g. bite, individual plant, stand, home range, and landscape) and each of them may have different effects on moose winter browsing. Further, several factors interact and thus complicate the evaluation of the importance of the individual factors on moose browsing decisions. In our study, we tried to manipulate moose browsing behaviour by repellents, strictly speaking, at individual tree and stand level. Birch tar did not, however, show any reducing effect on moose browsing as there were no differences in damage variables between treatments. Even the short-term effect was negligible as we observed several moose tracks, bedding sites, and browsing signs in both experiments already at the preliminary checking in December 2007 and mid-February 2008.

Pellet group counts were used to estimate moose activity in the experimental stands. According to Neff (1968), the method can provide reliable data under most field conditions. In the treated blocks of experiment A, the number of pellet groups was almost double to that found in the untreated blocks. In addition, the observed number of pellet groups, even in the treated blocks, was comparable to the numbers reported from managed Scots pine-dominated forests in Finland (see e.g. Heikkilä & Härkönen, 1998). This also indicates that birch tar did not affect moose activity and thus behaviour at stand level.

The effective repellents normally cause aversion responses in ruminant herbivores by reducing digestibility and forage intake. In our study, however, moose did not reduce their browsing in the treated Scots pine stands. It is difficult to evaluate the ultimate reasons for the lack of effectiveness. For example, it may be possible that the birch tar was not properly applied to the shoots or the compounds in the tar are not effective against moose. In this respect, Pasanen (2006) reported that the effectiveness of birch tar is reduced by rain, even during

a few weeks period, and possibly also by sunshine. In our experiments, it was evident that the weather changes were remarkable during the study period (i.e. rain, snowfall, cold and mild weather, etc.). As a consequence, the long-lasting preventive effect is really hard to reach in forest stand conditions during winter.

In conclusion, it seems that birch tar does not have a sufficient repellent effect when used against moose browsing. Thus, development of cost-effective mechanical and/or chemical preventive methods is still needed to reduce the risk of moose damage in young Scots pine stands. However, there is also a strong need to control over-abundant moose population densities. From the 1970s, the moose density has increased in Finland (Torvelainen, 2007). Post-harvest moose population was at highest in 2001, when it was estimated to be 139 000 (i.e. 4.6 moose per 10 $km^2$ land area). After that the overall moose density has, however, been declining due to intensified hunting (see Torvelainen, 2007). We suggest that moderate moose densities with effective damage-preventive methods would allow, in the long run, both economically profitable forestry with high-quality timber and sufficient moose harvest.

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## Kasetõrva kasutamine põdrakahjustuste vältimiseks männinoorendikes

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Metsaomanikud on huvitatud odavatest ja samas piisavalt efektiivsetest repellentidest, mis kaitseksid metsakultuure põdrakahjustuste eest. Teadaolevalt on aianduses edukalt kasutatud nälkjate ja kahjurputukate peletamiseks kasetõrva. Käesolevas töös uuriti kasetõrva sobivust männinoorendike kaitseks põtrade eest. Selleks viidi läbi kaks eksperimenti, millest ühes töödeldi 2007. aasta sügisel neljas männinoorendikus puude ladvavõrseid kasetõrvaga, teises riputati samal ajal kolme noorendiku ümber ja sisse kotikesed kasetõrvaga immutatud puidugraanulitega. Järgmisel kevadel võrreldi talvel lisandunud põdrakahjustusi kasetõrvaga töödeldud ja kontrollaladel. Usaldusväärset erinevust ei leitud, mistõttu tehti järeldus, et kasetõrv ei ole efektiivne vahend männinoorendike kaitseks.