Use of traps to monitor and control hymenopteran pests of Megachile rotundata during storage and incubation

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Introduction & Objectives

The alfalfa leafcutting bee, Megachile rotundata, is a managed solitary species used for the pollination of alfalfa. Managing the bees in shelters in alfalfa fields can put them at risk of parasitism from a variety of wasps including Sapyga pumila, Melittobia sp., and Tetrastichus sp. Sapyga pumila is a univoltine kleptoparasite that kills the bee egg and uses the cell’s pollen reserve for its own offspring. Tetrastichus sp. is a multivoltine parasitoid that oviposits through the leafcutting bee cell and the prepupal skin. Melittobia sp. is a tiny multivoltine parasitoid that enters the leafcutting bee cell and oviposits on the outside of a prepupa.

Since these parasitoids have the potential to be devastating to managed alfalfa leafcutting bee populations, we attempted to develop a mass kill trap for the natural enemies over two field seasons. Protocols to protect bees from some of these pests currently are applied during storage and incubation. The most common anti-parasitoid practices during storage and incubation are the well-timed use of dichlorvos strips and ultraviolet light (UV) with water/oil traps. Non-chemical parasitoid controls are not available. While leafcutting bees are nesting, parasitism can be limited by assuring a snug fit of backings on bee boards. Attempts to control cleptoparasites and predators that attack at the nest entrance has been the use of mechanical (unbaited) traps for Sapyga (Arnett 1980). These traps are not widely used (if at all) and largely assumed ineffective (personal communication with bee managers).

In 2015, we tested a PVC trap in black and white and a nesting block “sticky” trap in black and gray. Both traps had baited and non-baited treatments. Baits were composed of compounds from solvent-extracts of M. rotundata whole nest cells. The PVC traps outperformed the sticky traps in the number of wasps trapped. Sapyga pumila were significantly more attracted to the black traps, without being significantly affected by the bait. Melittobia sp. were more attracted to the white traps and traps without bait. Tetrastichus sp. were more attracted to traps without bait. We aimed to refine our traps and continue evaluations.

In summer 2016, we retested the PVC traps, but only baited them with compounds extracted from the cocoons in the cell (not the whole cell). We also created a new trap designed to offer “snug” crevices for small wasps, and which could be used in incubation trays and in the field. We created two different flat trap designs, block and wave.

We also studied the reproduction and development of Melittobia sp. using incubating alfalfa leafcutting bee prepupae as hosts.

Methods for Wasp Traps

- Traps were placed in shelters in two different grower fields from June - September.
- We used cylindrical PVC traps and also flat sticky traps that we designed and made with a 3D printer.
- We hung black/white and baited/non-baited PVC traps in shelters near bee nesting blocks (Fig. 1).
- We pinned non-baited black/white and wave/block sticky traps to the nesting blocks (Figs. 1 & 2).
- Bait compounds where extracted by agitating either 100 whole cells or 100 whole cocoons in 25ml 2:1 chloroform, methanol solution for five minutes (Fig. 3).
- Traps were baited with 2.5ml of the extract pipetted onto filter papers.
- The traps were collected every week, the catch was recorded (Fig. 4), and the traps were reset back in the shelter.
Results: Field Trapping

While too few wasps were collected 2016 to analyze for affect. However, a trend suggests that *Melittobia* sp. were attracted to black traps, but repelled by the bait (Fig.5).
Methods and Results for Melittobia Life Cycle

All rearing of Melittobia was performed in a workshop where we set up an incubator for this purpose. The workshop was isolated from any stocks of alfalfa leafcutting bees (ALCB), which could easily become infected by this egregious pest.

Protocol for rearing and observations made:

- Day 0, Melittobia adults were introduced to ALCB cells by transferring them with a damp paint brush.
- Through Day 1, the female wasp inspects the cell and selects a location to chew through the cell. The wasp will only make it into the cell within 24 hrs if the cell has already been damaged and little work is needed to enter.
- Day 2, the female has entered the cell. She begins to lay eggs on the surface of the ALCB prepupa. Often the eggs are laid in a group or groups.
- Days 4 and 5, feeding larvae lighten in color and grow 3-4 times their original size.
- Day 6, larvae cease to feed and grow, and they begin to turn gray. Fecal material can be seen moving through their bodies.
- Days 7 and 8, larvae defecate and return to a light yellow body color. Larvae becomes segmented and begin to pupate.
- Day 8 (end), all wasps have pupated.
- The pupal stage lasts through Days 13 - 16 for males and females. Pupal eyes get progressively darker red as the rest of the body darkens. Males develop faster than females.
- By Day 14, males reach adulthood. They die within another 8 days, making their lifespan roughly 22 days.
- By Day 16, females reach adulthood. They generally die by Day 25.
- Females have two forms, short-winged non-disperser and long-winged dispersers. There are few of the short-winged form females, and although they lay eggs on the remains of the prepupa, there is not enough bee material left to raise a new clutch of eggs. The long-winged forms chew out of the cell and disperse to lay eggs in new prepupal cells.

Discussion

Field trials in 2016 to evaluate the efficacy of the different traps was largely inconclusive because of the low numbers of wasps collected. This may mean that the number of pests in general were low in the fields, rather than that the traps were ineffective. Nonetheless, the collection of some pests may help to alert the bee manager to potential problems that could build up in prewinter storage. Evaluations will resume in summer 2017. In addition, Y-tube bioassays will be performed.

Rearing Melittobia in the laboratory provided valuable information about their life cycle and reproductive capabilities during alfalfa leafcutting bee incubation. We now understand that a prepupae in the incubator can only support one Melittobia generation. This 1st generation of females hatches around Day 16. The dispersing forms of females find new prepupal cells (still in the incubator) on which they lay eggs, and their female progeny hatch in 16 or so more days. So, if a grower has Melittobia in the incubator, then the detection of those Melittobia won’t be known until the bee trays have been put out in the field (Day 30+), because new female bees will hatch in ~21-25 days. But, if the flat traps we made can catch Melittobia during incubation because those traps can lay right in the trays with the cells, the grower may have a chance to stop the next generation. These and future work will help to find new management techniques for alfalfa leafcutting bee pest control.