

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

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Abstract Raspberry cane midge, *Resseliella theobaldi*, is a widespread pest of cultivated red raspberry in Europe. There is a need for more accurate means to monitor the pest and pheromone traps could provide this. Volatiles were collected from virgin female and virgin male midges separately by air entrainment. Analysis by gas chromatography (GC) coupled to mass spectrometry showed four female-specific components. In analyses by GC coupled to electroantennographic recording from the antennae of a male midge, at least three of these elicited EAG responses. The three minor components were present at approximately 30% of the major component and were identified as 2-undecanone, 2-acetoxyundecane and 2-undecanol by comparison of GC retention times and mass spectra with those of synthetic standards. The major component was proposed to be 2-acetoxy-5-undecanone on the basis of its GC retention indices and mass spectrum, and this was confirmed by synthesis of the racemic compound in seven steps and 67% yield from 4-pentenoic acid. GC analyses of pheromone collections on a chiral cyclodextrin 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 a chiral column for field tests. The 2-acetoxyundecane and 2-undecanol in pheromone collections were similarly shown to be the

S enantiomers. In two field trapping tests (*S*)-2-acetoxy-5-undecanone was highly attractive to male *R. theobaldi* and the *R* enantiomer was unattractive. The racemic compound was just as attractive as the *S* enantiomer and addition of the three minor components in racemic form at three different overall loadings did not affect catches. The pheromone could be dispensed from both rubber septa and polyethylene vials for at least one month under field conditions, but the former was preferred as it gave a more uniform release. 2-Acetoxy-5-undecanone belongs to a new group of pheromone structures in the Cecidomyiidae, most others being mono- or di-esters.

Keywords raspberry cane midge, *Resseliella theobaldi*, Cecidomyiidae, sex pheromone, 2-acetoxy-5-undecanone, 2-undecanone, 2-acetoxyundecane, 2-undecanol, pheromone trap