Host searching and oviposition behaviour of *Agathis bishopi* (Hymenoptera: Braconidae), a larval parasitoid of false codling moth, *Thaumatotibia leucotreta* (Lepidoptera: Tortricidae): a potential proxy indicator for fruit infestation

K. Zimba[1*], U. Heshula[1], S.D. Moore[1,2] & M.P. Hill[1]

[1]*Department of Zoology and Entomology, Rhodes University, Grahamstown, 6140 South Africa*
[2]*Citrus Research International, P.O. Box 20285, Humewood, Port Elizabeth, 6031 South Africa*

Agathis bishopi (Nixon) (Hymenoptera: Braconidae) is an arrhenotokous larval endoparasitoid of *Thaumatotibia leucotreta* (Meyrick) (Lepidoptera: Tortricidae) (Gendall 2007; Hofmeyr *et al*. 2015) commonly known as false codling moth (FCM), a major pest of citrus in South Africa (Moore *et al*. 2004; Malan *et al*. 2011). Under field conditions, *A. bishopi* was identified attacking more than 34 % of FCM larvae in fruit, showing good biocontrol potential (Gendall 2007). Preference by *A. bishopi* for parasitising the early instars of its concealed host suggests that the parasitoid has strong natural host location ability (Sishuba 2003; Gendall 2007). Host location behaviour of *A. bishopi* could be harnessed for the development of a detector for infested fruit, particularly before the FCM infestation symptoms are clearly visible. Such a detector would provide a potential for accurate screening of fruit in the packhouse before it is exported to markets where FCM has a phytosanitary status (Bloem *et al*. 2003; Moore & Hattingh 2012). However, understanding the behavioural mechanism involved in the search and discovery of FCM-infested fruit by *A. bishopi* is a major preliminary step in manipulating the parasitoid behaviour (Wackers *et al*. 2011). In addition, understanding the distinctiveness of behavioural alterations exhibited by *A. bishopi* in the presence of infested fruit would provide important information for establishing reliable 'behavioural indicators' that are typical for infested fruit (Tomberlin *et al*. 2008). Therefore, this study examined the changes in the duration of basic host searching behavioural parameters (resting, walking, oviposition) in the presence of FCM-infested fruit, and further characterised the host location and oviposition behaviour of *A. bishopi*.

A culture of *A. bishopi* was established and maintained at Rhodes University (Waainek Research Laboratory). The parasitoids were reared on their natural host, FCM, using a method previously described (Gendall 2007; Zimba *et al*. 2015). After eclosion and before the bioassays, male and female parasitoids were kept in separate glass jars (250 ml). To produce mated females, male and female parasitoids (sex ratio 1:2 male: female) were kept in the same jar for 24 h before the bioassay. A small piece of cotton wool soaked in water was placed in the jar as a water source for the parasitoids while food was provided by soaking a piece of cotton wool in dilute honey and suspending it through a hole on the metal lid of the jar. The water and dilute honey was replenished daily. The glass jars containing parasitoids were kept in the rearing room (25 °C ± 2, 50 % RH ± 10 and 12L:12D photoperiod. All bioassays were carried out using 2–5-day-old female parasitoids.

FCM larvae used for fruit infestation were obtained from an established culture maintained at Rhodes University (Waainek Research Laboratory). The larvae were reared on artificial diet using a method described by Moore *et al*. (2014). Until the larvae (first instar) were used for fruit infestation, the moths were maintained at 25 °C ± 2, 30 % RH ± 10 and 12L:12D photoperiod.

Orange fruit (cv. Navel) of fairly uniform size were collected from farms in Sundays River Valley (Eastern Cape Province, South Africa) and stored in a cold room at ~4 °C until they were used in the bioassays. Before infestation with FCM larvae, fruit were removed from the cold room and kept at room temperature for 24 h. In order to obtain uniformly infested fruit, 10 neonate FCM larvae were placed individually on the fruit rind. Preliminary observations showed that most larvae died before they burrowed into the fruit, thus this relatively higher number of larvae were inoculated per fruit to ensure successful infestation. Both infested (fruit with burrowed and frass-filled FCM larval holes) and healthy fruit were kept in the rearing room (25 °C ± 5, 30 % RH ± 10 and

*Author for correspondence. Present address: Department of Plant Science, School of Agriculture, University of Zambia, P.O. Box 32379, Lusaka 10101, Zambia.
E-mail: zimbakj@gmail.com / kennedy.zimba@unza.zm

ISSN 1021-3589 [Print]; 2224-8854 [Online]
DOI: http://dx.doi.org/10.4001/003.024.0524