FINAL REPORT

PROJECT TITLE: Biology and Management of Pear Pests

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COOPERATOR: Tom Unruh

OBJECTIVES:
Project objectives are to develop new means for controlling arthropod pests in pears, with emphasis on pear psylla. Focus of the project is to improve our understanding and utilization of natural enemies and biological control in pear orchards. The research consists of a mix of basic and applied studies in both the laboratory and field.

SIGNIFICANT FINDINGS:
2001-2002 seasons:

- Finished analysis and publication of mowing project, showing that reduced frequency of mowing in pear orchards led to substantially higher densities of natural enemies in the ground cover and (for some taxa) in the tree canopy.
    - ***Comment****:* This was a project begun originally using WPCC funding. Those data were then used to obtain a 2-year Western Region SARE grant ($110,000). The studies were done at sites in Hood River, Yakima, and Peshastin. Technology transfer included three field days in Hood River and Peshastin, presentations at workshops and scientific meetings, and publication of papers in technical and trade journals (see list at end of this report).
- Compared approximately 20 cover crops for pest and predator populations in small plot trials. Results of these trials were used to select cover crop mix for 2003 studies (see below).
- Showed that *Campylomma verbasci* (the mullein bug) readily feeds and develops on pear psylla and spider mites, and may be a significant source of biological control in orchards.
- Studies of pest and predator overwintering led to:
    - Development of degree-day models for predator emergence from overwintering sites;
    - Demonstration that common mullein is important source of overwintered pests and predators;
    - Improved understanding of environmental and orchard factors that affect densities of predators overwintering in orchards.
- Showed that a common predator of pear psylla (*Anthocoris antevolens*) is actually a complex of reproductively isolated "cryptic" species, which may differ in how readily they colonize pear orchards.
    - ***Comment:*** This was a project begun originally using WPCC funding. Those data were then used to obtain a 3-year NRI grant ($200,000; Co-PI Tom Unruh).

2003 season:

- Compared taxonomic composition of predator communities in ground cover and tree canopy of pear orchards, as indirect means of learning what predator species might move between ground cover and tree canopy. This involved some rearing of immatures for several groups.
- Showed that predator densities in the tree and pear psylla densities were not substantially affected by presence of a cover crop in small plot trials, despite substantially higher densities of predators in the ground cover where the cover crop was planted. Population trends for both pest and predators, however, suggest possible enhancement of biological control in cover crop plots.

- ❖ Collected predators from both ground cover and tree to screen (using ELISA) for evidence of the predators having fed upon pear psylla, again to look for evidence of predator movement between the two habitats. ELISA assays are ongoing. With Tom Unruh.

RESULTS AND DISCUSSION (2003)

Background: My work has shown that it is easy to prompt a build-up of natural enemies in the ground cover of pear orchards (e.g., by reducing mowing frequency or by planting a cover crop). What is not clear is the extent that build-up contributes to biological control in the tree. This lack of understanding is due to several factors:

- ❖ Poor understanding of predator movement between ground and tree;
- ❖ Less than full understanding of taxonomic composition of some groups; specifically, certain groups (e.g., ladybird beetles, green lacewings) found in orchards are species complexes that may be composed of species having fairly strict habitat preferences (i.e., including ground cover species that never move into trees);
- ❖ Plots are often too small to demonstrate biological control, apparently because movement by pests and predators between plots "washes out" any actual treatment effects.

Objectives:

1) Compare predator community composition in tree and cover crop;
2) Test for effects of cover crop on psylla densities;
3) Address effects of inter-plot dispersal (studies delayed until 2004; see new Proposal);
4) Test for evidence of psylla predation in tree-collected and cover crop-collected predators, using ELISA.

Methods: Cover crop plots (2 tree rows wide x 4 trees long) were established in spring 2003 in the pear orchard at the Moxee farm. Plots were composed of a mix of vetch, winter wheat, crimson clover, and winter Austrian pea (a mix shown earlier by me to harbor large numbers of predatory insects). Control plots were composed of resident rye-grass. Five plots per treatment were established in a randomized block design. Trees and ground cover were sampled with beat trays and sweep nets, respectively every 3 weeks. Leaf samples (for immature psylla) were taken every 3 weeks (100 leaves per plot). Lacewings and ladybird beetles were taken to the laboratory for identification, since they often could not be identified in the field; immatures of these groups were reared to adulthood in the laboratory for identification, by feeding them a mix of pear psylla, green peach aphid, and pea aphid. On several other dates, predators were collected from both habitats, placed immediately on ice, taken to the laboratory and put in an ultrafreezer, and eventually analyzed using ELISA for presence of psylla proteins in the predator gut. Presence of psylla proteins in the guts of predators that were collected from the ground cover would be evidence that predators move between ground cover and tree habitats.

Results: Predator densities were considerably higher in the ground cover of the cover crop treatment than the control (grass) treatment (Fig. 1; data exclude spiders and misc. uncommon taxa). There was a suggestion that the effects carried over to the tree canopy, but the differences were not statistically significant (Fig. 2: tree). Thus, as with some of my earlier work, the results are suggestive of enhancement, but not statistically conclusive. Again, we must consider that plot size was too small to allow statistical differences to show, and that dispersal between plots washed out effects.

Fig. 1: Ground cover (number predators per 10 sweeps)

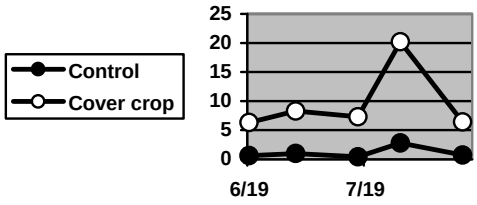
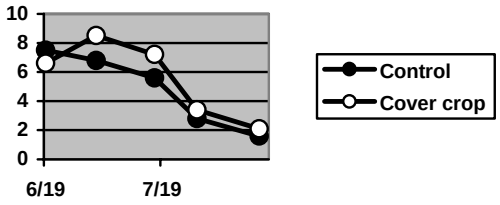


Fig. 2: Tree (number predators per beat tray)



Adult pear psylla were actually more abundant in the cover crop plots than in the grass plots (Fig. 3). This effect was consistent across all 5 blocks, and thus does not appear to be a chance event. It is unclear why adult psylla might prefer trees grown with a cover crop understory, but could include unknown effects of the cover crop on tree nutrition and water, or upon microenvironment surrounding tree. Despite the effects of the cover crop on adult psylla, numbers of psylla immatures per leaf were virtually identical in the cover crop and control plots (Figs. 4-5). When considered in combination with the adult data, results for eggs and nymphs suggest that mortality of immature psylla was higher in the cover crop plots; whether this apparent higher mortality was due to predation is unknown.

Fig. 3: Adult psylla per tray

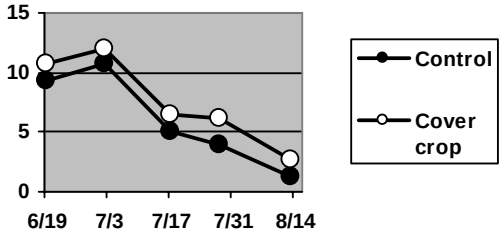


Fig. 4: Psylla eggs per leaf

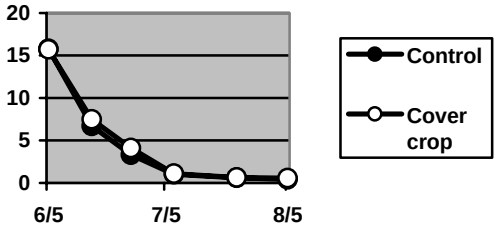
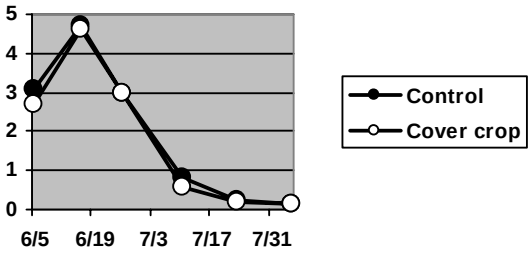


Fig. 5: Psylla nymphs per leaf



Composition of the predator communities is shown in Table 1 (excludes spiders and misc. uncommon taxa). In the ground cover, minute pirate bug and big-eyed bug were most abundant; in the tree, two predators of pear psylla (*Anthocoris, Deraeocoris*) were most abundant. Three groups (minute pirate bug, ladybird beetles, green lacewings) occurred regularly in both the tree canopy and ground cover (Table 1). Closer examination of species' composition for the ladybird beetles and lacewings showed that some species occurred in both habitats very regularly (Figure

Table 1. Percentage composition of major predator groups in tree and in ground cover ranked from highest to lowest.

Ground cover		Tree	
Minute pirate bug	48.5	*Deraeocoris*	57.0
Big-eyed bug	20.2	*Anthocoris*	33.9
Ladybird beetles	10.6	Green lacewings	4.1
Damsel bugs	9.6	Minute pirate bug	2.4
Green lacewings	8.6	*Campylomma*	1.2
Deraeocoris	2.8	Ladybird beetles	0.9
Brown lacewings	0.5	Brown lacewings	0.5

6-7): ladybird beetles - - *Coccinella transversoguttata* and *C. septempunctata*; lacewings - - *Chrysoperla plorabunda*. Thus, for these taxa in particular (including minute pirate bug), we might speculate that manipulation of ground cover to enhance their densities could lead to enhancement in the tree as well. Other species, however, were habitat specialists (Fig. 6-7): ground cover - - *Hippodamia convergens* (beetle) and *Chrysopa oculata* (lacewing); tree - - *Chrysopa nigricornis* (lacewing). Two major psylla predators (*Anthocoris*, *Deraeocoris*) are both habitat specialists, preferring the tree canopy, and their densities are unlikely to be affected directly by cover crop manipulation.

Fig. 6: Percent composition for ladybird beetles

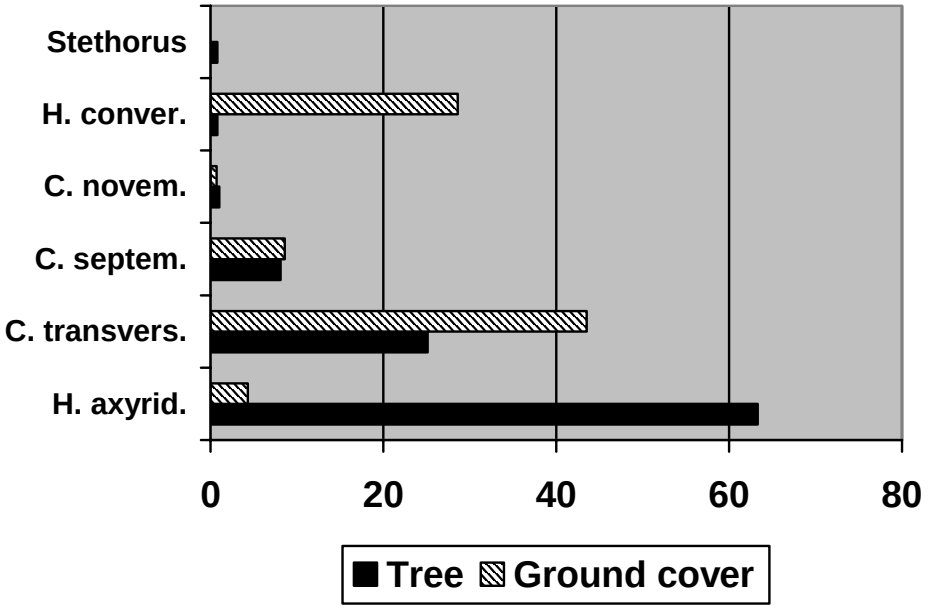
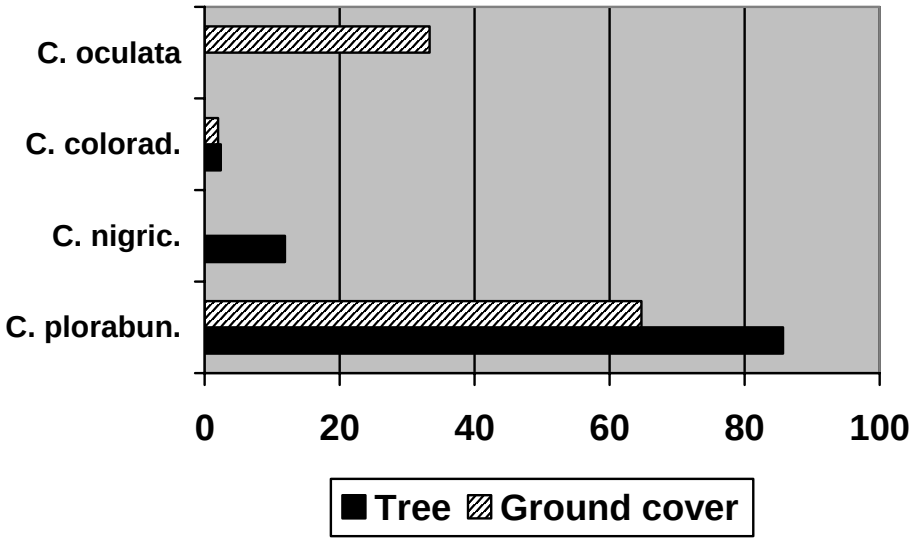


Fig. 7. Percent composition for green lacewings



For the ELISA work, predators were collected from both habitats over the duration of the study. We are currently analyzing the minute pirate bug samples, as we know that this species occurs in both habitats in the orchards. Results will be presented at the research review.

Conclusions: Results indicated that several predator taxa (including minute pirate bug, certain lacewing species, certain ladybird beetle species) utilize both tree and ground cover habitats, thus manipulation of ground cover to enhance numbers of these species potentially could lead to enhancement in the tree. Other taxa, however, were habitat specialists (preferring either the tree or the ground cover), and it seems that cover crop manipulation is unlikely to affect their effectiveness as predators of canopy-dwelling pests such as pear psylla. The ELISA studies are ongoing. A cover crop mix composed of wheat and 3 legumes was shown to provide habitat to high densities of several natural enemy taxa. There was a trend for total predator numbers to be higher in the tree in the cover crop plots as well. Psylla adults were actually more abundant in the cover crop plots than control plots; densities of eggs and nymphs, however, were identical in the two types of plots, suggesting that actual mortality rates of eggs and nymphs were higher in the cover crop plots. Better understanding of predator movements between plots, and between ground cover and tree would be valuable; these questions will be addressed in detail in 2004 (see new Proposal).

TECHNOLOGY AND INFORMATION TRANSFER

Mowing study

- Field days (3)
- Presentations at workshops and scientific meetings (5)
- Journal articles and Proceedings:
  1) **Know when to mow**. *Western Fruit Grower* 120 (#6): 20D-20H
  2) **Evaluating the effects of orchard floor management on biological control in pears**. *Organic Farming Research Foundation Information Bulletin* 10: 22-23.
  3) **Effects of mowing frequency on ground cover insects**. *Proc. Ann. Meeting Wash. State Hortic. Assoc.* 94: 144-147.
  4) **Natural enemy communities in pear orchards affected by mowing frequency**. *Good Fruit Grower* 54 (Dec. 2003): p. 50.

5) **Effects of mowing frequency on densities of natural enemies in three Pacific northwest pear orchards**. *Entomologia Exp. Appl*. 106: 135-145.

Predator overwintering studies

- Presentations at scientific meetings (2)
- Journal articles
  1) **Numbers and types of arthropods overwintering on common mullein in a central Washington fruit-growing region**. *J. Entomol. Soc. Brit. Col*. (in press).

Ground cover study (2003)

- Presentation at Wash. State Hortic. Assoc. meeting (Dec. 2003)

BUDGET

PROJECT TITLE: Biology and Management of Pear Pests
PI: David Horton
Project total (3 years): **$80,693**

Year	Year 1 (2001)	Year 2 (2002)	Year 3 (2003)
Total	34,673	30,050	15,970

Breakdown

Item	Year 1 (2001)	Year 2 (2002)	Year 3 (2003)
Salaries	25,683	22,260	12,700
Benefits	8990	7790	1270
Materials	0	0	2000
Total	**34,673**	**30,050**	**15,970**