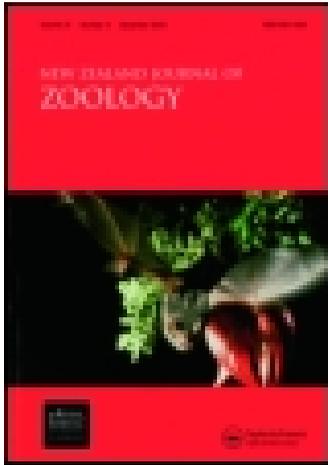


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Palatability and feeding preferences of *Uresiphita maorialis* (Lepidoptera: Crambidae) for three *Sophora* species

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SHORT COMMUNICATION

Palatability and feeding preferences of *Uresiphita maoralis* (Lepidoptera: Crambidae) for three *Sophora* species

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In a three-hour bioassay, we tested the palatability and feeding preferences of *Uresiphita maoralis* (kōwhai moth) for *Sophora tetraptera*, *Sophora microphylla* and *Sophora prostrata*. Palatability tests showed no differences among the *Sophora* species. Feeding preferences, on the other hand, showed that *S. tetraptera* and *S. microphylla* leaves are preferred over *S. prostrata* leaves. Our results support our field observations in Wellington city parks and gardens showing that *S. tetraptera* and *S. microphylla* plants frequently have higher densities of larvae than *S. prostrata*.

Keywords: host plant; multi-choice; New Zealand; *Sophora microphylla*; *Sophora prostrata*; *Sophora tetraptera*

Introduction

The relationship between moths of the genus *Uresiphita* (Hübner) and *Sophora* (L.) plants has been widely studied by Leen (1992, 1995, 1997) and Conant (1975). Generally speaking, the association of the genus *Uresiphita* with its host plants has mostly been attributed to the presence of quinolizidine alkaloids (Banko et al. 2002) in the plant tissues (e.g. Nihei et al. 2002). Species such as *Uresiphita reversalis*, for example, are known to sequester quinolizidine alkaloid from its host plants and use it as a defence as they become aposematic or toxic to predators (Bernays & Montllor 1989; Montllor et al. 1990).

In New Zealand, *Uresiphita maoralis* (Felder & Rogenhofer) is considered a garden and ornamental pest of *Sophora* (kōwhai) plants (Mulvey 1978; Spiller & Wise 1982; Leen 1997). It also feeds on *Lupinus arboreus* (lupin) (Molloy et al. 1991) and it may also feed on *Trifolium* sp. (clover),

Cytisus scoparius (broom) and *Ulex europaeus* (gorse) (Spiller & Wise 1982). *Uresiphita maoralis* was previously known as *Uresiphita polygonalis maoralis* (Felder), but it is now regarded as an endemic New Zealand species (Nuss et al. 2003–2013). In many cases, the host plants of the *Sophora* species become completely defoliated, though this generally does not result in the death of the host plant. Other species of legumes, such as *Lupinus arboreus* (lupin), have been reported to be killed by *U. maoralis* (Molloy et al. 1991), suggesting that this moth species can potentially kill its host plants.

Among the *Sophora* species included in this study, *S. tetraptera* has larger leaves than the other two *Sophora* species. Due to their lower lignin content and high water content, larger leaves may be easier for herbivores to digest (Poorter et al. 2004) and have a longer lifespan (Wright & Cannon 2001). Based on the high levels of infestation and defoliation observed on individuals of

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S. tetraptera in Wellington parks and gardens, in addition to its anatomic leaf features, we hypothesised that under laboratory-controlled conditions *S. tetraptera* would be the most palatable *Sophora* species for *U. maoralis*. We also hypothesised that caterpillars would prefer *S. tetraptera* to *S. microphylla* and *S. prostrata* in choice and multi-choice experiments.

For practical purposes, we defined ‘palatability’ as the quality of a plant to be accepted as a feeding substrate by a caterpillar, and ‘feeding preference’ as the caterpillar’s preference for feeding on one species of host plant when compared to another.

Methods

We examined leaf palatability of leaves from three species of *Sophora* spp: *S. tetraptera*, *S. microphylla* and *S. prostrata* (Fig. 1). Second and third instar larvae were collected in the field from trees of *S. molloyi*. To remove traces of plant material from their digestive systems, and to reduce the potential interference from the previous host plant, larvae were kept in tubes containing a special multipurpose diet (Singh, 1983) until they reached later instars (fourth-fifth). The palatability experiment was a no-choice trial, where a single caterpillar was individually placed in a 100 × 15 mm Petri dish with 0.5–0.8 g of leaves. Thirty-fourth or fifth instar caterpillars of *U. maoralis* were used in

each treatment. We used late instar caterpillars as they move more actively than early instars. In the field, late instar caterpillars can drop from their host plants and move to other plants located in the vicinity (Mundaca E. pers. obs.). The petri dishes were held out in temperature-controlled environments at 22 ± 2°C for 3 h with an unvented lid. Simultaneously, 10 Petri dishes (replicates) of each treatment were kept without larva as controls to check for water loss of the plant tissue under those conditions.

To test feeding preferences we carried out two separate experiments, where caterpillars were simultaneously exposed to different feeding substrates. Both experiments utilised the same plants used for the palatability experiment. We exposed 0.5–0.8 g of leaves to one caterpillar in an individual Petri dish, in paired and multi-choice food treatments. Thirty-fourth and fifth instar caterpillars were used to carry out both experiments.

For both, palatability and feeding preference trials, we measured the initial weight of the leaf material of each species before exposing it to a caterpillar. After 3 hours, we measured the final weight of the sample. For each plant species in a dish, we first recorded the occurrence of consumption as ‘yes’ or ‘no’ because some larvae did not consume any leaf tissue during the trials. Weight measures were carried out using a Mettler Toledo® AG204 scale, with 0.00001 g of accuracy.

To correct for leaf weight reduction due to water loss, we multiplied each final weight measurement observed in the control dish by the percentage of real consumption. Hence, we calculated the plant tissue consumed or food consumption through the following formula:

$$FC = (Fw - Iw) RC$$

Where:

FC = Food consumption

Fw = Final plant weight

Iw = Initial plant weight

RC = Real food consumption or frequency of observed consumption in relation to the total number of replicates per treatment.

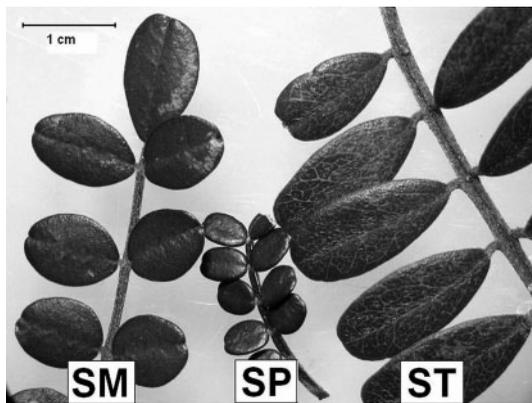


Figure 1 Leaflet morphology of the three species of *Sophora* employed in this study. ST, *S. tetraptera*; SM, *S. microphylla*; SP, *S. prostrata*.

Shapiro–Wilk normality and homoscedasticity tests were employed to analyse the data's distribution for each experiment. Normally distributed data were analysed using a one-way analysis of variance for no-choice and multi-choice tests, while *t*-tests were used in paired choice tests. Kruskal–Wallis and Wilcoxon's independent paired tests were used to analyse data that were not normally distributed. A Tukey HSD post hoc test was carried out to check for variations within the treatments for the one-way analysis of variance. The data were analysed using the STATISTICA 7.1[©] statistical package.

Results

We tested palatability by placing larvae in a no-choice situation where there was only feeding substrate available. The results of the experiments showed no differences ($F = 0.57$, NS, d.f. = 2) among the consumption options of leaf material, showing that all treatments were equally accepted by the larvae. Although many caterpillars did not feed during the trials, the measured levels of effective consumption were above 50% in all treatments (Fig. 2).

The first feeding preferences trial was carried out through a paired choice experiment (Fig. 3). The larvae could choose only between two feeding substrates at the time. *Sophora prostrata* was the least preferred feeding substrate when paired with *S. tetraptera* ($Z = 4.72$, $P < 0.01$) and *S. microphylla* ($Z = 4.782$, $P < 0.01$). The larvae did not show specific preferences for either the *S. tetraptera* or *S. microphylla* substrate ($Z = -0.4564$, NS). When testing the three species simultaneously (Fig. 4), we found significant differences in the consumption levels of leaf material, with *S. tetraptera* showing higher levels of consumption than *S. microphylla* and *S. prostrata* ($H = 58.76$, $P < 0.01$, d.f. = 2). In a number of cases, we observed that some larvae refused to feed during the trial. We were not able to explain this particular behaviour, although, in some cases, larvae have been reported not to feed for unknown reasons in laboratory trials (Sagers 1992).

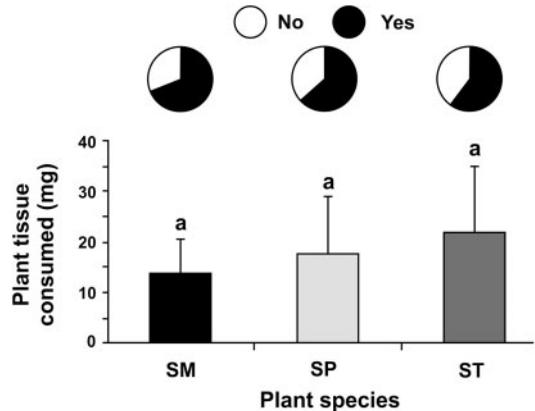


Figure 2 No-choice experiment. Palatability exhibited by *Uresiphita maorialis* larvae for three species of *Sophora* plants \pm SD ($n = 30$) during the 3-hour trials. The shaded portion of the circles represents the proportion of dishes of each plant species in which a caterpillar ate some part of the leaf. ST, *S. tetraptera*; SM, *S. microphylla*; SP, *S. prostrata*. Different letters indicate significant differences between treatments ($P < 0.01$).

Discussion

In this study, we defined 'palatability' as the quality of the plant material to be accepted as a feeding substrate by our herbivore. All three species of *Sophora* offered in the trials were equally palatable to *U. maorialis*. Interestingly, *S. prostrata*, which is widely used as an ornamental plant in Wellington gardens, had never been reported as a host plant. Although *U. maorialis* fed on *S. prostrata* in laboratory bioassays, further experiments are necessary to test the capacity of the larvae to develop into adult stages and to produce viable progeny when reared on *S. prostrata*.

The objective of the choice and multi-choice experiments was to test a situation commonly found in gardens and parks where two or more potential host plant species occur in the same physical space. The paired choice experiment confirmed our hypothesis that *S. tetraptera* was the most preferred feeding substrate. Although we did not analyse the influence of chemical compounds and leaf anatomy on the caterpillar's feeding choices, our results are consistent with those observations made in the field. Hence, in terms of palatability and feeding preferences, we found that the larvae in captivity have



Figure 3 Choice experiment. Feeding preferences exhibited by *Uresiphita maorialis* larvae when testing the three species of *Sophora* \pm SD ($n = 30$) during the 3-hour trials. The shaded portion of the circles represents the proportion of dishes of each pair of plant species in which a caterpillar ate some part of the leaf. ST, *S. tetraptera*; SM, *S. microphylla*; and SP, *S. prostrata*. Different letters indicate significant differences between treatments ($P < 0.01$).

the ability to move and choose different feeding substrates, which seems to suggest that the larvae may be able to discriminate among different food substrates. Consequently, last instar larvae of *U. maorialis* could, to some extent, shift their food consumption towards alternative species of host plants. This could be an important factor driving the defoliation of the plants observed in parks and gardens where, contrary to what happens in natural conditions, planted individuals of different species of *Sophora* occur at short distances from each other. This allows the larvae to move from plants of one species to another. The importance of this discriminating capacity could be less relevant in natural environments, however, where *Sophora* species tend to occur in non-specific patches. Finally, the extent to which this larval capacity explains the defoliation patterns observed in parks and gardens remains unclear, as, like most Lepidoptera species, it is the female adult of *U. maorialis* the one that chooses the oviposition substrate.

According to what we have observed in the field, our findings advance our understanding of the patterns of defoliation observed in the Wellington city area. The dramatic fluctuations that some populations of *U. maorialis* show during the summer

months on individuals of, mainly, *S. tetraptera*, and, secondarily, on *S. microphylla* could indicate, for example, that *U. maorialis* has managed to adapt to a host plant widely available in the Wellington urban area.

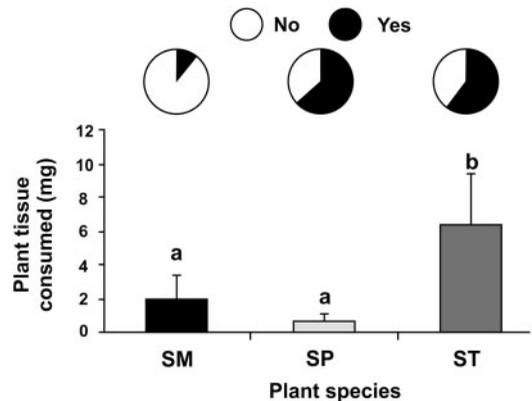


Figure 4 Multi-choice experiment. Feeding preferences exhibited by *Uresiphita maorialis* larvae when testing the three species of *Sophora* \pm SD ($n = 30$) during the 3-hour trials. The shaded portion of the circles represents the proportion of dishes of each plant species in which a caterpillar ate some part of the leaf. ST, *S. tetraptera*; SM, *S. microphylla*; SP, *S. prostrata*. Different letters indicate significant differences between treatments ($P < 0.01$).

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