

Leafroller oviposition on larval host plants

A. R. TOMKINS

Ruakura Agricultural Centre, Ministry of Agriculture & Fisheries, Private Bag,
Hamilton, New Zealand

D. R. PENMAN AND R. B. CHAPMAN

Department of Entomology, Lincoln University, Canterbury, New Zealand

ABSTRACT

Caged greenheaded leafroller (*Planotortrix excessana* (Walker)) (Lepidoptera: Tortricidae) and lightbrown apple moth (*Epiphyas postvittana* (Walker)) (Lepidoptera: Tortricidae) adults were provided with the leaves of known larval host plants to determine the relative amount of oviposition on the different hosts. Relative to apple leaves, lightbrown apple moth oviposited fewer eggs on narrow-leaved plantain (*Plantago lanceolata* L.), and blackberry (*Rubus strigosus* agg.) and equal numbers on poplar (*Populus nigra* L.). Greenheaded leafrollers laid more eggs on poplar leaves than on apple leaves. Close examination of the likely factors determining oviposition sites revealed that hairs on the dorsal leaf surface could affect the choice of oviposition sites.

Lightbrown apple moths therefore tended to oviposit more frequently on the less hairy mature leaves of apple shoots compared to more hairy, emerging leaves which had a greater density of dorsal surface leaf hairs. Arrangement of host plant leaf clusters may have affected oviposition site preference as lightbrown apple moths tended to lay relatively more eggs on apple fruiting clusters than shoots.

Keywords: leafroller, *Epiphyas postvittana*, *Planotortrix excessana*, host plant, oviposition, apple, poplar.

INTRODUCTION

Identification of factors determining oviposition sites for fruit tree pests such as leafrollers may assist control measures. Such information could enable plant breeders to select for characteristics unfavourable to leafroller oviposition. In addition, pest population monitoring could be improved by using the information to select better sampling sites. For example, a major factor determining oviposition sites for codling moth (*Cydia pomonella* (L.)) is plant odour (Wearing & Hutchins 1973). As the odours stimulate female codling moths to lay eggs near fruit, fruiting clusters make an ideal sampling unit (Geier 1963). In contrast to codling moth, leafrollers have a wide range of hosts (Chapman 1973; Spiller & Wise 1982) and host plant odours may fulfil a relatively lesser role in the selection of oviposition sites (den Otter *et al.* 1978). Even so, leafrollers do tend to oviposit on a narrower range of plants than the larvae feed on and Chapman (1973) has termed plants commonly used for oviposition as primary hosts. This paper reports studies of oviposition by 2 leafroller species, the lightbrown apple moth (hereafter LBAM) (*Epiphyas postvittana* (Walker)) and the greenheaded leafroller (hereafter GHL) (*Planotortrix excessana* (Walker)) on known larval host plants and the importance of some factors affecting oviposition.

MATERIALS AND METHODS

Moths were obtained from laboratory colonies, several days after they had emerged. Colonies were reared on modified versions of the diet described by Thomas (1968). The basis of these diets were dried, ground leaves of 1 of 2 known larval host plants i.e. ivy (*Hedera helix* L.) and raspberry (*Rubus idaeus* L.) for LBAM and GHL respectively. Neither of these plants was used in the oviposition studies in case the larval host plant influenced oviposition as suggested by Hopkins (1916).

In each experiment, the leaves of apple (*Malus sylvestris* (L.) Mill cv. "Captain Kidd") and another known larval host (Spiller & Wise 1982) were compared for suitability as

oviposition sites. The host plants chosen were commonly found in or near Canterbury apple orchards i.e. poplar (*Populus nigra* L.) a common shelter tree, narrow-leaved plantain (*Plantago lanceolata* L.) occurred in orchard ground-cover and blackberry (*Rubus strigosus* L.) which was found often beneath fruit and shelter trees. Three replicates were used for each experiment. Each replicate consisted of a cage in which 6 bouquets (or clusters) of the leaves of 2 host plants were alternately arranged in 2 circular patterns. Twenty pairs of moths were placed in each cage for 24 h to oviposit. Cotton swabs soaked in sucrose solution were placed in the centre of each circle to provide the moths with moisture.

The wooden-framed cages of dimensions 350 × 520 × 590 mm were lined with tight mesh plastic netting (Sarlon wind break, Sarlon Reid, Auckland). This material was chosen because leafrollers could not oviposit upon its surface due to the mesh size.

Plant material was collected several hours before beginning an experiment, placed in sealed plastic bags and kept in a cool room until required. The leaves were checked to ensure they were free of naturally laid leafroller egg batches before they were used in these experiments. When placed in the cages, the base of each bouquet was inserted between the netting lining the base of the cages and into a water filled jar beneath. The water maintained the leaves' turgidity, although more succulent hosts such as narrow-leaved plantain required further treatment. This involved inserting the leaf stalks into small test tubes filled with cooling agar. Once the agar had set, the tubes were then inserted through the cage floor.

After each experiment, the number of leaves per bouquet, its position (for leaves attached to stems) and the size of each egg batch (hereafter batch) were recorded. The area of each leaf was measured with a Li-Cor portable leaf area meter (model Li-3000).

Two experiments were conducted for comparisons of apple with blackberry and plantain for LBAM and poplar for GHL. These data were pooled for statistical analysis. The mean size of egg batches laid on the leaves of different host plant leaves were compared by regression analysis and the mean numbers of egg batches or eggs per bouquet/cluster were compared by ANOVA using the data from each of the 6 bouquets/clusters as replicates.

RESULTS

Both GHL and LBAM showed host preferences in the selection of oviposition sites (Table 1). Thus LBAM laid no batches on the narrow-leaved plantain leaves even though large numbers of batches were laid on the apple leaves in the same cages. Similarly, when LBAM were provided with apple and blackberry leaves, only 7.0% of the batches were laid on the latter which constituted 29.8% of the available leaf surface area. There was some indication that batches laid on less suitable host plants were smaller although none of the differences in egg batch size were significant.

Differences in batch size were incorporated into comparisons of relative oviposition on hosts by expressing oviposition as the number of eggs laid per cm² leaf area. Accordingly 7.8 times as many LBAM eggs were laid on the apple as the blackberry leaves (Table 1).

In contrast, an equal number of LBAM batches were laid on apple and poplar leaves. When the same host plants were provided to GHL, relatively larger egg batches were laid on the poplar leaves with the number of eggs per cm² 3.6 times that on the apple leaves. However, these differences were not significant.

Amongst the plant characteristics which may influence leafroller oviposition is the presence of leaf hairs (or trichome). Because leafrollers lay their eggs in batches, hairs might obstruct the placement of a batch. Some support for this suggestion comes from the fact that both GHL and LBAM laid several batches on the hairless ventral surface of poplar leaves but not apple leaves which were hairy. The ventral leaf surface of many plant species are covered to varying degrees with hairs. The leaves of narrow-leaved plantain and to a lesser extent blackberry also have many hairs on the dorsal surface.

Apple leaves have hairs on the dorsal surface when they emerge but these are gradually lost as the leaf matures. Therefore, if leaf hairs affect leafroller oviposition, fewer or no batches should be laid on young apple leaves. To test this hypothesis, oviposition by LBAM

Table 1: Mean number and size of egg batches and eggs per unit leaf area laid on 6 bouquets/clusters of plant leaves by 2 species of caged leafroller moths.

Host plant	No. of batches†	No. of batches per cm ² †	Eggs per batch	Eggs per per cm ² †
(a) Lightbrown apple moth (<i>Epiphyas postvittana</i>)				
apple	15.2	0.0143	37.6	0.535
blackberry	1.2	0.0023	31.0	0.069
SED	2.0	0.0025	6.1	0.099
	**	*	NS	*
apple	32.5	0.0317	—	1.139
plantain	0.0	0.0	—	0.0
SED	3.9	0.0039	—	0.155
	**	**	—	**
apple	2.0	0.0190	45.5	0.079
poplar	2.0	0.0260	24.3	0.073
SED	0.6	0.0006	1.8	0.036
	NS	NS	NS	NS
apple (shoot)	5.7	0.0047	37.8	0.179
apple (fruiting cluster)	6.3	0.0089	30.1	0.264
SED	3.4	0.0035	4.5	0.129
	NS	NS	NS	NS
(b) Greenheaded leafroller (<i>Planotortrix excessana</i>)				
apple	3.7	0.0043	16.1	0.069
poplar	5.3	0.0103	24.7	0.246
SED	2.1	0.0048	8.5	0.066
	NS	NS	NS	NS

Note: †per 6 bouquets/clusters

SED = Standard error of difference

* = $p < 0.05$

** = $p < 0.01$

on the apple shoots which had been used in an experiment comparing apple and plantain were examined in more detail. Shoots were divided into 3 zones (top, middle, bottom), each zone containing an approximately equal number of leaves. Table 2 compares the leaf surface area and density of batches laid in the different zones. Leaves in the middle zone were the largest with a mean (\pm SD) surface area of 26.73 ± 10.22 cm² compared with 10.73 ± 9.28 and 17.65 ± 7.48 cm² for the bottom and top zones respectively. Similarly batches laid on middle zone leaves were largest. However, although middle zone leaves were 47.2% of total leaf area, 33.9% of the batches were laid in the bottom zone whose leaf area was only 21.6% of the total leaf area. Although fewer egg batches per leaf were laid on the top zone leaves and 2.1 and 1.2 times as many eggs were laid per cm² in the bottom and middle zones respectively as in the top zone these differences were not significant.

Table 2: Total leaf surface area, mean number and size of lightbrown apple moth (*Epiphyas postvittana* Walker) egg batches and density of eggs laid in different zones of apple shoots.

	Bottom	Shoot zone Middle	Top	SED	
Leaf surface area (cm ²)	622.22	1363.04	900.02		
No. of batches†	13.3	16.3	9.7	5.2	NS
No. of batches per cm ² †	0.0666	0.0352	0.0355	0.0136	NS
Eggs per batch	36.6	41.0	34.5	4.7	NS
No. of eggs† per cm ²	2.53	1.40	1.20	0.60	NS

Note: †per 6 bouquets/clusters

SED = Standard error of difference

Newly emerged apple leaves which were still actively growing could be distinguished by their relatively lighter colour in addition to the presence of dorsal leaf hairs. These leaves constituted 7.4 and 53.8% of the leaves in the middle and top zones respectively of the apple shoots. Oviposition was then compared on mature and emerging leaves regardless of zone (Table 3). Batch size was similar on the different leaf types even though mature leaves were 30% larger overall. Although 80.6 and 83.9% of the total leaf number and surface area respectively belonged to mature leaves, 94.1% of the batches were laid on them. On the basis of eggs per cm², 3.0 times as many eggs were laid on the mature leaves. This difference was significant but further studies are needed where a similar area of the two types of leaves are provided to ovipositing moths to conclusively establish whether emerging leaves are less suitable for oviposition.

Table 3: Total surface area of mature and emerging apple shoot leaves and mean number and size of lightbrown apple moth (*Epiphyas postvittana* Walker) egg batches laid on them.

	Leaf type		SED	
	Mature	Emerging		
Leaf surface area (cm ²)	2420.49	464.81		
No. of batches†	37.0	2.3	5.0	**
No. of batches per cm ² †	0.0464	0.0154	0.0046	**
Eggs per batch	37.8	39.1	4.6	NS
No. of eggs† per cm ²	1.76	0.63	0.15	**

Note: †per 6 bouquets/clusters

SED = Standard error of difference

** = $p < 0.01$

Another factor which affected oviposition was the type of leaf cluster. Oviposition by LBAM was compared on apple shoots and fruiting clusters (Table 1). A similar number of batches were laid on the 2 types of clusters, but in terms of eggs per cm² the fruiting clusters had 1.5 times as many eggs laid on them. However, this difference was not significant.

DISCUSSION

Most leafroller larvae that cause damage in orchards hatch from eggs laid by immigrant moths from neighbouring areas, although some may originate from sources inside an orchard, e.g., shelter trees. Orchardists may be able to ensure that shelter trees are not major sources of leafrollers by only planting trees which are not primary hosts. These studies have shown that poplar is a primary host of GHL and LBAM. Chapman & Lienk (1971) also found poplar to be a primary host of oblique-banded leafroller (*Choristoneura rosaceana* (Harris)), which damages apples in the USA.

Laboratory studies such as these may also enable the determination of factors which regulate where leafrollers oviposit. Therefore, if leaf hairs deter oviposition it would be advantageous to select fruit tree cultivars with hairy leaves. Leaf hairs have been found to influence oviposition by other tortricids, but Hagley *et al.* (1980) considered it to be of relatively minor importance for codling moth (*C. pomonella*) while Akingbohunge *et al.* (1980) found they increased oviposition by *Cydia ptychora* (Meyrick) on some host plant cultivars. However, these insects deposit their eggs singly and may not therefore find leaf hairs as disturbing as leafroller species such as GHL and LBAM which lay their eggs in batches. Similarly, while blackberry leaves were less favoured oviposition sites for LBAM (Table 1), Wilde *et al.* (1991) have found that the raspberry bud moth (*Heterocrossa rubophaga* Dugdale) which lays its eggs singly, favours the leaves of blackberry for oviposition. The observed lack of oviposition by LBAM on narrow-leaved plantain, agrees with observations by Caesar (1916) who noted that the fruit tree leafroller (*Archips aryoispilus* (Walker)) apparently did not oviposit on the plant even though large numbers of larvae fed on it.

As a greater number of eggs per unit area were laid by LBAM on apple tree fruiting clusters, they should be used as sampling units for the egg batches of this leafroller species.

ACKNOWLEDGEMENTS

The authors wish to thank the Lincoln College Grants committee for funding, Ms B. Dow for statistical analysis and the referee for a thorough and constructive review of this paper.

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