Host plant specialization influences the spread of endosymbiotic parthenogenesis in seed wasps (Hymenoptera: Torymidae)

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Abstract: Wasps of the *Megastigmus* genus are highly specialized on seeds of gymnosperms (Pinaceae and Cupressaceae) or angiosperms (Rosaceae and Anacardiaceae), which strongly shaped their evolutionary history and influences many processes of their population dynamics. When several wasp species exploit the same host, they strictly require the same ecological niche, which is then particularly propitious to direct intra- or interspecific interactions.

In this study, we investigated how such host-mediated interactions can drive the epidemiology of thelytokous parthenogenesis within the *Megastigmus* genus. In Hymenopterans, thelytokous parthenogenesis is a form of spontaneous loss of sexuality leading to strong distortion of sex ratio towards females and resulting from mutation, hybridization or infection by bacterial endosymbionts. In the genus *Megastigmus*, the dominant and ancestral form of parthenogenesis is by far arrhenotoky (a form of sexuality) as thelytoky characterizes only a minority of species, but both arrhenotokous and thelytokous species can occur in sympatry on gymnosperm or on angiosperm hosts. In this context, we address specifically the potential for phylogeny, ecology and infection by parthenogenesis-inducing endosymbionts to drive the spread of thelytoky within this group of seed wasps.

We first performed a large literature survey to examine the distribution of thelytoky in these wasps across their respective obligate host plant families. Second, we tested for thelytoky caused by endosymbionts by screening in 15 arrhenotokous and 10 thelytokous species for *Wolbachia*, *Cardinium*, *Arsenophonus* and *Rickettsia* endosymbionts and by performing antibiotic treatments. Finally, we performed phylogenetic reconstructions to examine the evolution of thelytoky in *Megastigmus* and its possible connections to both endosymbiont infection and host plant specialization.

We demonstrate that thelytoky evolved from ancestral arrhenotoky through the horizontal transmission and the fixation of the parthenogenesis-inducing *Wolbachia*. We find that ecological specialization in *Wolbachia*'s hosts was probably a critical driving force for *Wolbachia* infection and spread of thelytoky, but also a constraint. Sharing a narrow ecological niche opens an encounter filter between species, but also restricts the host spectrum to the few species exploiting a particular resource. Niche overlap opportunity being closely related to phylogenetic proximity between species, a compatibility filter can be open and facilitates symbiont infection. Our work shows that community structure of insects is a major driver of the epidemiology of endosymbionts and that competitive interaction among closely related species may facilitate their horizontal transmission.

Keywords: Ecological specialization, epidemiology, parthenogenesis, *Megastigmus*, phylogeny, thelytoky, *Wolbachia*