

Identification and Field Activity of a Male-Produced Aggregation Pheromone in the Pine Sawyer Beetle, *Monochamus galloprovincialis*

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Abstract The pine sawyer beetle, *Monochamus galloprovincialis*, is a pest of pine trees in Europe and North Africa. Previously considered a secondary pest of stressed and dying trees, it is now receiving considerable attention as a vector of the pine wood nematode, *Bursaphelenchus xylophilus*, the causal agent of a lethal wilting disease in susceptible species of pines. Adult beetles are attracted to traps baited with a kairomone blend consisting of a host volatile, α -pinene, and two bark beetle pheromone components, ipsenol and 2-methyl-3-buten-2-ol. More recently it has been shown that mature male *M. galloprovincialis* produce a pheromone that attracts mature females in a laboratory bioassay. Here, volatiles were collected from mature male and female *M. galloprovincialis*, and a compound produced specifically by mature males was identified as 2-undecyloxy-1-ethanol from its gas chromatographic retention times, its mass spectrum, and by comparison with synthetic standards. The naturally-derived and synthetic compounds elicited electroantennographic responses from both females and males. Sealed polyethyl-

ene vials and polyethylene sachets were shown to be effective dispensers with zero-order release, the latter giving a higher release rate than the former. In two field tests, multiple-funnel traps baited with synthetic 2-undecyloxy-1-ethanol caught both female and male *M. galloprovincialis*, with higher catches at the higher release rate. This compound also synergized the attractiveness of the kairomone blend, the combined mixture catching 80–140% more beetles than the sum of the catches to each bait separately and luring up to two beetles/trap/d in a moderate-density population. We conclude that 2-undecyloxy-1-ethanol is a male-produced aggregation pheromone of *M. galloprovincialis*. This is the first example of a sex-specific compound in the cerambycid subfamily Lamiinae with significant behavioral activity in the field at a range sufficient to make it a useful trap bait. The possible roles of this pheromone in the chemical ecology of *M. galloprovincialis* and its potential use in pine wilt disease management are discussed.

Key Words Aggregation pheromone · *Bursaphelenchus xylophilus* · Cerambycidae · Ethers · Gas chromatography-electroantennographic recording · Kairomone · Lamiinae · Monochaminae · *Monochamus galloprovincialis* · Pine sawyer · Pine wilt disease · Pine wood nematode · Trapping · 2-Undecyloxy-1-ethanol

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Introduction

Woodboring beetles of the genus *Monochamus* Dejean (Coleoptera: Cerambycidae) comprise a group of species in which the larvae usually colonize woody plants that are dead, dying, or severely stressed. As such they can be considered secondary pests included in the stressed or dead