Feeding and oviposition of *Diaphorina citri* (Hemiptera: Liviidae) on *Helietta apiculata* (Sapindales: Rutaceae): a potential host?

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The Asian citrus psyllid, *Diaphorina citri* Kuwayama (Hemiptera: Liviidae), is the main vector of the bacteria associated with huanglongbing or HLB. This disease currently is considered the most harmful for the citrus industry worldwide (Bové 2006; Grafton-Cardwell et al. 2014). HLB is thought to be caused by the bacteria '*Candidatus* Liberibacter asiaticus' (Las), '*Candidatus* Liberibacter americanus' (Lam), and '*Candidatus* Liberibacter africanus' (Laf) (Rhizobiales: Rhizobiaceae) (Machado 2010).

Lopes et al. (2009) suggested that the bacteria may lack host specificity, i.e., that they may be capable of infecting several alternative hosts. If this is so, then plant species in certain regions may be acting as a source of bacteria, which the insect vector can acquire and transmit to citrus plants.

The Asian citrus psyllid can exploit a large number of host plants, especially species of the family Rutaceae (Aubert 1987). Among the main hosts are orange jasmine *Murraya exotica* L. (a synonym for *Murraya paniculata* [L.] Jacquin) (Sapindales: Rutaceae) and species and varieties of the genus *Citrus* (Sapindales: Rutaceae) (Halbert & Manjunath 2004; Teck et al. 2011; Alves et al. 2014; Sétamou et al. 2015). Although adults can feed on a wide assortment of Rutaceae, the insects cannot complete their development on all of them (Burckhardt et al. 2014). Alternative hosts for adults are important because they allow the psyllid to survive on these plants in the absence of more suitable hosts.

This study evaluated the survival and fertility of *D. citri* on 2 plant species, *M. exotica* and *Helietta apiculata* Bentham (Sapindales: Rutaceae). For the survival test, groups of 10 *D. citri* adults (10 d old) were confined in mesh sleeve cages on *M. exotica* or *H. apiculata* saplings. The experimental design was fully randomized, with 10 repetitions (insect groups) per treatment (host). Survival was evaluated 1, 3, 5, 7, 10, 17, 24, and 31 d after the confinement.

The fertility of *D. citri* on the 2 host species was estimated from the number of eggs laid on each plant in a confinement test (no-choice test). With mesh sleeve cages, 2 *D. citri* couples (12 d old) were confined for 72 h on the plants (which were approx. 25 cm in height). After this period, the insects were removed and the eggs counted with the aid of a stereoscopic microscope. The experimental design was fully randomized, with 10 repetitions (each consisting of 2 couples) per treatment (host). Both experiments were conducted under controlled conditions, with a temperature of 25 ± 2 °C, relative humidity of 60 ± 10%, and a photoperiod of 14:10 h L:D.

The data for survivorship and number of eggs were analyzed by generalized linear models (GLM) (Nelder & Wedderburn 1972) through a quasi-binomial and quasi-Poisson distribution, respectively; the *F* value was calculated by ANOVA with the model. The quality of fit was determined with a half-normal graph of probabilities with simulation envelope (Demétrio & Hinde 1997). All analyses were carried out with R software (R Core Team 2015).

The survival of *D. citri* was similar between the 2 hosts until day 7 of confinement (Fig. 1). By day 10 and afterwards, the survivorship differed between the hosts (F = 5.126; df = 1,19; P = 0.036), with increasingly reduced survival on *H. apiculata*, although an average of 50% of the insects survived on *H. apiculata* for 17 d after confinement (Fig. 1). The results obtained indicate that *H. apiculata* can serve as a food host for *D. citri*, thus helping the psyllid to survive during periods of food shortages. In general, on *M. exotica* about 85% of the insects survived to the end of the assessments (31 d), whereas only 20% of the insects on *H. apiculata* survived after 31 d (Fig. 1). El-Shesheny et al. (2016) also obtained 80% mean survival of *D. citri* on *M. exotica*.

Oviposition was higher (F = 14.723; df = 1,19; P = 0.012) on *M. exotica*, with a mean of 24.5 eggs per plant, than on *H. apiculata*, with a mean of 5.5 eggs per plant (Fig. 2), indicating that *M. exotica* was more suitable than *H. apiculata* for oviposition.

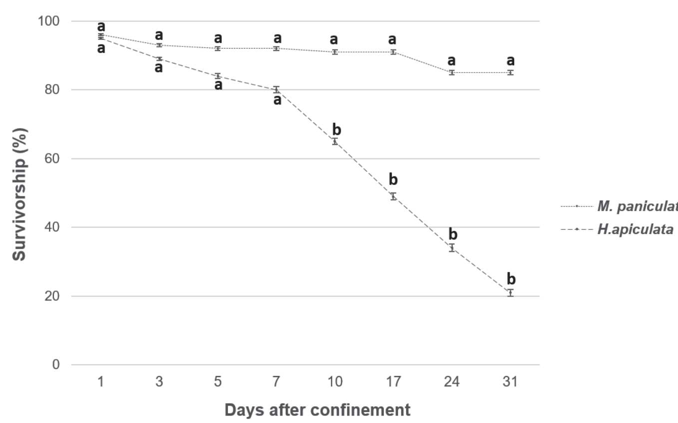

Fig. 1. Survivorship of adults of *Diaphorina citri* on 2 rutaceous species. Means followed by the same letter did not differ in the glm test by quasi-binomial distribution (F = 5.126; df = 1,19; P = 0.036).

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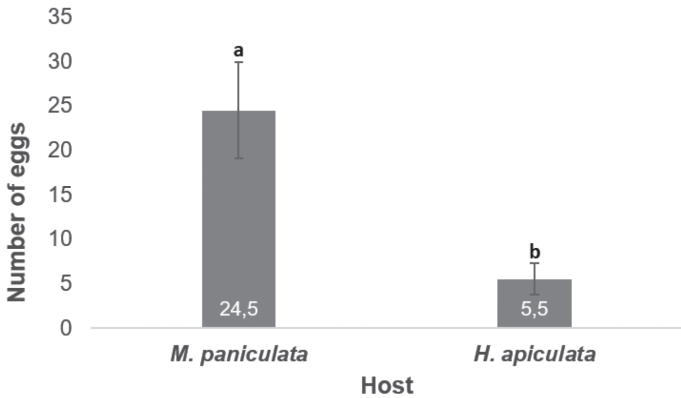

Fig. 2. Mean number of eggs laid on 2 rutaceous species by *Diaphorina citri* during 72 h. Means followed by the same letter did not differ in the glm test by quasi-Poisson distribution (F = 14.723, df = 1,19; P = 0.012).

Oviposition on *H. apiculata* was significantly lower than that obtained on *M. exotica*; however, this does not eliminate the possibility that *H. apiculata* can serve as a potential host for *D. citri*, because a low oviposition rate is not directly associated with impaired development of the offspring (Thompson 1988; Mayhew 2001; Wise et al. 2008). In areas that lack its main host (*M. exotica*) or citrus groves, *H. apiculata* could help *D. citri* survive and may be important for insect dispersal and the epidemiology of HLB.

The results of this study indicate that *H. apiculata* can be considered an important host plant for the survival of the psyllid, especially in locations where *H. apiculata* is abundant, such as along the edges of citrus groves and in urban areas. The next step is to determine if this species can support the complete development of the psyllid (egg to adult) and to compare its attractiveness with that of other hosts. In addition to *Citrus* species and *M. exotica*, more than 30 species of the family Rutaceae are reported in the state of São Paulo, Brazil (REFLORA 2016), and all are potential candidates for future studies of the vector.

The ability of *H. apiculata* to serve as a host for the *Candidatus* Liberibacter species also should be investigated. Similarly, if *D. citri* can colonize *H. apiculata*, it should be determined whether transmission of the bacteria to the next generation of insects via the feeding site occurs in this host.

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Summary

This study evaluated the survival and fertility of the huanglongbing vector *Diaphorina citri* Kuwayama (Hemiptera: Liviidae) on 2 species of the family Rutaceae, *Murraya exotica* L. (Sapindales: Rutaceae) and *Helietta apiculata* Bentham (Sapindales: Rutaceae). Females of *D. citri* oviposited on both hosts. The survival of *D. citri* was similar on both hosts until day 7 of confinement on the plants. *Helietta apiculata* can support *D. citri* in regions where the vector's main host (*M. exotica*) or citrus groves are absent, a potential factor in the dispersal and epidemiology of huanglongbing.

Key Words: alternative host; Asian citrus psyllid; insect–plant interaction; huanglongbing

Sumário

Esse estudo avaliou a sobrevivência e fertilidade de *Diaphorina citri* Kuwayama (Hemiptera: Liviidae) em 2 espécies da família Rutaceae, *Murraya exotica* L. (Sapindales: Rutaceae) (falsa-murta) e *Helietta apiculata* Bentham (Sapindales: Rutaceae). Fêmeas de *D. citri* ovipositaram em ambos hospedeiros. A sobrevivência de *D. citri* foi similar em ambos hospedeiros até o sétimo dia de confinamento nas plantas. *Helietta apiculata* pode auxiliar na sobrevivência do vetor em regiões onde seu principal hospedeiro (*M. exotica*) ou pomares cítricos são escassos, sendo este, um importante fator na dispersão e epidemiologia do huanglongbing.

Palavras Chave: hospedeiro alternativo; psilídeo-asiático-dos-citros; interação inseto-planta; huanglongbing

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