PINE WEEVIL (Hylobius abietis) ANTIFEEADANTS FROM LODGEPOLE PINE (Pinus contorta)

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Abstract—Pine weevils (Hylobius abietis) fed less on bark of lodgepole pine (Pinus contorta) than on bark of Scots pine (P. sylvestris). Two pine weevil antifeedants, ethyl trans-cinnamate and ethyl 2,3-dibromo-3-phenyl-propanoate, were isolated from bark of lodgepole pine. These two compounds significantly reduced pine weevil feeding in a laboratory bioassay. In field assays, the second compound significantly decreased pine weevil damage on planted seedlings. Ethyl 2,3-dibromo-3-phenylpropanoate has not previously been reported as a natural product.

Key Words—Antifeedant, ethyl 2,3-dibromo-3-phenylpropanoate, ethyl trans-cinnamate, Hylobius abietis, lodgepole pine, pine weevil, Pinus contorta, Pinus sylvestris, Scots pine.

INTRODUCTION

Seedling mortality resulting from stem-feeding by adult Hylobius weevils (Col., Curculionidae) is a major silvicultural problem wherever clear-felling followed by planting of conifer seedlings is practiced in temperate regions of the Northern Hemisphere. All over Europe, the pine weevil Hylobius abietis (L.) is the principal noxious species, and seedling mortality due to this insect leads to considerable economic loss. Permethrin has been used to control pine weevil damage in

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Sweden, but the use of insecticides for this purpose will soon be prohibited. Alternative measures to manage the pine weevil problem are, therefore, urgently needed.

There is strong evidence that plants have evolved defense systems against predators and that these systems, to a large extent, are based on the production of secondary metabolites (Rosenthal, 1986; Harborne, 1988, and references therein; Sunnerheim-Sjöberg, 1991; Daurade-Le Vaugueresse and Bounias, 1992; Suga et al., 1993). Even high priority food plants produce defense compounds against herbivores—presumably to prevent overbrowsing. Although the polyphagous pine weevil prefers pines to a multitude of other plant species (Eidmann, 1974), pines can be expected to contain some antifeedants against pine weevils. However, different species of pines and different parts of a pine tree may contain varying amounts of defense compounds.

Preliminary feeding tests indicated that pine weevils fed less on bark from lodgepole pine, *Pinus contorta*, than on bark from Scots pine, *P. sylvestris*. This result prompted us to look for compounds possessing antifeedant activity derived from *P. contorta*. Scots pine is the most abundant native pine species in Sweden. Lodgepole pine has been introduced from North America and planted on large areas in northern Sweden.

The aims of this study were to determine if compounds (either endogenous or spontaneously modified) possessing antifeedant activity could be isolated from coniferous hosts, and if these compounds could be exploited to reduce weevil damage. We:

• compared the feeding preference of *H. abietis* for bark from Scots and Lodgepole pine;
• isolated, identified, and bioassayed two antifeedants, ethyl trans-cinnamate (1) and ethyl 2,3-dibromo-3-phenylpropanoate (2), from Lodgepole pine;
• performed syntheses and field trials of compound (2).

**METHODS AND MATERIALS**

*Plant Material.* Stem samples of lodgepole and Scots pine were collected from plantations in northern Uppland (seed sources unknown). All fractions and extracts were subjected to feeding trials, and the results were used for selection of fractions for further fractionation. Fresh inner bark (500 g) was cut into small pieces and extracted in methanol for 24 hr. The extract was filtered, and the plant residue was discharged. The methanol was evaporated, keeping the temperature below 40°C. Water (200 ml) was added, and the suspension extracted with pentane (2 × 150 ml) followed by ethyl acetate (2 × 150 ml). The pentane and ethyl acetate fractions were dried over MgSO₄, and solvent was evaporated. Extracts of *P. sylvestris* were obtained in the same manner as described for *P. contorta*. 