

# (S)-2-Acetoxy-5-Undecanone, Female Sex Pheromone of the Raspberry Cane Midge, *Resseliella theobaldi* (Barnes)

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**Abstract** The raspberry cane midge, *Resseliella theobaldi*, is a widespread pest of cultivated red raspberry in Europe. Pheromone-baited traps could provide a much-needed, accurate means to monitor the pest. Volatiles collected separately from virgin female and male midges were analyzed by gas chromatography (GC) coupled to mass spectrometry (MS) to reveal four female-specific components. In analyses by GC coupled to electroantennographic (EAG) recording from the antennae of a male midge, at least three of these components elicited responses. Based on its GC retention indices and mass spectrum, we propose that the major component is 2-acetoxy-5-undecanone and confirm this by synthesis of the racemic compound in seven steps and 63% yield from 4-pentenoic acid. The three minor

components were each present at approximately 30% of the major component and were identified as 2-undecanone, (S)-2-acetoxyundecane, and (S)-2-undecanol by comparison of GC retention times and mass spectra with those of synthetic standards. GC analyses of the female-produced volatiles on an enantioselective column showed that only one enantiomer of 2-acetoxy-5-undecanone was present, and this was found to be the S-enantiomer by hydrolytic kinetic resolution of an epoxide intermediate in the synthesis and also by enantioselective hydrolysis of the racemic acetate with a lipase enzyme. The two enantiomers were also separated by high-performance liquid chromatography on an enantioselective column for field tests. In two field trapping tests, (S)-2-acetoxy-5-undecanone was highly attractive to male *R. theobaldi*; the R-enantiomer was not attractive. The racemic compound was just as attractive as the S-enantiomer, and addition of the three minor components in racemic form at two different loads did not affect catches. The pheromone could be dispensed from both rubber septa and polyethylene vials for at least 1 month under field conditions, but the former was preferred as it gave more uniform release. 2-Acetoxy-5-undecanone belongs to a new group of pheromone structures in the Cecidomyiidae, most others being mono- or diesters.

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2-Undecanone

## Introduction

The raspberry cane midge, *Resseliella theobaldi* Barnes (Diptera: Cecidomyiidae), is a widespread pest of cultivated