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# Isogamous, hermaphroditic inheritance of mitochondrion-encoded resistance to Qo inhibitor fungicides in *Blumeria graminis* f. sp. *tritici*

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**Abstract**

A mutation of glycine to alanine at position 143 in the mitochondrial cytochrome *b* amino acid sequence of *Blumeria graminis* f. sp. *tritici* cosegregated with the QoI-resistant phenotype in a ratio of 1:1 in a cross between a sensitive and a resistant isolate. This mutation was used as a mitochondrial marker to determine whether mitochondrial inheritance in *B. graminis* was anisogamous, as in heterothallic *Neurospora* sp., or isogamous and hermaphroditic, as in *Aspergillus nidulans*. Segregation of mitochondrial genotypes in *B. graminis* f. sp. *tritici* was consistent with inheritance of mitochondria being hermaphroditic and isogamous, in that all ascospores from an individual cleistothecium had the same mitochondrial genotype and that either parent could act as the maternal parent of a cleistothecium. Within each cleistothecium, nuclear segregation occurred independently of mitochondrial inheritance, as shown by segregation of resistance to the fungicide triadimenol and by segregation of avirulences to the wheat cultivars Galahad (*Pm*2), Armada (*Pm*4b), and Holger (*Pm*6). 

*Keywords:* *Blumeria graminis*; *Erysiphe graminis*; Mitochondria; Hermaphrodite; Isogamous; Strobilurin fungicides; Wheat powdery mildew

## 1. Introduction

*Blumeria graminis* [DC] f. sp. *tritici* E.O. Speer (synonym *Erysiphe graminis* DC Em. Marchal) is an obligate plant pathogenic fungus, which causes powdery mildew disease of wheat. Like most Ascomycetes, the sexual cycle of this heterothallic fungus is poorly characterized at both the molecular and the morphological levels. Formation of the pseudoantheridium and pseudoascogonium and events leading to ascus formation were described for related Erysiphales in the first half of the last century using light microscopy (Harper, 1905; Colson, 1938). However, neither these studies nor any others addressed the question of mitochondrial inheritance in the Erysiphales. Mitochondrial inheritance is non-Mendelian and in fungi there is a tendency for mitochondria to be transmitted uniparentally with a preference for maternal inheritance (reviewed by Griffiths, 1996; Röhr et al., 1999). Ascomycete fungi have one of two modes of inheritance of mitochondria. In species with uniparental, anisogamous inheritance of mitochondria, such as heterothallic *Neurospora* species, isolates produce either antheridia or ascogonia, with the maternal parent contributing the bulk of the cytoplasm, and hence the mitochondria, to the progeny (Griffiths, 1996). The paternal parent contributes only its nucleus to the protoperithecium, which results in all the progeny having the maternal mitochondrial genotype. Alternatively, mitochondria may be inherited in a hermaphroditic, isogamous manner where either parent can act as female, as in *Aspergillus nidulans* (Coenen et al., 1996). All ascospores within a perithecium therefore have the same mitochondrial type while individual perithecia vary. This results in a 1:1 segregation ratio of mitochondrial genotypes among the progeny if each parent is equally likely to be the female parent of a perithecium. These two modes of mitochondrial inheritance can be

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