

Tamarack (Pinaceae): previously unrecorded developmental host for pine engraver and southern pine engraver (Coleoptera: Scolytidae)

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The pine engraver, *Ips pini* (Say), is broadly distributed across North America (Lanier 1972; Wood 1982; Seybold *et al.* 1995) with a host range that includes most species of *Pinus* L., and in rare cases, species of *Picea* A. Dietrich (both Pinaceae), within its range (Swaine 1918; Bright 1976; Wood 1982; Furniss and Carolin 1992). *Ips pini* has been recorded from *Pinus banksiana* Lamb., *Pinus resinosa* Ait., and *Pinus strobus* L. (eastern North America), and from three of four subspecies of *Pinus contorta* Dougl. ex Loudon [*P. c. contorta*,² *P. c. latifolia* (Engelm.) Critch., and *P. c. murrayana* (Balf.) Critch.], *Pinus coulteri* D. Don, *Pinus jeffreyi* Balf., *Pinus ponderosa* Dougl. ex P. and C. Laws., and *Pinus flexilis* James (western North America) (Furniss and Carolin 1992; Seybold *et al.* 1995). Hopping (1964) reported *I. pini* on *Picea rubens* Sarg., *Picea glauca* (Moench) Voss, and *Picea engelmannii* Parry ex Engelm. The adult insect is intermediate in length relative to most *Ips* spp., ranging from 3.3 to 4.5 mm (Hopping 1964; Bright 1976; Wood 1982; USDA Forest Service 1985).

The southern pine engraver, *Ips grandicollis* (Eichhoff), colonizes many species of *Pinus* throughout eastern North America from Saskatchewan³ (*P. banksiana*) and western South Dakota (*P. ponderosa*) (Lanier 1970) to the Atlantic Coast (*P. strobus* and *Pinus taeda* L.). It also occurs in shelterbelt stands of *P. banksiana* in Nebraska (Lanier 1970, 1987) and *Pinus sylvestris* L. in Iowa (M Shour, personal communication). The native distribution of *I. grandicollis* also reportedly includes Honduras (Lanier 1987) and the Caribbean Islands (Wood 1982; Garraway 1986; Garraway and Freeman 1990); however, Lanier (1987) maintained that the southern pine engraver on Jamaica was *Ips cribricollis* (Eichhoff). *Ips grandicollis* has also been introduced into Australia in plantations of *Pinus radiata* D. Don (Morgan 1967). Wood (1982) lists 16 species of the genus *Pinus* as hosts. The adult is more variable in length than *I. pini*, ranging from 2.8 to 4.7 mm (Swaine 1918; Hopping 1965; Bright 1976; Wood 1982; USDA Forest Service 1985).

On 17 June 2000, we examined a pile of locally cut stems of tamarack, *Larix laricina* (Du Roi) K. Koch. (Pinaceae). The 3 m long logs, which still had bark and fresh phloem, were drying in open sunlight and were destined for use as stockade posts for a re-creation of a historic fur-trading post. The locality was Folle Avoine Historical Park, about 1 km from Yellow Lake (45°56'26'N, 92°25'14'W), Burnett County, Wisconsin. The logs were being colonized by the eastern larch beetle, *Dendroctonus simplex* LeConte (Coleoptera: Scolytidae), and the whitespotted sawyer, *Monochamus scutellatus* (Say) (Coleoptera: Cerambycidae), whose females were ovipositing through

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² Specimens of *I. pini* collected in 1954 and 1955 from *P. c. contorta* near Petersburg and Ketchikan, Alaska, by WF McCambridge and in 1959 on Douglas Island, Alaska, by DE Bright are deposited in the forest insect collection of the Pacific Northwest Research Station housed in Juneau, Alaska. This host record was confirmed by us in 2001 with a collection from Douglas Island and specimens deposited in the University of Minnesota Insect Collection, St. Paul, Minnesota, and the California Academy of Sciences, San Francisco, California.

³ Specimens of *I. grandicollis* collected in 1990 from *P. banksiana* located 55 km NE of Prince Albert, Saskatchewan, by DW Langor are deposited in the California Academy of Sciences, San Francisco, California. This represents a westward extension of the published distribution (Lanier 1970; Bright 1976; Wood 1982; Lanier 1987).

the bark surface. The bark crevices of the logs had piles of finely graded, reddish brown boring dust, and removal of the bark revealed nascent galleries with adult *Ips* spp., and eggs. Six parent adults of *I. pini* were collected (5 females, 1 male). On 30 June 2000, three of the logs were each cut into three 1-m pieces and transported to the University of Minnesota, St. Paul, where they were placed into emergence cages and reared at 30–32°C (Browne 1972).

Six adult *I. pini* and two adult *I. grandicollis* emerged within several weeks of the time that the logs were placed in the cage. These were likely re-emerging parent adults. During August, September, and December seven additional adults of *I. pini* and three additional adults of *I. grandicollis* also emerged. The lighter reddish brown coloration of the cuticle of these adults and the time to emergence suggested that they were progeny of the original parents. Between June and August 2001, the logs were dissected and nine additional parental *I. pini* and one additional progeny adult each of *I. pini* and *I. grandicollis* were recovered from beneath the bark. In this case, parents were found in the egg galleries and progeny at the periphery of the gallery at the end of larval mines. In total, 29 specimens of *I. pini* and 6 specimens of *I. grandicollis* were found in association with *L. laricina*. Dissection of the logs revealed galleries of *Ips* spp. that had been aborted during various stages of construction (e.g., nuptial chamber only, incompletely extended egg galleries). These aborted galleries appeared to be filled or rimmed with dried oleoresin, indicating a physical defense response by the tree tissue. Completed galleries of *Ips* spp. with egg niches, larval mines, and pupal cells were also present under the bark and emergence holes were present on the bark surface. Roundheaded borer larvae (likely *M. scutellatus*) had extensively mined the phloem and outer xylem, likely killing many of the *Ips* spp. larvae in their path. Host defense and predation may have limited the development and emergence of *Ips* spp. from *L. laricina*.

The emergence of progeny adult *I. pini* and *I. grandicollis* from the colonized logs and the presence of completed larval mines and emergence holes in the logs are evidence that these *Ips* spp. can develop in *L. laricina*. Further, we observed that these new adults were generally smaller than the parental adults, suggesting that development in *L. laricina* was not optimal relative to *Pinus* spp. hosts. To test this hypothesis, we measured body lengths of adult *Ips* from *L. laricina*, *P. c. contorta* (Alaska, Juneau Borough, 58°31'N, 134°37'W) (*I. pini* only), *P. ponderosa* / *P. jeffreyi* (California, Lassen County, 40°43'3''N, 121°11'11''W; 40°37'N, 120°55'54''W; 40°47'N, 121°17'32''W) (*I. pini* only), and *P. resinosa* (Wisconsin, Dunn County, 45°7'N, 91°46'W). Measurements were made in dorsal view from the head to the apex of the elytra using an ocular micrometer. A two-sample *t* test assuming equal variances among populations was performed to test the null hypothesis (H_0) that there are no differences in the body lengths of parent and progeny (F_1) adults (Minitab Inc 1995).

Mean lengths of *I. pini* collected from *L. laricina* (Table 1) and three *Pinus* spp. all fell within the published length range (3.3–4.5 mm); however, lengths of one progeny male that developed in *L. laricina* and one that developed in *P. resinosa* were outside this range (2.96 mm). *Ips grandicollis* in *L. laricina* (Table 1) and in *P. resinosa* also had mean lengths that fell within the published range (2.8–4.7 mm). Three female and 9 male parents, and 2 female and 11 male progeny from *P. resinosa* exceeded 4.7 mm (range of all specimens, 3.56–5.20 mm). Because it had been damaged, we were unable to determine the sex and measure the length of one of the six specimens of *I. grandicollis* from *L. laricina*.

In *L. laricina*, parental male *I. pini* were longer than progeny male *I. pini* and the body length difference was different from zero ($t_8 = 4.65$, $P = 0.0017$). This was not the case for females ($t_{17} = 0.93$, $P = 0.37$). Lengths of parental and progeny adult *I. pini* from *P. resinosa* were different for both males ($t_{75} = 4.12$, $P = 0.0001$) and females ($t_{86} = 4.50$, $P < 0.0001$). There were no differences in body lengths of parental and progeny

TABLE 1. Lengths of *Ips pini* and *Ips grandicollis* collected from *Larix laricina*.

	Generation*	n	Length (mm)	
			Mean ± SE	Range
<i>Ips pini</i>				
Female	P	16	3.95±0.07	3.28–4.26
Male	P	4	4.22±0.12	3.88–4.40
Female + male	P	20	4.01±0.06	3.28–4.40
Female	F ₁	3	3.79±0.17	3.60–4.12
Male	F ₁	6	3.36±0.13	2.96–3.92
Female + male	F ₁	9	3.50±0.12	2.96–4.12
<i>Ips grandicollis</i>				
Female	P	2	4.34±0.26	4.08–4.60
Male	F ₁	3	3.49±0.07	3.36–3.56

* P is the parental generation and F₁ is the progeny generation.

I. grandicollis males ($t_{67} = 1.88$, $P = 0.065$) or females ($t_{44} = 1.10$, $P = 0.28$) from *P. resinosa*. The sizes of several parent–progeny pairs could not be compared because we did not have both of the members of the pair (*I. pini* from Alaska and California lacked parental adults of either sex; *I. grandicollis* from *L. laricina* lacked male parents and female progeny).

These results suggest that the progenies of *I. pini* reared from both *L. laricina* and *P. resinosa* were generally shorter than their respective parents. Although we expected only the progeny from *L. laricina* to be shorter than their parents, brood logs of both *L. laricina* and *P. resinosa* were reared in greenhouse emergence cages where consistently high temperature and low moisture may have contributed to suboptimal development of *I. pini* in both hosts. Rearing conditions do not completely explain the differences. *Ips grandicollis* were reared identically (and from the same *P. resinosa* logs) and there were no differences between the lengths of parents and progeny for either sex of this species.

This study demonstrates that *I. pini* and *I. grandicollis* can colonize and reproduce in *L. laricina*. This finding is not unexpected because the genera *Larix* and *Pinus* belong to the same family, and because several Eurasian species of *Ips* colonize *Larix* spp. (Wood and Bright 1992), in particular *Ips cembrae* (Heer) which has been recorded from at least 3 *Larix* spp. (Pfeffer 1995). Although no North American *Ips* spp. have been reported from *Larix* before, *Orthotomicus caelatus* (Eichhoff), a pine- and spruce-infesting scolytid that is closely related to *Ips* spp. (Bright 1976; Wood 1982), has also been reported to colonize *L. laricina* (Dodge 1938). We also recently observed *O. caelatus* colonizing a small fallen tree of *L. laricina* in northern Minnesota. Our study suggests that host selection and successful colonization by some scolytids is perhaps more flexible than has been previously recorded in the literature.

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