Available online at www.sciencedirect.com
SCIENCE DIRECT®
Biological Control 32 (2005) 65–69
Biological Control
www.elsevier.com/locate/ybcon

Effects of alyssum flowers on the longevity, fecundity, and sex ratio of the leafroller parasitoid *Dolichogenidea tasmanica*

Lisa A. Berndt*,[1], Steve D. Wratten

Bio-Protection and Ecology Division, P.O. Box 84, Lincoln University, Canterbury, New Zealand

Received 16 March 2004; accepted 22 July 2004
Available online 17 September 2004

Abstract

A laboratory experiment assessed the effect of floral food resources on the longevity, fecundity, and sex ratio of *Dolichogenidea tasmanica* (Cameron) (Hymenoptera: Braconidae), a parasitoid of leafrollers (Lepidoptera: Tortricidae). Alyssum (*Lobularia maritima* (L.), Brassicaceae) plants with flowers were compared with plants without flowers, with water available in both treatments. Adult parasitoids were provided with an excess of second-instar larval hosts, which were then reared to determine the composition of the F1 parasitoid generation. Female parasitoids with access to alyssum flowers lived, on average, seven times longer than those without flowers. Male longevity was three times greater with, than without flowers. The lifetime realised fecundity of *D. tasmanica* was also significantly increased in the presence of flowers, although this was a consequence of the increase in longevity, rather than an increase in daily fecundity. Without flowers, offspring sex ratios were strongly male biased, but when females had access to flowers an approximately equal sex ratio was produced. These results are discussed in relation to the use of flowers in agroecosystems for the conservation biological control of leafroller pests.

Keywords: Alyssum; *Lobularia maritima*; Nectar; Pollen; Floral feeding; Parasitoid; *Dolichogenidea tasmanica*; Braconidae; Fecundity; Longevity; Sex ratio; Leafroller *Epiphyas postvittana*; Tortricidae; Habitat manipulation

1. Introduction

Dolichogenidea tasmanica is a solitary endoparasitoid of the larvae of leafroller moths. It originates from Australia, where its primary host is *Epiphyas postvittana* (Walker) (Lepidoptera: Tortricidae), but it also occurs in New Zealand where it is the most common parasitoid attacking this, and other, pest leafroller species (Charles et al., 1996; Suckling et al., 1998). Previous studies in New Zealand have investigated the possibility of enhancing the efficacy of this parasitoid by adding floral resources to apple orchards (Irvin et al., 2000) and vineyards (Berndt et al., 2002). These studies investigated the hypothesis that many agroecosystems lack food resources, such as nectar and pollen, required by the adult stage of many Hymenopteran parasitoids. Adding floral resources to an agroecosystem may enable certain parasitoids to increase their impact on pest populations (Gurr et al., 1998; Jervis et al., 2004; Landis et al., 2000). Without access to appropriate foods, parasitoids may suffer reduced survival, fecundity, and search efficiency (Hocking, 1967; Irvin et al., 1999; Jervis et al., 1996; Johanowicz and Mitchell, 2000; Leatemia et al., 1995; Leius, 1961; Yadav, 1985). The availability of food may also affect the offspring sex ratio of some parasitoids (Khafagi, 1998; Leatemia et al., 1995). This change in sex ratio in the presence of floral resources was observed in *D. tasmanica* in a field experiment in which flowering buckwheat (*Fagopyrum esculentum*

* Corresponding author. Fax: +64 364 2812.
E-mail address: lisa.berndt@forestresearch.co.nz (L.A. Berndt).
[1] Present address: Forest Research, P.O. Box 29 237, Fendalton, Christchurch, New Zealand.

1049-9644/$ - see front matter © 2004 Elsevier Inc. All rights reserved.
doi:10.1016/j.biocontrol.2004.07.014

Moench) was added to a vineyard system (Berndt et al., 2002). In the present study alyssum flowers (*Lobularia maritima* (L.)) are used in a laboratory experiment to further examine this effect of floral resources on the sex ratio of this species, and to investigate the effect of these resources on the longevity and fecundity of *D. tasmanica*. Alyssum was used here because it produces prolific small, white flowers with shallow corollae that are similar in size to buckwheat flowers and in their benefits to *D. tasmanica* (Irvin, 1999). In addition, the small size of alyssum plants made it possible to use live plants in laboratory cage experiments.

2. Materials and methods

Six replicates of each of two treatments (alyssum and control) were set up across three controlled environment rooms in a randomised block design. Alyssum treatments provided parasitoids with nectar- and pollen-producing alyssum flowers (cv. Carpet of Snow) as a food source, and control treatments had alyssum plants with the flower removed. Although flowers condition was not specifically recorded, all plants were flowering prolifically and had florets in a range of stages present throughout the experiment. Each replicate consisted of a $51 \times 51 \times 56$ cm clear Perspex cage, with a 25×25 cm Terylene mesh door. Each of these cages contained one female, and two male *D. tasmanica*, leafroller larvae on artificial diet (from The Horticulture and Food Research Institute of New Zealand Ltd, Auckland, modified from Singh, 1983), water-soaked cotton wool, and an alyssum plant with or without flowers. In control treatments, flower buds were removed as they appeared on plants during the experiment. Plants in both the control and the alyssum flower treatments received the same amount of water during the experiment. Each cage was illuminated by six fluorescent tubes (three Osram L30W/77 Fluora, and three Osram L30W/11-860 Luminex Plus Daylight), which emitted daylight-equivalent spectra. Rooms were at 17 °C with a 4 °C range, and a L16:D8 photoperiod. Mean relative humidity in the rooms was 55% with a 9% range.

Parasitoids used in this experiment were laboratory-bred offspring of *D. tasmanica* reared from *E. postvittana* released and recovered at a vineyard in Canterbury, New Zealand, using methods described in Berndt et al. (2002). *Epiphyas postvittana*, from a colony maintained by The Horticulture and Food Research Institute of New Zealand Ltd, Auckland, was used as a host in the experiment and in parasitoid cultures. Parasitoid culturing was conducted under the same environmental conditions as the experiment. Parasitoids for each treatment cage were randomly selected from a collection of *D. tasmanica* of the appropriate age, with female parasitoids less than 12 h old, and males between one and two days old. Any that appeared abnormal in their behaviour were discarded.

To increase the likelihood of mating, each female was enclosed with its assigned males in a mating cage for 24 h before being released into the larger experimental cage. These cages consisted of a cylinder of transparent plastic sheeting 15 cm high and 6.5 cm in diameter, with a fine Terylene mesh top and a Petri dish for a base. Each cage contained water-soaked cotton wool, and those in alyssum treatments also had a freshly cut alyssum flower head in a vial of water.

An excess of leafroller larvae were presented to the parasitoids in plastic rearing boxes (Clare et al., 1987) containing artificial diet. Leafrollers were reared from eggs in these boxes (approximately 200 mature eggs per box) resulting in a mean of 156 ± 7.3 (± 1 SE) larvae per box. Boxes were presented to parasitoids after 4–6 days at an average temperature of 20 °C, when the larvae were in the second instar.

Throughout the experiment, cages were checked between 08:30 and 09:30 h each day. During these checks, parasitoid deaths were recorded and female parasitoids were captured and confined in the leafroller rearing boxes inside each of the treatment cages. Parasitoids were confined in the boxes to prevent the leafroller diet drying out. Between 12:30 and 13:30 h each day, female parasitoids were released from the rearing boxes back into the main cage. After three daily four hour periods of exposure to the parasitoids, leafroller rearing boxes in the experimental cages were replaced with fresh ones. This procedure continued until the female parasitoid in each cage died. This method ensured that each female was exposed to one box of leafrollers for 4 h at a time on three consecutive days before a fresh box of leafrollers was introduced. This procedure gave female parasitoids access to approximately 156 hosts every three days. An egg load of 300 has been recorded in *D. tasmanica* with access to buckwheat flowers (Irvin, 1999), but no previous work has been done on the number of hosts this species is capable of attacking per day, so the assumption was made that the number of hosts per box was sufficient to provide an excess.

Once rearing boxes were removed from the experimental cages, they were returned to 20 °C conditions, and leafrollers were reared to either moth pupa or parasitoid cocoon. No formal observations were made of flower visiting by *D. tasmanica* in the experiment, but parasitoids were seen apparently feeding on flowers on several occasions (personal observation).

Mean parasitoid fecundity per day was calculated for each three-day period (number of parasitoid cocoons produced/number of days exposed to hosts). Sex ratio, defined as the proportion of offspring that were male, was also calculated for each three-day period separately. Data were analysed using an ANOVA model (Systat,