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Ambrosia Beetles: A Multimillion Dollar Degrade Problem of Sawlogs in Coastal British Columbia

by

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Abstract

Ambrosia beetle degrade of sawlogs processed through the Vancouver log market in 1980/81 is calculated to be C\$63.7 million. Similar losses can be expected in the future unless there are major changes in log inventory management. *Gnathotrichus sulcatus* was shown to penetrate Douglas-fir and western hemlock logs 3 cm and 8 cm respectively. The comparable figures for *Trypodendron lineatum* are 3 cm and 4 cm respectively. Factors that lead to the build up of ambrosia beetle populations in forest settings and processing areas must be identified to ensure maximum clearwood yield from logs.

Résumé

La dégradation des billes de sciage qui passent par le marché du bois de Vancouver est évaluée pour l'année 1980-1981 à 63,7 millions \$. On peut s'attendre à des pertes semblables dans le futur si des changements majeurs ne surviennent pas dans la gestion de l'inventaire des billes. *Gnathotrichus sulcatus* a pénétré les billes de Douglas taxifolié de 3 cm, et de pruche occidentale de 8 cm. Les résultats respectifs pour *Trypodendron lineatum* sont de 3 et 5 cm. Les facteurs qui causent l'accroissement des populations des scolytes du bois dans les régions d'exploitation et les installations forestières doivent être identifiés afin d'assurer un rendement ligneux maximum provenant des billes.

The knot-free clear outer wood of logs from the conifer forests of coastal British Columbia produces the highest value grades of lumber for the West Coast forestry industry. This clear wood also produces the high quality veneer desired for surfacing plywood. This same high value wood is also the preferred home of several species of ambrosia beetle, some of which can attack logs within a few weeks of felling.

In the first formal survey of forest insects in British Columbia, Swaine (1914) listed *Gnathotrichus sulcatus* (LeConte), *G. retusus* (LeConte) and *Platypus wilsoni* Swaine as the major damaging species. More recently *Trypodendron lineatum* (Olivier) has been recognized as the most abundant and damaging species of ambrosia beetle (Nijholt 1975). Ambrosia beetles carry symbiotic fungi into their galleries. Soon after a successful ambrosia beetle attack has been initiated on a log the dark staining fungi spread throughout the wood around each gallery to make a conspicuous pinhole (Fig. 1). When these logs are processed, the pinholes show clearly on the surfaces of boards (Fig. 2) and veneer (Fig. 3). Pinholes in lumber and plywood downgrade products to con-

struction grades and core stock, respectively. Offshore export markets will not pay premium prices for logs or lumber with pinholes.

The coastal forest industry relies on producing a steady proportion of clear lumber to realize full value from sawlogs. Ambrosia beetles can reduce this percentage from an expected 15-20% to a 0-4% level (McBride and Kinghorn 1960). An updated analysis of the McBride and Kinghorn study by Dobie (1978) showed that lumber cut from moderately-attacked logs was downgraded by up to \$3.4/m³ and \$8.22/m³ for Douglas-fir and western hemlock respectively.

The objective of this paper is to explore the attack depth parameters of the two most common ambrosia beetles, *T. lineatum* and *G. sulcatus*, on Douglas-fir and western hemlock and to estimate annual losses caused by these beetles to the coastal forest industry of British Columbia.

Methods

Four 50-cm sections were collected from each of eight western hemlock and eight Douglas-fir logs attacked by *G. sulcatus* at the UBC Research Forest in Maple Ridge, B.C. and

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Figures 1-3. Ambrosia beetle galleries in: 1. log, 2. tangential face of cut lumber, and 3. plywood veneer, showing the visual degrade associated with intersected galleries. Note the dark stain around each gallery that is produced by the symbiotic ambrosia fungi.

split into quarters. The depths of penetration of galleries on the radial faces (Fig. 4) were measured, a frequency histogram constructed, and the 95 percentile limits indicated. The results were compared with those reported by Prebble and Graham (1957) for *T. lineatum*. These data were applied to log volumes moving through the Vancouver log market in 1980-81 (Ministry of Forests 1981) and a total degrade value loss estimated.

Figure 4. Radial surface of a split western hemlock log showing pinholes at various depths into the log. Note that beetles make their galleries within the softer spring wood.

Results and Discussion

The frequency histograms for *T. lineatum* and *G. sulcatus* show the depths to which these beetles can penetrate in their two major hosts (Fig. 5). Depth of penetration by *T. lineatum* in Douglas-fir was 3 cm and in western hemlock 4 cm (95 percentile point). Comparable data for *G. sulcatus* showed a penetration of 3 cm in Douglas-fir and 8 cm in western hemlock (Fig. 5). Galleries in Douglas-fir logs do not extend beyond the sapwood, but the moister wood of western hemlock supports deeper gallery formation by both species of ambrosia beetles.

Ambrosia beetle penetration into a log causes the outer slabs to be downgraded (Fig. 6). With deeper galleries, as in western hemlock, the damage is much greater; the second board is frequently infested (Fig. 6); and remanufacture of pieces may be required (Richmond 1968). A measure of the proportion of a log degraded by ambrosia beetle attack can be made by considering the percentage of wood infested in a standard log (Table 1). In western hemlock logs, up to 64% of the volume, including the outer clear lumber, can be degraded by *G. sulcatus* (Table 1).

What are the effects of pinhole degrade on the value of sawlogs sold in the Vancouver log market? In 1980/81 some 18 million m³ of wood are calculated to have passed through this market (Table 2). According to Chow,² an average of 30% of the logs processed in Vancouver sawmills have been attacked by ambrosia beetles (Table 3). Mass-trapping studies on Vancouver Island by Phero Tech Ltd.³ showed that 92% of eight million beetles captured at several locations on Vancouver Island in 1983 were *T. lineatum* and 8% *G. sulcatus*. An estimate of the volume of infested wood, obtained by applying the specific beetle degrade parameters (Table 1) to the proportions of volumes in Table 2 damaged by beetles, is 1.38 million m³/yr. This equates to an aggregated loss to the coastal forest industry of \$63.7 million/yr (Table 3).

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Figure 5. Depth of attack of the ambrosia beetles *Trypodendron lineatum* and *Gnathotrichus sulcatus* on western hemlock and Douglas-fir as determined from radial surfaces of split logs. *T. lineatum* data modified after Prebble and Graham

(1957). Arrows indicate 95 percentile point of frequency histogram. *G. sulcatus* data based on 1032 and 718 pin-holes in the western hemlock and Douglas-fir samples respectively.

Table 1. Impact of ambrosia beetles on Douglas-fir and western hemlock logs of standard dimensions.

Host	Beetle	Depth of penetration (cm)	Volume of log ¹ degraded (m ³)	Log volume degraded (%)
Douglas-fir	<i>T. lineatum</i>	3.0	0.34	28
	<i>G. sulcatus</i>	3.0	0.34	28
Western Hemlock	<i>T. lineatum</i>	4.0	0.44	36
	<i>G. sulcatus</i>	8.0	0.78	64

¹Standard log defined as 10 m long, 44 cm basal diameter, 34 cm top diameter, volume 1.214 m³

Table 2. Volumes of fir and hemlock logs scaled to the Vancouver log market 1980-81 in the coastal Vancouver and Prince Rupert Regions.

Log species	Millions m ³				Volumes sawlogs ⁴
	Vancouver (C) ²	Prince Rupert (C) ² (50%)	Private Land and Old Temporary Tenures ³	Total volumes	
Fir ¹	1.471	0.046	1.039	2.556	2.300
Hemlock	5.074	0.948	4.124	10.146	6.595
Balsam	2.857	0.312	2.170	5.339	3.791
Hemlock	7.931	1.260	6.294	15.485	10.386
Total volume	9.402	1.306	7.333	18.041	12.686

¹Log species indicated as per BC Forest Service nomenclature: fir, Douglas-fir; hemlock, mountain hemlock and western hemlock; balsam, *Abies* spp.; hemlock, hemlock plus balsam.

²Taken from BC Ministry of Forests Annual Report 1980-81, Table C3, p. 37.

³Ibid, Table C5, p. 38. Proportion from coastal Vancouver Region computed as 0.965 as per Table C3. Species allocation assigned in proportion to combined volumes in columns 1 and 2.

⁴Proportions assigned as sawlogs: fir 0.9, hemlock 0.65, balsam 0.71.

Table 3. Impact of ambrosia beetles on the log volumes handled by the Vancouver log market in 1980/81.

Log ¹ species	Volume scaled in 1980-81 (millions m ³) ²	Volume infested ³ (000 m ³)	Proportion of log volume degraded ⁴	Volume degraded (m ³)	% of total volume degraded
Fir	2 3000	690.0	0.28 (T.I./G.s.) ⁵	193 200	14.0
Hemlock	6 595				
Balsam	3 791				
Total hembal	10 386	3115.8	0.92 ⁵ × 0.36 (T.I.) 0.08 ⁵ × 0.64 (G.s.)	1 031 953 159 529	74.5 11.5
				1 384 682	100.0

Loss on 1 384 682 m³ @ \$46.00⁶ = \$63 695 400

¹Tree species as per Table 2, footnote a.

²From Table 2.

³Based on 30%-infestation — S. Chow, Canadian Forest Products Ltd., pers. com., and 35% (Gray and Borden 1984) — corroborated. Figures in this column represent Column 2 × 0.30.

⁴See Table 1, T.I. = *Trypodendron lineatum*, G.s. = *Gnathotrichus sulcatus*. For fir, both ambrosia beetles penetrate to the same depth. Varying attack depths of hembal by the two ambrosia beetles has necessitated an adjustment relative to the abundance of each beetle species.

⁵Relative species abundance from report "Ambrosia Beetle" — Phero Tech Ltd. (formerly PMG/Stratford Ltd.), Vancouver, 1983.

⁶Industrial recovery from outer portion of log; 1 m³ wood = 230 fbm; loss of \$200/M fbm equivalent to \$46/m³.

Figure 6. Cross-section of a 53-cm (24 inch) diameter log showing a typical sawing pattern, pieces affected by 3 cm or 8 cm depth of penetration by ambrosia beetles. Dotted lines indicate possible remanufacture options. Knots represented diagrammatically in the core. Df = Douglas-fir, western hemlock, and G.s. = *Gnathotrichus sulcatus*.

Degrade by ambrosia beetles is clearly an important factor reducing profits of forest companies. Companies that minimize felled and bucked inventories and reduce the time between felling and delivery to the sawmill, will suffer the lowest losses. There are opportunities to prevent attack by ambrosia beetles by water misting (Richmond and Nijholt 1972) and by mass trapping using semiochemical-baited traps (Borden and McLean 1980; Lindgren and Borden 1983; Shore 1982). Beetle attacks on stored logs may also be reduced by applying pine oil (Nijholt 1980).

The outer clear wood in old growth coastal logs is one of the few competitive advantages for coastal sawmilling compared with the interior industry with its lower logging costs. Future coastal sawmilling strategy will focus even more on

developing clear wood products. It is vital that ambrosia beetle damage be brought under control if the full potential of this strategy is to be realised. Losses of the scale indicated in this study represent many lost revenue opportunities for sawmill modernization, profit, and hence taxes to federal and provincial governments, or survival of the industry. Further studies of ambrosia beetle populations in forest settings should be undertaken to gain an understanding of practices that exacerbate the problem with a view to identifying procedures to minimize ambrosia beetle population buildup in the woods.

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