

# Distribution and reproductive effects of *Wolbachia* in stalk-eyed flies (Diptera: Diopsidae)

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*Wolbachia* are cytoplasmically inherited bacteria capable of altering the reproductive biology of their hosts in a manner which increases their spread within a population. These microbes can cause cytoplasmic incompatibility, parthenogenesis and feminization of genetic males. Because *Wolbachia* have been associated with female-biased sex ratio distortion, we used a PCR assay to examine 17 species of stalk-eyed flies (Diptera: Diopsidae), two of which exhibit female-biased sex ratios, for the presence of these microbes. Type A *Wolbachia* was detected in four diopsid species, three from the genus *Sphyracephala*, none of which exhibit biased progeny sex ratios. The reproductive effects of the microbe were examined in one of those species, *S. beccarii*, by conducting reciprocal crosses between infected and uninfected strains. In this species, *Wolbachia* do not cause detectable cytoplasmic incompatibility or reduce host fecundity. In contrast, our results are consistent with an association between the microbes and enhanced male fertility. Possible explanations for the pattern of distribution and effects on male fertility include a predisposition for acquiring Type A *Wolbachia* by these flies and accommodation by the host genome to bacterial presence.

**Keywords:** cytoplasmic bacteria, Diopsidae, *Sphyracephala*, stalk-eyed flies.

## Introduction

*Wolbachia* are a monophyletic group of proteobacteria with two major divisions, Type A and B, which have been associated with a wide range of reproductive changes in arthropods (Werren *et al.*, 1995a). They are primarily found within the cells of the gonadal tissues of infected individuals (O'Neill, 1995) and are typically inherited by vertical transmission through the maternal cytoplasm (Hoffmann & Turelli, 1988). Horizontal transmission, especially of Type A *Wolbachia*, is believed to play an important role in spreading the infection between species and maintaining phylogenetically similar strains in diverse Orders of arthropods (Werren *et al.*, 1995b). *Wolbachia* have not been found extracellularly and their existence and proliferation appear to be intimately linked with that of their arthropod hosts (O'Neill, 1995).

*Wolbachia* typically alter the reproductive biology of their hosts in a manner which ultimately

promotes the spread of the microorganisms. The effects of *Wolbachia* infection include unidirectional and bidirectional cytoplasmic incompatibility (CI), parthenogenesis, and feminization of genetic males (see Werren, 1997 for review). *Wolbachia* can have either positive effects on host fecundity (Girin & Bouletreau, 1995; Stolk & Stouthamer, 1996; Poinot & Mercot, 1997) and fertility (Wade & Chang, 1995) or negative effects on host fecundity (Hoffmann *et al.*, 1990). The positive or negative consequences of infection may be related to differences in the mode of microbe transmission and maintenance in different groups of organisms. Models of symbiont transmission predict that negative effects on host reproduction will be prevalent in systems where symbiont populations are maintained by horizontal transmission, and positive effects will be more common when vertical transmission dominates (Frank, 1996).

Recently, female-biased sex ratio distortion has been reported in two species of stalk-eyed flies (Diptera: Diopsidae), *Cyrtodiopsis dalmanni* and *C. whitei* (Burkhardt & De La Motte, 1983), and ascribed to X chromosome meiotic drive (Presgraves *et al.*, 1997).

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