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## Association of two co-occurring mutations at the *AvrMlp7* avirulence locus in poplar rust during the breakdown of *RMlp7* resistance gene

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### ABSTRACT

The deployment of plant varieties carrying resistance (*R*) genes exerts strong selection pressures towards pathogen populations. Several studies reported the rapid evolution of avirulence (*Avr*) genes to escape *R*-mediated plant immunity and identified a variety of mechanisms leading to virulence. The poplar rust fungus *Melampsora larici-populina* is the most damaging pathogen of poplars. A major adaptive event occurred in 1994 with the breakdown of *RMlp7* resistance gene in poplar. Population genomics studies identified a locus in the genome of *M. larici-populina*, which likely corresponds to the *AvrMlp7* candidate avirulence gene. We used a population genetics approach combined with dedicated qPCR assays on a comprehensive set of 281 isolates, covering 27 years (encompassing the resistance breakdown event), to validate the candidate locus and to assess its polymorphism. We found two mechanisms, a point mutation and a deletion, that allowed the pathogen to escape *RMlp7*-mediated resistance. Six diploid genotypes were thus characterized at the candidate locus (three avirulent and three virulent). In addition, a temporal analysis revealed that the two virulence alleles pre-existed (harboured as avirulent heterozygous genotypes) since the early samplings and were found in association (as virulent genotypes) at the time of the resistance breakdown. Our study documented that, in a diploid pathogen, combining virulence determinisms is adaptive.

### Keywords

*Melampsora larici-populina*, molecular evolution, gene-for-gene interaction, pathogen, fungi