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Adult feeding preferences of the large pine weevil, *Hylobius abietis* (Coleoptera: Curculionidae)

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Abstract. The adult feeding preferences of *Hylobius abietis* were tested at three temperatures, 10, 15 and 20°C, with three different host plants, *Pinus sylvestris, Picea abies* and *Fraxinus excelsior*, in simple paired choice tests.

At all temperatures adult weevils showed a marked and significant preference for *P. sylvestris* over the other two host plants. *F. excelsior* was not a preferred host plant and there was some evidence to suggest that at higher temperatures, the presence of *F. excelsior* inhibited feeding.

Adult weevils consumed up to five times as much food at 20°C than they did at 10°C, 252.9 mm^2 of bark of *P. sylvestris* at 20°C compared to 47.8 mm^2 at 10°C, 137.2 mm^2 of *P. abies* bark at 20°C compared to 27.3 mm^2 at 10°C and 24.6 mm^2 of *F. excelsior* bark at 20°C compared 4.0 mm^2 at 10°C. These results are discussed in relation to possible pest management strategies.

INTRODUCTION

The feeding preferences of adult herbivores have marked implications for their patterns of occurrence and the likelihood of migration to or from their adult emergence site. If the site in which they emerge as adults is well stocked with preferred host plants then the likelihood of migration is low, whereas an area devoid of suitable host plants should stimulate a mass exodus (Watt et al., 1989). These behavioural patterns have an important bearing on pest management strategies.

The large pine weevil, *Hylobius abietis* L. (Coleoptera: Curculionidae), is probably the most important pest of establishment forestry in continental Europe and has been estimated to cause the death of approximately 30% of all conifers planted in restocked sites in Britain in recent years (Heritage et al., 1989; Wilson & Day, 1994). *H. abietis* breeds principally in the stumps of felled conifers and the adults feed on the bark of living trees, primarily conifers but also on broadleaved species (Scott & King, 1974). As a larva, *H. abietis* is reported to be better adapted to pine species than other conifers (Munro, 1928). Its preferences as an adult have not been documented, although it has been assumed that its favoured hosts are likely to match those of the larvae (Bejer-Petersen et al., 1962).

Restocked areas tend to be planted up in either pure stands of one particular tree species, or in mixed plantings of two tree species in an even mixture, but rarely, if ever, with a broad-leaved species interspersed amongst the conifer species (Hibberd, 1991). Broad-leaved planting, when it is carried out, tends to be for conservation and amenity reasons and is often around the edges of the main conifer crop (Hibberd, 1991). It is

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possible that different planting strategies may have an effect on the damage caused by *H. abietis* on restocking sites.

This paper reports the results of a laboratory trial to investigate the feeding preferences of adult *H. abietis* when presented with two conifer species and one broad-leaf species. A knowledge of feeding preferences may lead towards a possible means of reducing damage levels in the field.

MATERIAL AND METHODS

Freshly cut twigs (3 cm long, 1 cm diameter) of *Pinus sylvestris* (Scots pine), *Picea abies* (Norway spruce) and *Fraxinus excelsior* (Ash) were placed in pairs; *P. sylvestris* alone, *P. abies* alone, *F. excelsior* alone, *P. sylvestris* with *P. abies*, *P. sylvestris* with *F. excelsior* or *P. abies* with *F. excelsior*, in small sealed plastic boxes (5.5 × 4.5 × 2.8 cm) with an air hole in the upper surface, at 10, 15 and 20°C, under long day conditions (16L : 8D). Ten replicates per combination per temperature were used. One adult weevil caught from a field collection at Bramshill Forest, Bracknell, Berkshire on 18 May 1993 was placed in each box, a total of 180 weevils.

The weevils were then allowed to feed for one week. At the end of this time, the weevils were removed from their boxes and the amount of feeding damage recorded using a modification of the method described by Collins (1993). In essence, the twigs were encased with water proof sticky tape, and the areas damaged traced onto the tape using a waterproof marker pen. The tape was then removed from the twigs and stuck on to millimetre squared graph paper. The number of millimetre squares occluded by the traced patterns were then counted and the area damaged (consumed by the weevil) was then calculated for each length of twig.

RESULTS

Host plant and temperature

At each of the three temperatures in single host presentations, significantly more *P. sylvestris* bark was consumed than from the other species of twig (Table 1). *Fraxinus excelsior* was only eaten with reluctance, at 10°C only 4 mm^2 of bark were consumed on average and even at 20°C only 24.6 mm^2 were eaten. This was less than 10% of the area of *P. sylvestris* eaten under the same conditions.

TABLE 1. Area (mm^2) of host plant consumed by adult *Hylobius abietis* in a no choice situation under long-day conditions (16L : 8D) at 20, 15 and 10°C (± s.e.).

Host plant	10°C	15°C	20°C
Pinus sylvestris	47.8 ± 10.71	67.4 ± 5.73	252.9 ± 25.1
Picea abies	27.3 ± 5.6	52.1 ± 5.1	137.2 ± 20.6
Fraxinus excelsior	4.0 ± 3.1	32.1 ± 8.2	24.6 ± 5.9
F-value	8.34	14.1	34.2
Significance	< 0.001	< 0.001	< 0.001

Adult weevils consumed up to five times as much food at 20°C than they did at 10°C, 252.9 mm^2 of bark of *P. sylvestris* at 20°C compared to 47.8 mm^2 at 10°C, 137.2 mm^2 of *P. abies* bark at 20°C compared to 27.3 mm^2 at 10°C and 24.6 mm^2 of *F. excelsior* bark at 20°C compared 4.0 mm^2 at 10°C.

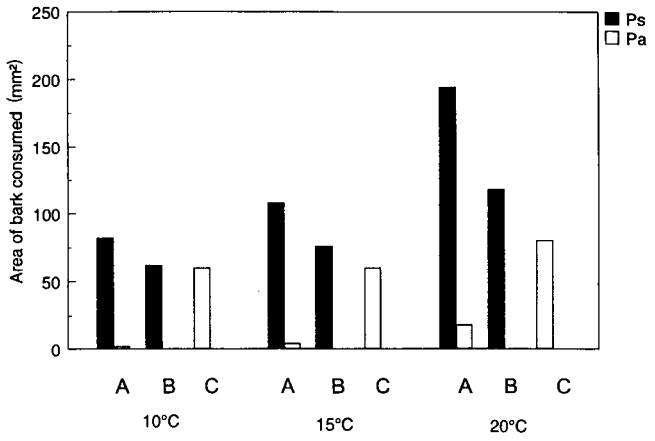

Fig. 1. Feeding preferences of adult *Hylobius abietis* in paired choice chambers under long day conditions (16L : 8D) at 10, 15 and 20°C. (Ps = *Pinus sylvestris* ■, Pa = *Picea abies* □). A = Ps vs Pa, B = Ps vs Fe, C = Pa vs Fe. The weevils did not feed on *F. excelsior* at all.

Host preferences

In two host presentations at all three test temperatures, *P. sylvestris* was preferred as an adult food source when compared to either *P. abies* (Fig. 1) or *F. excelsior*. *Picea abies* was also significantly preferred as a host in comparison to *F. excelsior*. In fact, the weevils did not feed on *F. excelsior* at all if there was a choice of conifer available. In those combinations in which *P. sylvestris* and *F. excelsior* were presented as alternative hosts, the area of *P. sylvestris* bark eaten was significantly less than in those combinations where the two conifer species were presented together (10°C $t = 10.1$, $P < 0.001$; 15°C $t = 14.3$, $P < 0.001$; 20°C $t = 15.8$, $P < 0.001$).

DISCUSSION

It is apparent that of the three host plants tested in this experiment, *P. sylvestris* is the preferred choice as an adult food source for *H. abietis* over the temperature range examined (Table 1, Fig. 1). This is in agreement with results obtained in Scandinavia (Langström, 1982). In this study maximal feeding occurred at 20°C and this is in general agreement with other studies that have shown an apparent general temperature optimum of 22°C for this species (Christiansen & Bakke, 1968; Christiansen, 1971; Nuorteva, 1972). It also appears that the presence of another conifer species may act as a feeding stimulus, or conversely, that the presence of a non-coniferous species, in this case *F. excelsior*, may act as a feeding depressant for *H. abietis*, as the amounts of *P. sylvestris* eaten in those combinations where pine and ash were presented together was less than eaten when pine was presented together with spruce.

Damaged conifers produce emissions of several volatiles, including ethanol and several monoterpenes, many of which have been shown to be attractive to adult *H. abietis*, in particular the monoterpenes α- and β-pinene (Ohnesorge, 1953; Mustaparta, 1974;

Nordenheim & Eidmann, 1991), and to influence the feeding behaviour of the adult weevils (Selander et al., 1973). It is highly likely that the volatiles produced by *F. excelsior* are very different from those produced by the two conifer species and that they may either act as feeding depressants or in some way interfere with the activation of the olfactory cells. This should be investigated further. It would also be useful to find out whether other commonly planted broad leaf species have similar effects, as ash is a more demanding species silviculturally speaking than many of the conifer species (Hibberd, 1991) and would not make a good mixture crop with *P. sylvestris* for example.

These findings may have significant implications for the pest management of *H. abietis*. It is possible that planting an intimate mixture of a preferred host plant and less preferred host plant may result in a reduction of damage to the conifer crop, thus reducing the need to (a) employ costly insecticidal treatments and (b) replace damaged plants. A similar scenario has been proposed as an alternative to chemical control of the pine beauty moth *Panolis flammea* (Leather, 1992; Leather & Knight, 1995). In addition, this type of planting strategy would allow current British broad leaf planting requirements to be met as part of an alternative, environmentally friendly, control measure. Field trials on the effect of planting different tree mixtures on the damage levels caused by *H. abietis* are urgently required.

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REFERENCES

BEJER-PETERSEN B., JUUTINEN P., KANGAS E., BAKKE A., BUTOVITSCH H., HEQVIST K.J. & LEKANDER B. 1962: Studies on Hylobius abietis L. 1. Development and life cycle in the Nordic countries. *Ann. Entomol. Fenn.* **17**: 1–107.

CHRISTIANSEN E. 1971: Laboratory study on factors influencing pre-imaginal development in Hylobius abietis L. (Col., Curculionidae). *Norsk Entomol. Tidsskr.* **18**: 1–8.

CHRISTIANSEN E. & BAKKE A. 1968: Temperature preference in adults of Hylobius abietis L. (Coleoptera: Curculionidae) during feeding and oviposition. *Z. Angew. Entomol.* **62**: 83–89.

COLLINS S.A. 1993: *The Potential of Entomopathogenic Nematodes to Reduce Damage by Hylobius abietis L.* Ph.D. Thesis, Imperial College, University of London, 194 pp.

HERITAGE S.G., COLLINS S. & EVANS H.F. 1989: A survey of damage by Hylobius abietis and Hylastes spp. in Britain. In Alfaro R.I. & Glover S.G. (eds): *Insects Affecting Reforestation: Biology and Damage*. Forestry Canada (Pacific and Yukon Region),Victoria, Canada, pp. 28–33.

HIBBERD B.G. 1991: *Forestry Practice*. Forestry Commission Handbook 6, HMSO, London, 239 pp.

LANGSTRÖM B. 1982: Abundance and seasonal activity of adult Hylobius weevils in reforestation areas during first years following final felling. *Commun. Inst. For. Fenn.* **106**: 4–23.

LEATHER S.R. 1992: Forest management practice to minimise the impact of the pine beauty moth. *For. Commn. Res. Inf. Note* **217**: 1–3.

LEATHER S.R. & KNIGHT J.D. 1995: Pines, pheromones, parasites and predators: an integrated approach to controlling the pine beauty moth, Panolis flammea. *For. Ecol. Manag.* (in press).

MUNRO J.W. 1928: The biology and control of Hylobius abietis L. Part 1. *Forestry* **2**: 31–39.

MUSTAPARTA H. 1974: Response of single olfactory cells on the pine weevil Hylobius abietis L. (Col.: Curculionidae). *J. Comp. Physiol.* **97**: 271–290.

NORDENHEIM H. & EIDMANN H.H. 1991: Response of the pine weevil Hylobius abietis L. (Col., Curculionidae) to host volatiles in different phases of its adult life cycle. *J. Appl. Entomol.* **112**: 353–358.

NUORTEVA M. 1972: Die Geschwindigkeit der Nahrungspassage durch des Darmkanal bei Hylobius abietis L. Imagines (Col., Curculionidae). *Ann. Entomol. Fenn.* **38**: 113–118.

OHNESORGE B. 1953: Des Einfluss von Geruchs-und Geschmackstoffen auf die Wahl der Frasspflanzen beim grossen braunen Rüsselkäfer Hylobius abietis L. *Beitr. Entomol.* **3**: 437–468.

SCOTT T.M. & KING C.J. 1974: *The Large Pine Weevil and Black Pine Beetles*. Forestry Commission Leaflet 58. HMSO, London, 12 pp.

SELANDER J., KANGAS E., PERTTUNEN V. & OKSANEN H. 1973: Olfactory responses of Hylobius abietis L. (Col.: Curculionidae) to substances naturally present in pine phloem or their synthetic counterparts. *Ann. Entomol. Fenn.* **39**: 40–45.

WATT A.D., LEATHER S.R. & STOAKLEY J.T. 1989: Site susceptibility, population development and dispersal of the pine beauty moth in a lodgepole pine forest in northern Scotland. *J. Appl. Ecol.* **26**: 147–157.

WILSON W.L. & DAY K.R. 1994: Spatial variation in damage dispersion, and the relationship between damage intensity and abundance of the pine weevil (Hylobius abietis L.). *Int. J. Pest Manag.* (in press).

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