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Notes and Comments

Quadrastichus mendeli (Hymenoptera: Eulophidae): parasitism on *Leptocybe invasa* (Hymenoptera: Eulophidae) and first record in Brazil

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The eucalyptus gall wasp *Leptocybe invasa* Fisher & La Salle (Hymenoptera: Eulophidae), of the subfamily Tetrastichinae, from Australia, is an important exotic pest in eucalypts plantations in the world. The first report of *L. invasa* in Brazil was in 2007 damaging plants of *Eucalyptus camaldulensis x Eucalyptus grandis* hybrid clones in nursery and plantations in the Bahia state (Costa et al., 2008).

Damage by this insect reduces the growth and wood production of *Eucalyptus* spp. This insect lays eggs in the region of the central rib of the leaves, petiole, apex and new branches where its larvae make galls, affecting the sap flow and may cause plant death (Kavitha-Kumari et al., 2010; Costa et al., 2008).

Biological control and genetic selection of plants are promising to manage *L. invasa*, since the efficiency of chemical insecticides against larvae of this pest in their galls is reduced (Masson, 2015). The specific parasitoid of *L. invasa*, *Selitrichodes neseri* Kelly & La Salle (Hymenoptera: Eulophidae: Tetrastichinae), was imported from South Africa to Brazil in 2015. This natural enemy has adapted to laboratory rearing, released and established in the field with adequate efficiency (Masson et al., 2017). *Quadrastichus mendeli* Kim & La Salle (Hymenoptera: Eulophidae: Tetrastichinae), from Australia, is another promising and effective parasitoid of *L. invasa* (Kim et al., 2008).

The parasitoid *Q. mendeli* is distributed in South Africa, Argentina, China, India, Israel, Italy and Thailand with adequate parasitism levels (Kim et al., 2008; Shylesha, 2008; Nugnes et al.; 2016; Zheng et al., 2016; Mendel et al., 2017; Aquino et al., 2018; Bush et al., 2018; Sangtongpraow & Charernsom, 2019) and efficiently controlled *L. invasa* in Thailand (Sangtongpraow & Charernsom, 2019).

Quadrastichus mendeli parasitized young and mature *Leptocybe* sp. larvae (Huang et al., 2018a) and its well-developed ovipositor is adapted to access its host inside the galls (Huang et al., 2019). In addition, the high number and variety of chemosensory antennal sensilla on the *Q. mendeli* indicate that olfactory cues are important for this natural enemy host pests (Huang et al., 2018b). Volatiles released by galls induced by *L. invasa* attract *Q. mendeli* (Huang et al., 2021, 2022).

Branches of a *Eucalyptus grandis* clone with developed *L. invasa* galls were collected in a forest plantation in the municipality of Luís Antônio (-21.49583, -47.93254), São Paulo state, Brazil in 2018. These branches were transferred to the Laboratory of Biological Control of Forest Pests (LCBPF) of the FCA/UNESP, Campus of Botucatu, São Paulo state, Brazil, caged in plastic pots with water in acrylic vial at 25 ± 2 °C and 60 ± 2% relative humidity until insect emergence. The insects emerged were identified as *L. invasa* females, except for 30 individuals of other species (Figure 1). The latter were sent to Dr. Il-Kwon Kim (School of Botany and Zoology, Australian National University) for identification confirming *Quadrastichus mendeli* Kim and La Salle (Hymenoptera: Eulophidae: Tetrastichinae).

The DNA, which identified the insect as *Q. mendeli* was extracted and analyzed, in triplicate, with 80 µL of 10% Chelex100® resin solution [Bio-Rad Laboratories, USA] and 8 µlL of proteinase K (20 mg/ml). The 28S gene of *Q. mendeli* was amplified in a thermocycler [Infinigen, TC-96CG, USA] with the primers 28SF3633 (5'-TACCGTGAGGGAAAGTTGAAA −3′) and 28SR4076 (5′-AGACTCCT TGGTCCGTGTTT −3′) (Tiawsirisup et al., 2008) following the PCR denaturation cycle with initial denaturation step at 94 °C for 2 min; 38 cycles of 94 °C for 30 s, annealing at 58 °C for 50 s, 72 °C for 1 min 30 s; and extension at 72 °C for 10 min, submitted to 1% agarose gel electrophoresis and analyzed with UV light. The DNA sequence obtained showed high identity with *Q. mendeli* 28s gene and it was deposited in the GenBank as accession nº. MT645225.

Leptocybe invasa galls were offered to *Q. mendeli* females after the identification of this natural enemy, to

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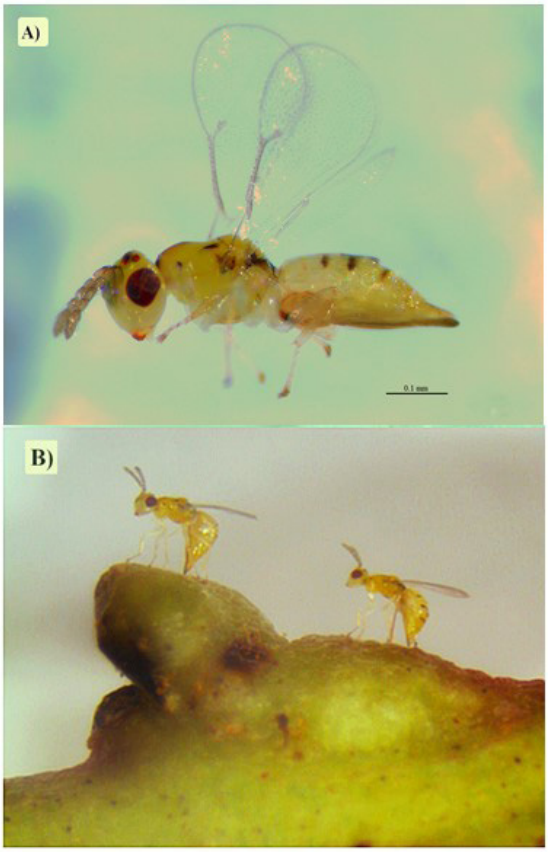

Figure 1. *Quadrastichus mendeli* (Hymenoptera: Eulophidae: Tetrastichinae) females (A) emerged from *Leptocybe invasa* (Hymenoptera: Eulophidae) galls and parasitizing *L. invasa* larvae into its galls (B).

evaluate parasitism. *Quadrastichus mendeli* parasitized *L. invasa* larvae (Figure 1), completed its cycle inside this pest galls and its adults emerged after 40 days of parasitism. The parasitism of *L. invasa* larvae into galls by *Q. mendeli* supports the potential of this parasitoid as a biological control agent in the integrated management of *L. invasa* in Brazil.

This manuscript is an original contribution with the first report of the occurrence of *Q. mendeli* in Brazil and its record parasitizing *L. invasa* larvae into its galls, as a good contribution for biological control programs of this pest.

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