INFLUENCE OF TEMPERATURE AND FLOWERS ON LONGEVITY OF ADULT *PLATYGASTER DEMADES*

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ABSTRACT

Failure by *Platygaster demades* to provide effective biological control of apple leaf curling midge (ALCM) may be because the second, spring generation of the parasitoid is asynchronous with that of its host. Asynchrony may result from relatively slow development of *P. demades* at low temperatures in spring. In laboratory experiments, adult female *P. demades* provided with honey-agar diet lived significantly longer at 11°C (47.9 ± 2.8 days) than at 19°C (19.4 days) and 27°C (2.7 days). *Platygaster demades* were provided with fresh flowers of *Anethum graveolens* (dill), *Coriander sativam* (coriander), *Fagopyrum esculentum* (buckwheat), *Lobularia maritime* (alyssum), *Phacelia tanacetifolia* (purple tansy) and *Sinapis alba* (white mustard). Both sexes lived longest (and comparably to the honey-agar diet) when provided with buckwheat flowers. The possibilities for using buckwheat in apple orchards to prolong the first generation of *P. demades* sufficiently to synchronise with the second generation population of ALCM are discussed.

Keywords: *Platygaster demades*, longevity, temperature, floral nectar.

INTRODUCTION

Platygaster demades Walker (Hymenoptera: Platygastridae), an egg parasitoid of apple leaf curling midge (ALCM), *Dasineura mali* Kieffer (Diptera: Cecidomyiidae), was first introduced to New Zealand in 1925 to control pear leaf curling midge *Dasineura pyri* (Bouché) (Todd 1956). In the field, mature ALCM larvae (either parasitised or unparasitised) leave their feeding sites within leaf curls and fall to the ground. They pupate in or on the soil. Larvae of *P. demades* develop inside the parasitized ALCM larvae and mature after the host larva spins its cocoon in the soil. Five generations of ALCM and *P. demades* emerge every year between early October and late April, but parasitoid numbers are usually low in the second spring generation (early November) when ALCM numbers increase dramatically (Todd 1956; Berry & Walker 1989; Shaw et al. 2005). The reason for low parasitoid numbers in spring may be that larvae and pupae of ALCM develop faster than *P. demades* at low temperatures, so low soil temperatures in spring may simply delay emergence of *P. demades* until after peak ALCM egg hatch (Sandanayaka & Shaw 2005). Such a delay might not only allow the second generation of ALCM to largely escape parasitism, but also delay an effective numerical response of the parasitoid until late summer (as is frequently observed).

In laboratory experiments, adult *P. demades* emerged from soil over a longer period when the air temperature was below 20ºC (Sandanayaka & Shaw 2005). One way to manage the delayed emergence of second generation *P. demades* adults might be to prolong the life-span of late emerging first generation females, so that they are alive and able to attack early second generation ALCM eggs in mid November. The availability of floral nectar and pollen can increase the longevity of adult parasitoids (Baggen & Gurr 1998; Baggen et al. 1999). In this study the feasibility of this strategy was tested by measuring the effects of both temperature and flowers on the adult life span of *P. demades*.

MATERIALS AND METHODS

Insects

Field-collected ALCM larvae and *P. demades* (in infested apple leaves) were reared in the laboratory. Adult parasitoids less than 12 hours old were used in the experiments.

Platygaster demades longevity at different temperatures

The longevity of adult *P. demades* was measured in the laboratory at five temperatures (11ºC, 15ºC, 19ºC, 23ºC and 27ºC). A group of five females and five males were kept in a plastic Petri dish (1.5 × 8.5 cm diameter) sealed with Parafilm® to prevent escape. A moist filter paper (0.25 ml water on 4.25 cm diameter No. 2 filter paper) was replaced weekly to maintain humidity. The insects were fed with a honey-agar diet (5 g sugar, 5 g honey and 0.25 g agar in 25 ml water, boiled together for 5-10 minutes, dispensed as droplets, and refrigerated until required (D.J. Allan, pers. comm.), but they were not provided with ALCM eggs. Parasitoid survival was recorded daily between 1 p.m. and 2 p.m. There were ten replicates, giving a total of 50 females and 50 males at each temperature.

Platygaster demades longevity with different flowers

The longevity of adult *P. demades* held with six flowering plants (species commonly used in parasitoid feeding studies elsewhere) was measured. The plants were alyssum (*Lobularia maritime* L) and white mustard (*Sinapis alba* L.) (both Cruciferae/Brassicaceae), buckwheat (*Fagopyrum esculentum* Moench, Polygonaceae), coriander (*Coriander sativam* L) and dill (*Anethum graveolens* L.) (both Apiaceae) and purple tansy (*Phacelia tanacetifolia* Benth, Hydrophyllaceae). Plants were grown from seeds in the glasshouse and tested in sequence as they flowered. Hence alyssum, buckwheat, purple tansy and white mustard were tested first and coriander and dill were tested later, under the same laboratory conditions. Experiments were carried out in a laboratory with 15:9 h light:dark and 19ºC, a temperature that might be expected in apple orchards in spring.

Flowering shoots with flower buds were provided, to ensure a continuous supply of flowers for several days. Each shoot was placed into a vertically-held Petri dish (85 × 15 mm) with the stem extending through a foam plug fitted into an opening cut in the base of both the lid and the dish. The stem extended into a 50 × 10 mm tube of water held under the Petri dish and the tube was plugged with the foam to keep the flowers fresh. Control dishes were plant free and consisted of water alone. A female and a male *P. demades* were released into each Petri dish, which was then sealed with a layer of Parafilm®. Survival of insects was recorded daily by midday and the old shoots were replaced with fresh flowering shoots every 2-3 days. Forty to fifty replicates were carried out for each treatment according to the availability of insects. Insects that died while trying to escape from the Petri dishes were not included in the analysis of data.

Data from both experiments were analysed using analysis of variance, followed by means separation with Tukey's LSD (P=0.05) (Origin 7.5). Values presented are the mean ± SEM.

RESULTS

Platygaster demades longevity at different temperatures

Adult *P. demades* fed on the honey-agar diet lived longer at lower temperatures (Fig. 1). The longevity of females (47.9±2.8 days) and males (31.3±2.7 days) was greatest at 11ºC, and least at both 23ºC and 27ºC (females: 8.2±0.5 days and 2.7±0.2 days; males: 4.1±0.3 days and 2.6±0.2 days respectively). At 19ºC females lived on average for 19.4±1.0 days and males for 15.7±0.8 days.

Platygaster demades longevity with different flowers

Females with access to flowers of buckwheat, mustard, alyssum or coriander lived longer than those with access to water alone (Fig. 2). The longevity of males with access to flowers was not significantly different from that of males with access to water alone, except on buckwheat. Buckwheat was the only flower to provide longevity for females at 19°C (22.4±0.7 days) equivalent to that provided by a honey-agar diet.

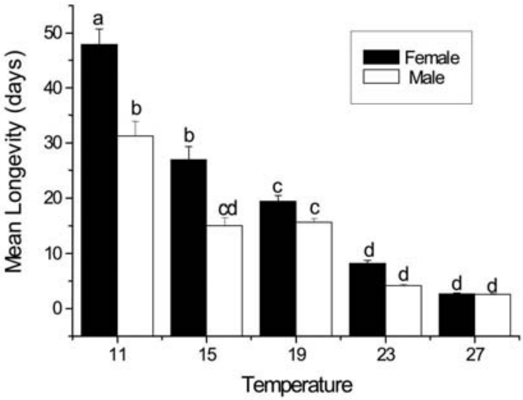

FIGURE 1: **Longevity (days) of female and male *Platygaster demades* at different temperatures when fed on honey-agar diet. Mean values followed by different letters are significantly different (Tukey's LSD, P=0.05). Error bars represent the standard error of the means.**

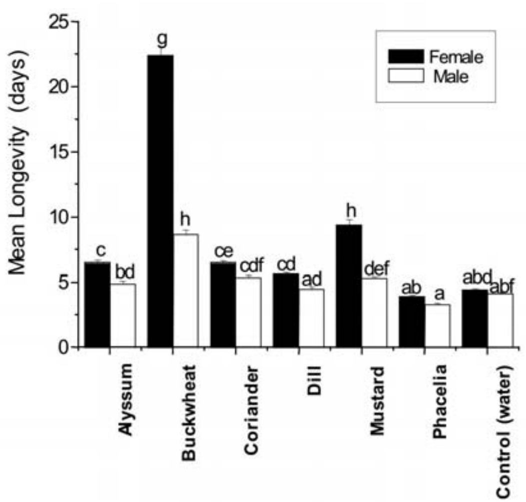

FIGURE 2: **Longevity (days) of female and male *Platygaster demades* fed on different sources of floral nectar or water. Mean values followed by different letters are significantly different (Tukey's LSD, P=0.05). Error bars represent the standard error of the means.**

DISCUSSION

The longevity of male and female *P. demades* fed on a honey-agar diet was greater at lower temperatures than at higher temperatures. Survival of adult parasitoids on flowers was measured at 19ºC because the mean air temperature in key pipfruit regions in New Zealand during October–November is between 11ºC and 24ºC (HortResearch weather station data at Riwaka). However, the constant laboratory temperatures may underestimate longevity, because fluctuating daily temperatures during the day and night in the field might have some effect on the life span of the parasitoids.

It is presumed that the 5-fold increase in longevity of adult *P. demades* confined with buckwheat flowers (compared with those confined with water) was a result of their feeding on the flower nectar. This is consistent with studies on many other parasitoids (Lavandero et al. 2005). Several reasons may lie behind the lack of such a strong response with the other flowers. It is possible that the nectar from those flowers may not contain enough nutrients for parasitoids to live longer or that these flowers (and their nectar) may deteriorate faster than buckwheat in laboratory conditions. It is also possible that the nectar was simply inaccessible, lying beyond the reach of the mouthparts of such small parasitoids (Patt et al. 1997). Floral morphologies of some plant species, such as highly elongated corolla tubes, deter small hymenopteran parasitoids feeding on nectar (Jervis et al. 1993). Buckwheat nectar also contains a higher sucrose/(glucose + fructose) ratio than that of other plant types on which parasitoids tend to feed (Vattala 2005).

Adult female *P. demades* emerge with a fully developed egg load (W.R.M. Sandanayaka, unpubl. data), and hence appears to be pro-ovigenic like many other Platygastridae (Flanders 1969; Drost et al. 1999; Jervis et al. 2003). Her ability to lay a full complement of eggs is hence limited only by an ability to locate sufficient numbers of host eggs before she dies. As *P. demades* females carry ca 1000 eggs, successful biological control of ALCM is perhaps influenced especially by the longevity, activity, and searching efficiency of *P. demades*.

Emergence data for a 'typical' season (1996-97) in Nelson showed that the interval between the first and the second generation ALCM egg peaks was approximately 55 days, and that numbers of *P. demades* adults were likely to be low during the 2nd peak oviposition period (Shaw et al. 2005). However, *P. demades* emerge for a longer period than ALCM at the low temperatures that prevail during spring (Sandanayaka & Shaw 2005). Results of the present study indicate that *P. demades* females provided with a suitable source of food (honey-agar or buckwheat flowers) may survive at least 20-25 days in spring in the absence of ALCM eggs. Hence it is conceivable that prolonging the life of the late emerging first generation *P. demades* females by supplying buckwheat flowers might enable them to parasitise sufficient numbers of newly laid ALCM eggs to provide some control of the second ALCM generation.

Understorey management has been increasingly recognised as a way to improve biological control of a number of polyphagous insect pests (Irvin et al. 1999; Landis 2000; Berndt et al. 2006). The ideal temperature range for buckwheat growth in a growth cabinet was 13ºC to 26ºC (Bluett 1999), and since the expected temperatures in October-November in apple growing areas in New Zealand are within that range, it is reasonable to suggest that buckwheat could be grown in apple orchards during that period. There is a possibility that other nectar sources already exist, and that adding buckwheat would have no additional effect. However, in practice, the natural occurrence of spring flowers in orchards, of equal value to buckwheat, is likely to be irregular and patchy. The next step is to determine whether the results reported here can be feasibly achieved in New Zealand pipfruit orchards, by planting buckwheat in the understorey so that they flower in time to provide a source of nectar to increase longevity of *P. demades*. Potentially this could result in higher levels of parasitism during the second ALCM generation egg laying period.

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