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# Root Deformation Reduces Tolerance of Lodgepole Pine to Attack by Warren Root Collar Weevil

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**ABSTRACT** Surveys were conducted on regenerating stands of lodgepole pine to determine the relationship between root deformation and susceptibility to attack by the Warren root collar weevil, *Hylobius warreni* Wood. The total number of trees attacked by *H. warreni* did not differ between planted and natural trees. A matched case-control logistic regression suggested that root cross-sectional area was more important in predicting weevil attack for naturally regenerated trees than for planted trees, but weevils were associated with a larger reduction in height-to-diameter ratios for trees with planted root characteristics than for trees with natural root form. Neither the stability of attacked versus unattacked trees differed significantly and there was no significant interaction of weevil attack and tree type, but weevil-killed trees had different root characteristics than alive, attacked trees. Lateral distribution and root cross-sectional area were significant predictors of alive attacked trees versus weevil-killed trees, suggesting that trees with poor lateral spread or poor root cross-sectional area are more likely to die from weevil attack. We conclude that root deformation does not necessarily increase susceptibility to attack but may increase the likelihood of mortality. Thus, measures to facilitate good root form are needed when planting pine in areas with high risk of Warren root collar weevil attack.

**KEY WORDS** *Pinus contorta*, root form, forest regeneration, tree stability, *Hylobius warreni*

The Warren root collar weevil, *Hylobius warreni* Wood (Coleoptera: Curculionidae), a flightless, long-lived weevil native to the boreal and sub-boreal conifer forests of North America (Cerezke 1994), is widespread throughout the central interior of British Columbia. It has the potential to become an important pest as regeneration of its primary host, lodgepole pine, *Pinus contorta* Dougl. variety *latifolia* Engl., increases (Schroff et al. 2006), particularly in the aftermath of a huge outbreak of the mountain pine beetle, *Dendroctonus ponderosae* Hopkins (Coleoptera: Curculionidae: Scolytinae) (Klingenburg 2008, Kurtz et al. 2008). Lodgepole pine is the dominant conifer in central British Columbia and has been extensively planted over the past decade. Thus, many existing plantations in this area are now at a susceptible age.

Eggs are laid at or on the root collar of major roots, and larvae feed on phloem in the living tree (Cerezke 1994). Development from egg to adult normally takes 2 yr, and extensive girdling can occur on smaller trees. Weevil attacks occur on lodgepole pine of all ages, but are most evident on 5- to 20-yr-old trees because of impacts on growth and mortality. Young trees severely affected by Warren root collar weevil exhibit aboveground growth reduction and decreased root diameter growth (Cerezke 1974), often leading to instability (Cerezke 1994). Significantly, reduced height and diameter increment occurs when girdling by weevil larvae exceeds 60–80% of the circumference of the stem (Cerezke 1994). Despite these growth losses, the insect is not considered a major pest in lodgepole pine plantations, because mortality caused by weevil attack is usually limited (Cerezke 1974).

Even though there is evidence to suggest a possible link between root development problems and attack by insects, there are no quantitative or qualitative data collected from planted trees to directly verify the effect of root development problems on Warren root collar weevil host choice. Hay and Woods (1978) and Graham and Bormann (1966) (cited in Van Eerden 1978) showed that root deformation, as can occur in planted trees (Robert and Lindgren 2006), serves as an impediment to carbohydrate transport toward the tip of the taproot. Root deformation that inhibits translocation of water and nutrients may alter the susceptibility of trees to attack by insects such as the Warren root collar weevil. The research presented here was conducted based on our observations that planted lodgepole pine trees with severe spiral root seemeded more likely to support infestations of weevil larvae. Weevil attack on J-rooted trees also appeared to occur more frequently or to cause more severe damage than

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