BRIEF REPORT

Feeding Preferences of *Hylobius pinastri* Gyll.

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Abstract

Hylobius (Coleoptera: Curculionidae) weevils, especially *Hylobius abietis* L., are harmful regeneration pests that cause damage by killing planted coniferous seedlings and are economically the most important regeneration pests in Europe. *Hylobius pinastri* Gyll. is one of the lesser-known forestry pests of the genus. A feeding experiment was performed, to follow the feeding choices of *H. pinastri* between Norway spruce and Scots pine. Insects were allowed to choose freely between Norway spruce and Scots pine twigs during a week-long experiment. The results indicate that *H. pinastri* prefers Norway spruce but also accepts Scots pine for nutrition. Feeding scars were large enough to kill seedlings. Results support the observation that *H. pinastri* is abundant in moist Norway spruce-dominated forests.

Key words: feeding experiment, *Hylobius pinastri*, nutrition selection, regeneration pest.

Introduction

Hylobius (Coleoptera: Curculionidae) weevils are the most significant seedling pests in regeneration areas in Europe (Bejer-Petersen et al. 1962, Långström and Day 2004). These pine weevils are polyphagous and cause economic losses to forestry as they feed on the bark and phloem of one- to five-year-old conifer seedlings (Eidmann 1974, Nordlander et al. 1986, von Sydow 1997). *Hylobius abietis* L. is the most widespread and abundant species of the genus, whereas *Hylobius pinastri* Gyll. is less abundant and *Hylobius piceus* De Geer is relatively rare (Eidmann 1974, Långström 1982, Sibul 2000). Volatile compounds emitted from fresh wood and logging residues attract pine weevils to reforestation areas (Tilles et al. 1986, Nordlander 1991), but pine weevils also use sight to locate suitable food, and seedlings that have not previously been attacked are mainly chosen randomly (Nordlander 1987). In addition, conifers are known to emit į-pinene and ethanol, which stimulate pine weevil feeding (Tilles et al. 1986, Nordlander 1990, Brattli et al. 1998, Sjödin et al. 2000). Spruce turpentine combined with ethanol is an attractant for *H. abietis, Hylastes cunicularius* Er. and *Hylastes brunneus* Er., but not for *H. pinastri* (Lindelöw et al. 1993).

Pine weevils start to swarm in central Sweden in late May and early June and search fresh logging sites for breeding (Solbreck and Gyldberg 1979) and females fly up to 9 km (Solbreck 1980). In summer, they feed in the vicinity of conifer stumps (Nordlander et al. 1997) and lay eggs which hatch the following spring and adults feed before overwintering in the bark and phloem of conifer roots. In the following spring, adults feed for several weeks before swarming. The development of a new generation takes about two years in southern Finland, but the development time is longer in the north (Bejer-Petersen et al. 1962, Bakke and Lekander 1965, Lekander et al. 1985, Långström 1982). Due to the heavy damage caused to forest regeneration, pine weevils are actively controlled with insecticides. Approximately 415 million conifer seedlings are protected annually against pine weevil in nurseries in Austria, the Czech Republic, Denmark, Finland, France, Hungary, Ireland, Norway, Poland, Romania, Sweden and the U.K. (Långström and Day 2004).

The lesser pine weevil, *H. pinastri*, has spread throughout Scandinavia (Saalas 1949, Eidmann 1974, Ehnström and Axelsson 2002) and the species is considered a harmful pest in Latvia (Ozols 1985) and Estonia, where its frequency is about 24% that of the abovementioned *Hylobius* species (Maavara et al. 1961 in Luik and Voolma 1989). In Finland, the frequency of *H. pinastri* is about 10% that of *Hylobius* weevils, but in fertile sites, it can be as much as 30% (Långström 1982). The species is very rare in Sachsen-Anhalt, Germany (Schneider and Gruschwitz 2004). The ecology of *H. pinastri* has not been studied comprehensively, so that its significance as an agent causing seedling damage is not clear. Most information on the species has been gained from studies related to *H. abietis*. The purpose of this study was to investigate the feeding preference of adult *H. pinastri* on Scots pine and Norway spruce in paired-choice tests.

Material and methods

Scots pine seeds (seed origin SV 337) were sown between 4–6 May 2009 and seedlings were fertilized five times in 2009 with a total of 35 g m^{-2} Kekkilä Forest-Superex. In addition, they were treated five times with Tilt 250 EC fungicide (a.i. propiconazole 250 g L^{-1}). Norway spruce seeds were sown in April 2009 and were fertilized 12 times with Kekkilä Forest-Superex and once with Kekkilä Taimi-Superex, the total amount of fertilization being 80 g m^{-2}. The seedlings were also sprayed twice with Tilt 250 EC.

The one-year-old seedlings were grown in PL-81 trays (Lännen Plant Systems, Finland). Seedling height, annual growth and stem diameter at 1 cm height were measured before the experiment, to ensure that the seedlings were of equal size. The experiment was conducted in a laboratory at room temperature at 25.1ºC (± 1.6 ºC) and at 43.2% (± 5.4%) relative humidity.

Adult weevils used in this experiment were collected via pitfall traps in Joensuu and Rääkkylä, Eastern Finland during a two-week trapping period in June 2010. Traps provided 240 weevils for the experiment. After collection, the weevils were kept in jars with sawdust in groups of 20, at +5°C. Water and fresh pine twigs were added to the jars. Only healthy, medium-sized individuals were used for the experiment. Before the experiment, weevils were weighed and inspected. From the 240 weevils captured, 108 were selected for the experiment based on their weight; the lightest and the heaviest individuals were rejected. The selected individuals were placed singly in Petri dishes (∅ 15 cm) on moistened filter paper and kept without food for 24 h. After fasting, the weevils were weighed and replaced in Petri dishes, where they were allowed to feed for 7 d on 10 cm-long pieces of stem cut from the bases of the tree seedlings. The weevils were weighed at the end of the experiment, left without food for another 24 h and weighed again. One weevil died during the experiment and one escaped.

The total bark area was calculated for each stem piece after its mean diameter and length had been measured with a digital pocket slide gauge. The twigs were placed in order according to their diameter and were arranged in pairs, so that twigs of the two tree species as closely sized as possible were supplied to the experimental insects. The mean length of Norway spruce twigs was 100.3 ± 0.4 mm (mean ± S.D.) and the mean diameter at the stem base was 4.1 ± 0.4 mm. Scots pine twigs had a mean length of 100.3 ± 0.5 mm and mean diameter of 3.9 ± 0.3 mm. The mean weight of the experimental weevils before one-day of fasting was 0.046 ± 0.004 g, (mean ± S.D.).

The feeding scars were copied onto plastic foils with a pen and the foils were then scanned and the images edited using Adobe® Photoshop® 5.5 (Adobe Systems Inc.), after which the total gnawed bark area was calculated with WinSEEDLE 2010a software (Regent Instruments Inc.). Changes in the weight of weevils and the gnawed bark areas of tree species were compared using one-way ANOVA. The influence of weevil weight on the area of gnawed bark was tested with the Pearson correlation coefficient. Both tests were performed with SPSS® Statistics 17.0 (SPSS® Inc.).

Results

On average, the weevils fed on 145 mm^2 Norway spruce twigs, which was 12% of the total twig surface. The corresponding values for Scots pine were 88 mm^2 and 8%. The bark area of Norway spruce twigs was 6% greater ($DF = 1$, $F = 26.7$, $P < 0.001$) than the surface area of Scots pine. In terms of feeding, 62% of the total amount occurred on Norway spruce twigs; the difference between tree species was significant ($df = 1$, $F = 24.14$, $P < 0.001$). There was no significant correlation between the initial weevil weight after the first fast and the area of Norway spruce bark consumed (Norway spruce, $r = 0.07$, $P = 0.478$, $n = 106$ or Scots pine, $r = 0.11$, $P = 0.263$, $n = 106$).

Following the one-day fast before the experiment, mean weevil weight decreased by 4% ($df = 1$, $F = 6.77$; $P = 0.009$) and the mean weight was 0.044 ± 0.006 g, (± S.D.). During the second fast, the mean weevil weight also fell by 4% ($df = 1$, $F = 4.08$, $P = 0.045$). At the end of the experiment, the mean weight of the insects was 0.047 ± 0.005 g (mean ± S.D.), so that during the seven-day feeding experiment, the mean weight of *H. pinastri* increased by 1% ($df = 1$, $F = 0.20$, $P = 0.65$, comparing the weight after the first and second fast); the difference, however, was not significant. Each weevil consumed, on average, 33.2 mm^2 of bark per day.

Discussion

H. pinastri preferred Norway spruce to Scots pine in the feeding experiment. Norway spruce twigs were larger than Scots pine twigs. It can be assumed that by choosing equally sized weevils for the experiment, we minimised the differences between individuals, since there was no correlation between the feeding rate and the weight of weevils. The mean daily feeding rate for *H. abietis* was about 50 mm^2 (Bylund et al. 2004; Toivonen and Viiri 2006). The mean bark area consumed per individual per day was 62 mm^2 for females, due to the egg-laying period, and 40 mm^2 for males (Bylund et al. 2004). A feeding rate of 33 mm^2 per day in this experiment can be interpreted as representing a normal feeding amount for the smaller-sized *H. pinastri*. The temperature during the experiment was high, which might have influenced the feeding activity, which is known to be lower at high temperatures (Christiansen and Bakke 1971). The feeding rate of pine weevils has been found to be highest at 20-25°C (Christiansen and Bakke 1968, Leather et al. 1994) and feeding is nocturnal in extreme conditions in exposed sites (Christiansen and Bakke 1971). Here, *H. pinastri* favoured Norway spruce over Scots pine for its nutrition, thus confirming the previously observed habitat requirements of the species. *H. pinastri* is common in fresh, moist sites dominated by Norway spruce (Långström 1982). Långström (1982) has shown that *H. pinastri* prefers Norway spruce instead of Scots pine when choosing trap billets. Furthermore, according to observations of Kangas (1958), *H. pinastri* is more common in Norway spruce than Scots pine forests. According to Eidmann (1974), the *H. pinastri* development period corresponds to that of *H. abietis*. However, development appears to be longer for pine weevils feeding on Norway spruce (Bejer-Petersen et al. 1962) and a minority of the larvae (5%) in Norway spruce required a further year for their development (Bakke and Lekander 1965). More information is needed concerning *H. pinastri*, including for example, what is the role of field layer vegetation in their diet.

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КОРМОВЫЕ ПРЕДПОЧТЕНИЯ СРЕДНЕГО СОСНОВОГО ДОЛГОНОСИКА *HYLOBIUS PINASTRI* GYLL.

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Резюме

Долгоносики рода *Hylobius* (Coleoptera: Curculionidae), в частности большой сосновый долгоносик *H. abietis* L., приносят большой ущерб лесным культурам хвойных пород, часто обуславливая их гибель. Большой сосновый долгоносик считается одним из экономически наиболее опасных вредителей леса в Европе. Однако другой вид этого рода – средний сосновый долгоносик, *H. pinastri* Gyll. – является менее известным и гораздо меньше привлекал внимание исследователей.

Мы провели эксперимент кормления *H. pinastri* с целью прослеживания предпочтения отдаваемого долгоносиком в качестве кормового растения ели европейской и сосны обыкновенной. Насекомым было представлено свободно выбирать между ветками ели и сосны в течение недельного эксперимента. Результаты показывают, что *H. pinastri* предпочитает ель, но также питается на сосне. Кормовые раны на коре были достаточно большими, чтобы причинять гибель растений. Результаты подтверждают наблюдение, что *H. pinastri* многочисленно встречается в более влажных условиях местопроизрастания ели.

Ключевые слова: вредители лесовозобновления, выбор кормового растения, эксперимент кормления, *Hylobius pinastri*