

PRIMARY ATTRACTION OF *ZPS LATZDENS* (LECONTE) AND *HYLASTES GRACILIS* LECONTE (COLEOPTERA: SCOLYTIDAE) TO HIGH-GIRDLED LODGEPOLE PINE, *PINUS CONTORTA* VAR. *LATIFOLIA* ENGELMANN

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Abstract

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In the absence of secondary attraction, 2 species of Scolytidae, *Ips latidens* (LeConte) and *Hylastes gracilis* LeConte, showed significant preference while in flight for high-girdled over non-girdled lodgepole pines, *Pinus contorta* var. *latifolia* Engelmann. In contrast, beetles in 2 genera of Elateridae, *Ampedus* and *Ctenicera*, showed significant preference for non-girdled over high-girdled lodgepole pines. Beetles in 12 other families, as well as other scolytids and elaterids, did not show any significant preference or aversion to high-girdled trees. This is the first clear demonstration of primary attraction for a North American *Ips* species and the second for an *Hylastes* species.

Résumé

En l'absence d'attraction secondaire, 2 espèces de Scolytidae, *Ips latidens* (LeConte) et *Hylastes gracilis* LeConte ont montré une préférence significative, en vol, pour des pins *Pinus contorta* var. *latifolia* Engelmann ceinturés haut plutôt que non ceinturés. À l'inverse, des coléoptères représentant 2 genres d'Elateridae, *Ampedus* et *Ctenicera*, ont montré une préférence significative pour des pins non ceinturés plutôt que ceinturés haut. Des coléoptères représentant 12 autres familles ainsi que d'autres scolytidés et Blat&ides n'ont pas montré de préférence ou d'aversion pour les pins ceinturés haut. Il s'agit de la première démonstration d'attraction primaire chez une espèce nord-américaine d'*Ips*, et de la seconde pour une espèce d'*Hylastes*.

Introduction

Scolytidae exploit ephemeral and patchy habitats, such as the winter's accumulation of wind-downed and diseased trees (Atkins 1966). Initial choice of host trees and slash by bark beetles may be mediated by chemical and/or visual cues (primary attraction), or may be simply random but followed by sustained feeding on preferred hosts (Borden 1982; Wood 1982; Birch 1984). Primary attraction to unattacked hosts has been shown for 5 species of ambrosia beetles and 10 species of bark beetles, including *Hylastes nigrinus* (Mannerheim), *Dendroctonus pseudotsugae* Hopkins, *Ips typographus* L., and *Trypodendron Zineatum* (Olivier), but has not been demonstrated for 12 other species of *Dendroctonus* and *Ips*, including *D. ponderosae* Hopkins, *I. latidens* (LeConte), and *I. pini* (Say) (Moeck et al. 1981). For several species, such as *T. Zineatum* and *Gnathotrichus sulcatus* (LeConte), ethanol and various monoterpenes have been identified as attractants (Cade et al. 1970; Moeck 1970, 1971; Bauer and Vité 1975; Nijholt and Schönherr 1976).

Madden (1968) demonstrated that girdling the trunk of Monterey pine, *Pinus radiata* D. Don, resulted in preferential attack by the wood wasp, *Sirex noctilio* F. This high-girdling technique results in increased fermentation of phloem tissue below a girdle due to photosynthate starvation, and increased rates of loss of monoterpenes, water, and respiratory gases across the phloem and bark, probably due to changes in tissue permeability (Madden 1977).

Our objective was to test the hypothesis that scolytid beetles would show preferences in host selection in response to the probable release of volatiles induced by high-girdling of lodgepole pine, *P. contorta* var. *latifolia* Engelmann.

Materials and Methods

On 10 May 1983, 40 lodgepole pines (16.2-24.9 cm diameter at breast height, 100-120 years old) were selected in lodgepole stands at 3 sites near the east gate of Manning Park, British Columbia, in 10 replicates of 4 trees each. Within each replicate, trees were spaced roughly linearly, 10-15 m apart. The 3 sites were within 4 km of each other and contained 3, 3, and 4 replicates, respectively. Populations of *D. ponderosae*, *I. latidens*, and *I. pini* were recorded in the area during the previous 2 years (personal observations).

Within each replicate, 2 trees were high-girdled by removing a 5- to 7-cm band of phloem and bark at 3.5-4.0 m above ground level. One high-girdled tree and one non-girdled tree were sprayed with 2% carbaryl [Sevin SL, Union Carbide Agricultural Products Co. (Canada), Inc., Calgary, Alberta, Canada T2H 1H9] to a height of 4 m to prevent successful attacks by scolytids and preclude the expression of secondary attraction.

A further set of 8 lodgepole pines, spaced 10-15 m apart, was selected on 20 July 1983, on a 4th site. Five trees were high-girdled and 3 left as controls. None was sprayed with carbaryl.

Wire-mesh bands (20 cm wide; 6.4-mm mesh), coated with Pest Glue (Seabright Enterprises, Emeryville, California, USA 94608), and mounted on plastic backs, were stapled 1.7-1.9 m above ground level on all trees, circling the trunks. All beetles were collected from these sticky traps between 10 May and 26 August 1983, at approximately 2-week intervals. Beetles were washed with Shell Solvent, stored in 70% ethanol, and identified in the laboratory. Statistical analyses were performed using the G statistic for frequency data (Sokal and Rohlf 1981). Taxa were tested for heterogeneity (G_H) among replicates and the pooled statistic (G_p) was used to test for effects due to girdling treatment. Tests of independence were used on the pooled data (for those taxa that did not show any significant heterogeneity among replicates at $P = 0.05$) to determine the effects, if any, of location and spraying.

Results and Discussion

Beetles in 14 families of Coleoptera were caught on sticky bands, with Elateridae, Melandryidae, and Scolytidae accounting for 77.2% of the total catch (Table 1). Although the total numbers of beetles caught on non-girdled and high-girdled trees differed significantly from an expected 1:1 ratio, only the Scolytidae showed a significant departure from 1:1 (G-test, $P < 0.001$).

Significant heterogeneity among replicates was found in Elateridae and Scolytidae and attributed to variation among species. Beetles in the genera *Ampedus* and *Ctenicercus* showed significant preferences for non-girdled over high-girdled lodgepole pines. The heterogeneity among replicates in the genus *Athous*, due to one trap catching 91% of all *Athous* beetles, suggests that the observed difference in response was due to chance and not indicative of any preference.

Twelve species of bark and ambrosia beetles (Scolytidae), in 7 genera, were caught. *Hylastes gracilis* and *I. latidens*, 2 of the 3 most abundant scolytids caught, showed a significant preference for high-girdled lodgepole pines. No *D. ponderosae* were caught even though a large-diameter tree at one site, approximately 3 m from a high-girdled tree, was mass-attacked by this species in early August.

There was no significant difference in the response of the sexes of *I. latidens* to high-girdled & non-girdled trees ($P > 0.05$); the overall proportion of females was 0.65 to 1 male.

Table 1. Total beetles caught on 40 lodgepole pines, *Pinus contorta* var. *latifolia*, between 10 May and 26 August 1983, at 3 sites near Manning Park, B.C.

	Total catch	Percentage		Significance levels	
		Non-girdled (n = 20)	High-girdled (n = 20)	Differences among replicates*	Differences between treatments t
Staphylinidae	36	36.1	63.9	NS	NS
Buprestidae	30	56.7	43.3	NS	NS
Elateridae	264	50.2	49.8	0.001	NS
<i>Ampedus</i> spp.	55	65.5	34.5	NS	0.025
<i>Dalopius</i> spp.	49	53.1	46.9	NS	NS
<i>Athous</i> spp.	53	5.7	94.3	0.025	0.001
<i>Ctenicera</i> spp.	100	62.0	38.0	NS	0.025
Other spp.	8	71.4	28.6	—	—
Cantharidae	78	42.3	57.7	NS	NS
Lycidae	17	41.2	58.8	NS	NS
Cleridae	20	45.0	55.0	NS	NS
Cucujidae	17	41.2	58.8	NS	NS
Melandryidae					
<i>Xylita</i> spp.	293	44.7	55.3	0.05	NS
Curculionidae	12	53.8	46.2	NS	NS
Scolytidae	234	33.6	66.4	0.001	0.001
<i>Hylurgops reticulatus</i>	45	44.4	55.6	NS	NS
<i>Hylastes gracilis</i>	46	32.6	67.4	NS	0.025
<i>Ips latidens</i>	97	25.8	74.2	NS	0.001
<i>Trypodendron lineatum</i>	14	57.1	42.9	NS	NS
Other spp.	32	40.6	59.4	NS	NS
Other families	20	45.0	55.0	NS	NS
Total	1021	43.8	56.2	0.001	0.001

*No significant heterogeneity among replicates at $P = 0.05$ (G-test) except as noted.

†Ratio of beetles caught on non-girdled to those caught on high-girdled trees was not significantly different from 1:1 at $P = 0.05$ (pooled G-test) except as noted.

Pesticide treatment had no significant effect on the responses of *H. gracilis* and *I. latidens* to high-girdled/non-girdled trees ($P > 0.05$). Of 72 *I. latidens* responding to high-girdled trees, 33 were caught on the carbaryl-treated trees. Similarly, 21 of the 31 responding *H. gracilis* were captured on the carbaryl-treated trees. No visual evidence (i.e. frass or pitch tubes) of successful attacks was found on any trees during the summer of 1983 nor in 1984 and 1985. Therefore, we conclude that secondary attraction was not a factor in the differences in the response of *H. gracilis* and *I. latidens* and that their attraction to high-girdled lodgepole pine was primary in nature.

Werner (1972) demonstrated that *Ips grandicollis* (Eichh.) were attracted by volatile monoterpenes isolated from loblolly pine, *P. taeda* L., but did not show attraction to trees on the basis of naturally occurring volatiles. Our research is the first demonstration of primary attraction for a North American *Ips* species and the second for an *Hylastes* species.

Volatiles from either the stressed phloem below the girdles or from sap exuding at the girdles could be responsible for the observed preference. The lack of preference shown by *T. lineatum*, known to be attracted by α -pinene and ethanol (Cade *et al.* 1970; Moeck 1970, 1971; Bauer and Vité 1975; Nijholt and Schönherr 1976), may suggest that either *T. Zineatum* responds to a higher ethanol concentration or that ethanol was of little, if any, importance in the primary attraction of *H. gracilis* and/or *I. latidens*.

Attraction of both *H. gracilis* and *I. latidens* began 12-23 days after girdling but lasted less than 11 days for *H. gracilis* while *I. latidens* responded for approximately 32 days.

At the 4th site, set up in July to determine whether time of girdling would affect responses, attraction of *Zf. grucilis* began within days of girdling but lasted less than 10 days; 92 *H. grucilis* were caught on 5 high-girdled trees while only 10 were caught on the 3 controls (significantly different from an expected ratio of 5:3, $P < 0.001$). During this same period only 3 *H. grucilis* were caught on all 12 trees at a major site, less than 100 m away, across a landing.

Hylastes grucilis does attack freshly cut bolts of lodgepole pine, often in association with *I. pini* (personal observations). *Ips latidens* seems to prefer drier phloem tissue (Miller and Borden 1985). Primary attraction of *H. grucilis* may be a short-term phenomenon, probably in response to initial wound responses by the trees, whereas *I. latidens* may be responding more to the volatiles released from stressed phloem.

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