Contribution of Predation and Parasitism to Mortality of Citrus Leafminer Phyllocnistis citrella Stainton (Lepidoptera: Gracillariidae) Populations in Florida

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Abstract

Direct observation and exclusion methods were used to evaluate the individual contributions of predation and parasitism to CLM mortality in the field. Ant predation, especially of young instars, was the largest single cause of mortality, accounting for over 30% of all deaths by natural enemies, and 60% of all death by predators. Ageniaspis citrella was the most important parasitoid, contributing 8.2-28.6% mortality compared to 9.6-14.7% from indigenous parasitoids. The total impact of biotic mortality was 65-70%. Elements of the biotic mortality complex tended to compensate for each other in response to partial exclusion, demonstrating the value of a divers predator and parasitoid biomass.

Background

The citrus leafminer (CLM) is native to southern Asia and an important pest in citrus nurseries and young tree blocks in Florida and more recently, California. It is also known to increase the rate of spread of citrus canker caused by the bacteria Xanthomonas citri and is thus a treat to citrus of all ages. Biological control was deemed the most environmentally sound long-term solution to CLM in Florida and A. citrella from Australia introduced (Hoy and Nguyen 1997) spread quickly and became the most important parasitoid attacking CLM in S.W. Florida (Pomerinke, 1999). However, predation, especially by ants, appeared to provide greater levels of mortality to P. citrella cohorts during most months, although exclusion experiments were inconclusive. The objective of the present study was to: 1) evaluate the relative contribution of biotic factors to CLM mortality through direct observation and exclusion; and 2) reconcile experimental results on leafminer mortality with field observations in the citrus grove.

Material and methods

Year 2002-2003: Sticky barrier exclusion Objective: estimate mortality from crawling predators. 1) Sticker barrier: A two inch wide strip of Tanglefoot® painted on the branch as a barrier to crawling insects; (2) control without barrier.

Timed cage exclusion Objective: Estimate timing of predation/parasitism. A total of about 250-300 eggs were used in the experiment. 1) branch caged from day 1 to day 6 (late 2nd instar), then cage removed; 2) branch caged from oviposition until moth emergence; 3) control: no cage. Other conditions as above, observations were recorded daily until emergence.

Field survey of CLM mortality Objective: Evaluate mortality in open field. Mines were examined under a stereoscopic to determine the proportion containing live larvae, dead larvae or missing larvae. Dead and missing larvae were categorized according to the aspect of the mine by the above criteria. Using this data, an imaginary cohort of 100 individuals starting with 1st stage larva was constructed.

Year 2005 Sticky barrier exclusion: Objective: evaluate timing of predation by crawling insects. Each treatment contained expanding leaves and 120 leafminer eggs or neonate larvae (40x3 replications). Branches were randomly divided into four treatments: 1) control: A. citrella released in no cage. Other conditions as above, observations were recorded daily until emergence.

Cage exclusion Objective: Assess timing of predation/parasitism. One pair of adult CLM were released into an organy sleeve cage over a branch containing expanding leaves for 48hrs to obtain approximately 40 eggs (3 replications x 4 treatments). 1) Branch caged from day 6 (late 2nd instar) to emergence; 2) Branch caged from oviposition to day 6, then cage removed; 3) Branch caged from day 7 until moth emergence; 4) control: no cage. Observations were as above.

Results

Year 2002-2003: Sticky barrier exclusion: Overall survivorship of CLM was less than 10% in both sticky barrier and control (Fig. 1). However, there were differences in individual components of mortality (Table 1). Predation accounted for almost 60% mortality in the control compared to half that value in the barrier treatment. In contrast, parasitism accounted for over 40% mortality in the sticky barrier treatment compared to 18% on untreated branches.

Table 1: Mobility of citrus CLM in open field

<table>
<thead>
<tr>
<th>Branch Treatment</th>
<th>Mortality (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>10.5</td>
</tr>
<tr>
<td>Sticker barrier:</td>
<td>4.6</td>
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</tbody>
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Field survey of CLM mortality: Inspection of mines revealed that mortality of the first 3 larval instars ranged from ca 31 to ca 42% so that only about 25% of a reconstructed cohort would have survived through the feeding stages (Table 4). With an additional 55% mortality observed to the prepupal and pupal stage, total cohort survivorship was estimated at only 12%. Observed mortality from predators ranged from over 30% in the 1st instar to 21% in the 3rd instar to nothing in the pupae stage. Mortality due to parasitism was primarily observed in the prepupal stage where it caused 55% lose, A. citrella was responsible for about 41% mortality.

Conclusions

1. Ant predation, acting primarily on early instars, was the largest single cause of CLM mortality for both year, accounting for over 30% of all deaths by natural enemies, and 60% of all death by predators.

2. Ageniaspis citrella was the most important parasitoid contributing 8.2-28.6% mortality compared to 9.6-14.7% from indigenous parasitoids, although some differences occurred between years.

3. Multiple sources of predation and parasitism tended to compensate for each other in response to partial exclusion.

References cited

