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Host suitability and preference studies of *Trichogramma cordubensis* (Hymenoptera: Trichogrammatidae)

V. Roriz, L. Oliveira *, P. Garcia

Departamento de Biologia, CIRN, Universidade dos Açores, P-9502 Ponta Delgada Codex, Açores, Portugal

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Abstract

Studies of host suitability and preferences of *Trichogramma cordubensis* Vargas and Cabello (Hymenoptera: Trichogrammatidae) were performed with eggs of six Lepidoptera (Noctuidae) species: *Thysanoplusia orichalcea* Fabricius, *Peridroma saucia* (Hübner), *Xestia c-nigrum* L., *Phlogophora meticulosa* (L.), *Noctua pronuba* (L.), and *N. atlantica* (Warren). Host suitability was studied by analysing separately the effects of the attacked host species and the influence of the rearing host species on different biological parameters of *T. cordubensis*. Host preference was analysed by offering eggs of two host species simultaneously to a single female wasp without previous oviposition experience (dual-choice tests). Results show that *P. saucia*, followed by *P. meticulosa* were the least suitable hosts for *T. cordubensis,* since on these species the preimaginal development of the parasitoids was significantly longer and, the number of parasitized eggs as well the number of offspring per female were significantly lower. Contrarily, *T. cordubensis* parasitized at a higher rate the eggs of the endemic non-target species, *N. atlantica*. Dual choice tests showed that the option of the first host to be accepted by the wasp was random; however, the mean number of parasitized eggs differed significantly when two host species were offered simultaneously to *T. cordubensis*, always being the host species with heavier eggs the most parasitized.

Keywords: *Trichogramma cordubensis*; Egg parasitoids; Host suitability; Dual-choice tests; Biological control; Non-target species

1. Introduction

The use of egg parasitoids for the control of pests has long been an essential part of pest management strategies in crop protection. Numerous egg parasitoids are effective natural enemies of important agricultural and forestry pests, and among these, the genus *Trichogramma* Westwood is worldwide used in several pest management programs (Li-Ying, 1994). *Trichogramma cordubensis* Vargas and Cabello (Hymenoptera: Trichogrammatidae) is one of the most important species of egg parasitoids found on the island of São Miguel-Azores (Portugal). Under natural conditions *T. cordubensis* parasitizes eggs of the following Lepidoptera (Noctuidae): *Autographa gamma* (L.), *Chrysodeixis chalcites* (Esper), *Phlogophora meticulosa* (L.), *Peridroma saucia* (Hübner), *Xestia c-nigrum* (L.), and *Noctua pronuba* (L.) (Garcia, 1992, 1995; Garcia et al., 1995, 1998).

Even though *Trichogramma* wasps are generally polyphagous (Smith, 1996), host preferences have been demonstrated for several species (Dijken et al., 1986; Guang and Oloo, 1990; Monje et al., 1999; Mansfield and Mills, 2003). In addition, there are several studies reporting on the different suitability of host species for *Trichogramma*: characteristics such as host egg volume (Bai et al., 1992; Pak, 1988), chorion thickness (Pak, 1988; Pak et al., 1990), nutritional contents (Barrett and Schmidt, 1991), age (Calvin and Losey, 1991; Garcia, 2000; Monje et al., 1999; Reznik et al., 1997) can influence parasitism rates as well as the number of wasps per host egg (Corrigan and Laing, 1994; Hoffmann et al., 2001; Honda and Luck, 2001) and, body size and fecundity (Greenberg et al., 1998; Kazmer and Luck, 1991), longevity (Kuhlmann and Mills, 1999), and sex ratio

* Corresponding author. Fax: +351 96 653455.
E-mail address: ziza@notes.uac.pt (L. Oliveira).

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(Corrigan and Laing, 1994; Kuhlmann and Mills, 1999) of *Trichogramma* offspring.

Since the host-specificity features of the candidate species are generally considered among the factors determining their effectiveness as control agents, the choice of a suitable species is crucial for the success of a biological control program (Pak, 1988). Furthermore, studies concerning the effects on non-target host species need also to be developed to avoid possible parasitism of these populations, as observed by Babendrier et al. (2003) and Mansfield and Mills (2003).

Within this context, we aimed to study the suitability and preference of six Lepidoptera species found on Azores as hosts for *T. cordubensis*: (i) three species are exotic pests (*Thysanoplusia orichalcea* Fabricius, *P. saucia*, and *X. c-nigrum*) of several agriculture crops such as lettuce, tomato, and cabbage, (ii) two are exotic species (*P. meticulosa* and *N. pronuba*) not considered as pests but that under some environmental conditions can cause damages to agriculture crops such as tomato, lettuce, and tobacco, and, (iii) one is an endemic non-target species (*Noctua atlantica* (Warren)) found in the Azorean natural ecosystems (Laurisilva) and considered as vulnerable according to the "Red Data List" (Meyer, 1995).

2. Materials and methods

2.1. Insects

The colony of *T. cordubensis* used in these experiments was originally established from parasitized eggs of *P. meticulosa*, *P. saucia*, and *T. orichalcea* found at Ribeira do Guilherme (São Miguel Island-Azores, Portugal). Parasitoids were reared during 3–7 generations on *Ephestia kuehniella* Zeller (Lepidoptera: Pyralidae) eggs, at 21 ± 0.5 °C and 70 ± 5% r.h., with a natural photoperiod, according to the methods of Tavares and Vieira (1992).

The colony of *T. orichalcea* was established from eggs collected in the above-mentioned locality. The other colonies of host species, *P. saucia*, *X. c-nigrum*, *P. meticulosa*, *N. pronuba*, and *N. atlantica*, were obtained from adults captured at Remédios (São Miguel Island-Azores), using light traps (Pennsylvania type). Adult males and females were placed inside oviposition cages (50 × 50 × 50 cm) and supplied with an aqueous solution of sugar (10%). Eggs were disinfected in 5% formaldehyde solution for 20 min and rinsed with distilled water. Hatched larvae were kept in groups until pupation inside 2 L plastic containers. Larvae were fed with small portions (1 cm^3) of artificial diet (Poitout and Bues, 1970), renewed every 2 days until pupation. Upon adult emergence, males and females were placed together inside oviposition cages to allow mating and oviposition. All host colonies were reared under natural photoperiod at 21 ± 0.5 °C and 70 ± 5% relative humidity. To ponder the dimension of the eggs from the different host species their mean weight was determined using a precison weighing scales (MOD. 40SM-200 A). Eggs were weighted in groups of 10 and 25–30 replications were made for each species.

2.2. Host suitability

Host suitability was studied by analysing separately the effects of the attacked host species and the influence of the rearing host species on different biological parameters of *T. cordubensis*. To test the effects of the host species which *T. cordubensis* attacks, egg cards (2.0 × 0.8 cm) were prepared containing 30 eggs (<24 h old) of one host species, glued to the surface of the card by a solution of "Arabic glue" (30%). Each egg card was exposed to a single *T. cordubensis* female (<24 h old) during 3 days, inside a glass tube (7.0 × 1.0 cm) with a drop of honey solution (10%) to provide the wasp a carbohydrate source. The number of dead females was recorded at the end of the parasitism period (i.e., on the third day) and those alive were removed from the glass tubes. Cards with parasitized eggs were kept inside glass tubes for the preimaginal development of the parasitoids. The following parameters were evaluated: female's mortality, number of parasitized host eggs that turned black (i.e., with parasitoid prepupae), number of offspring per host egg, number of offspring per female, wasp's preimaginal development time and emergence rates. The number of replications per host species was always above 45, varying according egg availability (see Table 1).

To evaluate the influence of the rearing host species on the wasps developed in these host eggs, 40 females (<24 h old) emerged from each host species were individually isolated in glass tubes (7.0x1.0 cm) and allowed to parasitize 200 eggs (<24 h old) of *E. kuehniella* during 7 days. Host eggs were glued to egg cards (2.0 × 0.8 cm) by a solution of

Table 1
Mortality of the females on the 3rd day (%), preimaginal development time, number of parasitized eggs, number of offspring per female, and adult emergence rates of *T. cordubensis* (means ± SD) when parasitizing different host species

Host	*n*	Mortality (%)	Development time (days)	Number of parasitized eggs	Total number of offspring per female	Emergence rate (%)
P. saucia	52	19.23a	16.98 ± 0.87a	7.23 ± 3.20c,d	8.19 ± 3.73d	93.71 ± 12.83a
X. c-nigrum	48	10.42a,b	16.23 + 0.83b	9.13 + 2.86c	13.60 + 5.25c	96.14 + 8.28a
T. orichalcea	52	3.85a,b	16.00 ± 0.77b	19.33 ± 4.03a	24.38 ± 6.62b	97.17 ± 4.51a
P. meticulosa	52	3.85a,b	17.25 ± 0.84a	6.60 ± 2.90d	10.38 ± 4.95c,d	94.11 ± 11.57a
N. pronuba	52	0.00b	17.06 ± 0.78a	12.37 ± 4.03b	22.37 ± 6.81b	98.28 ± 3.97a
N. atlantica	50	8.00a,b	15.86 ± 0.64b	19.12 ± 5.15a	33.88 ± 9.36a	97.85 ± 4.37a

Values in each column that are followed by a different letter are significantly different ($P < 0.05$).