FINAL REPORT

TITLE: Pear Psylla Biology and Management

PROJECT NO.: ARS

PERSONNEL: David Horton, ARS, Wapato

REPORTING PERIOD: 1995/96 to 1997/98

ACCOMPLISHMENTS AND RESULTS:
My research on this project can be divided into 4 major topics: **(1)** Biology and management of pear psylla, emphasizing use and effects of COMPLY (1995/96-1997/98); **(2)** Basic biology of predatory bugs in orchards and adjacent habitats (1996/97-1997/98); **(3)** Effects of mowing schedule on insects associated with pear understory (1997/98); **(4)** Effects of insect growth regulators on larvae of obliquebanded leafroller (1997/98). Capital letters in brackets following portions of text indicate citation (see PUBLICATION list, at end).

(1) Biology and management of pear psylla.
COMPLY:

(i) I showed (with B. Higbee and J. Krysan) that contact by female psylla with fenoxycarb or pyriproxyfen caused a reduction in hatch of eggs deposited on untreated foliage **[A]**. Duration and magnitude of the effect depended upon contact duration and dosage.

(ii) A fall application of COMPLY was shown to have minimal effects on spring fecundity and longevity of overwintered psylla **[D]**. An early (October) application caused a modest drop in overwintering survival in the field; later applications (Nov., Dec.) had no effect. Laboratory studies showed that COMPLY-treated winterforms had only slightly reduced tolerance to extremely cold temperatures, and only if exposure was of sufficient duration.

(iii) I showed that the delayed dormant spray was more effective against eggs laid 4 weeks following the spray if branches were drenched with water 4 weeks following the spray **[G,L,M]**. COMPLY apparently is transported from sprayed wood onto unsprayed, expanding foliage by water in sufficient concentration to kill newly laid eggs. These results suggest that judicious use of overhead irrigation in April or rainfall in April may enhance egg kill; furthermore, year-to-year variation in effectiveness of the delayed dormant spray may be caused by rainfall (see below).

(iv) I estimated how long in the field delayed dormant and clusterbud sprays killed newly laid eggs **[O]** (see also **PROGRESS REPORT**).

(v) Susceptibility of psylla eggs to topical applications was shown to depend upon age of eggs **[O]** (see also **PROGRESS REPORT**).

(vi) I spent a great deal of time looking at the effects of spray timing on prebloom densities of psylla at the Moxee orchard **[I,J,P]**. In 1995, the delayed dormant application provided good control well into May (Table 1). However, in both 1996 and 1997, residual life of the delayed dormant spray did not outlast egglaying by winterforms, and we had poor control by the mid-May sample (Table 1). The clusterbud (prepink) spray was of marginal effectiveness all 3 years. The double spray provided the best control (Table 1). I have tentatively concluded from these studies that: (a) the delayed dormant spray has insufficient residual life (in many or most[?]

Table 1. Effects of COMPLY timing on nymphal counts in Moxee pear; all samples taken in mid-May. Values are for total nymphs per sample, expressed as percentage of that occurring in unsprayed control.

	Delayed dormant	Clusterbud	DD + CB
1995	6.5	9.7	3.0
1996	57.5	37.5	9.5
1997*	25.3	35.6	10.4

* Densities on control trees in 1997 were extremely high.

years) to kill eggs laid in mid-April and later (see **PROGRESS REPORT**); and (b) the clusterbud spray fails to kill the earliest laid eggs due to their low susceptibility to COMPLY (see **PROGRESS REPORT**). The question arises: why was the DD spray apparently more effective in 1995 than in 1996 and 1997 (Table 1)? I can only speculate on this question, and suggest that temperature and precipitation are important. Weather patterns differed substantially the three years (Table 2): 1995 was very warm in February (resulting in rapid post-diapause development, early reentry, and early onset of egglaying), and was very wet in March and April (perhaps resulting in improved egg-kill in April due to drench?); 1996 and 1997 were cooler in February, and much drier in March and April than in 1995 (Table 2). It might be of interest to determine whether orchard-wide control of psylla is improved by judicious use of overhead watering in April following a delayed dormant spray of COMPLY.

Table 2. Mean high temperature and monthly precipitation February-April, 1995-1997.

	FEBRUARY		MARCH		APRIL	
	Temp.	Precip.	Temp.	Precip.	Temp.	Precip.
1995	51.8	0.32	55.7	1.28	61.3	1.83
1996	41.2	1.81	54.2	0.57	63.6	0.22
1997	44.2	0.19	54.7	0.60	61.0	0.29

Psylla coldhardiness:

I showed (with L. Neven) that misting overwintering pear psylla with water or water and surfactants caused a substantial increase in susceptibility to subzero temperatures **[C,H]**. Psylla are most cold-hardy in mid-winter (December); early-diapause (October) and late-diapause (February) insects are less tolerant of subzero temperatures.

Antifeedants:

I showed (with T. Weissling) that egglaying, feeding rates, and ovarian development rates are decreased in the presence of certain organic and inorganic compounds, and demonstrated that diapause status affected strength of response **[B,E]**. Results indicated that several "summer type" mineral oils reduce egglaying and feeding; similar results were obtained for other products, notably NEEM, garlic, and extracts from buffalo gourd (Cucurbitaceae).

(2). Basic biology of predatory bugs in orchards and adjacent habitats.

(i) Much of my effort here has been in documenting use of alternative habitats by predatory bugs (*Anthocoris* and *Deraeocoris*). Numerous tree and shrub species were found to support high densities of predatory bugs, including willow, oak, poplar, cottonwood, pear, and bitterbrush **[N,Q]**. Use of these different hosts varied seasonally, with willow and bitterbrush being the most important host in March as the bugs first become active. Predator species differed in host plant preferences: (a) *Deraeocoris* brevis was the most generalized, and was more likely than *Anthocoris* spp. to be found on herbaceous vegetation; (b) *A. antevolens* and *A. tomentosus* were similar in host plant use, except that *A. antevolens* occurred on oak and poplar (in both cases apparently feeding on aphids), whereas *A. tomentosus* was rare on these species; (c) *A. whitei* tended to be restricted to bitterbrush (feeding on a small psyllid); the other anthocorids were almost never found on this species; (d) none of the anthocorids were found in apple except very infrequently (even when aphid densities were very high); conversely, *D. brevis* was common in apple; (e) *A. tomentosus*, *A. antevolens*, and *D. brevis* often built up to large numbers late in the season in pear orchards having high fall densities of psylla; (f) host plants that supported populations during the growing season served as overwintering sites as well (poplar windbreaks were of importance to *A. antevolens*); (g) *A. nemoralis* (introduced from Europe to control psylla) appears to have disappeared from the Yakima valley; in the laboratory, *A. nemoralis* obtained from the San Francisco Bay area (where the species was feeding on an acacia psyllid), was a highly voracious predator of pear psylla.

(ii) Mating behavior, diapause, and overwintering were studied in several species of bugs **[F,K,Q]**. Sex ratios of overwintering adults were strongly female-biased in *Anthocoris* and *Orius* (minute pirate bugs), and modestly biased in *Deraeocoris brevis*. I found that mating is necessary to prompt ovarian development in *Anthocoris* spp. (unlike in most other insects), and that lack of mating, delays in mating, or mating of insufficient duration results in resorption of eggs before any egglaying. Diapause is under control by photoperiod, with shorter days causing adults to diapause rather than to reproduce. Dissections of field-collected bugs indicated that individuals having diapause characteristics (immature ovaries and large amounts of fat body) could be collected all season, for unknown reason.

(3) Effects of mowing schedule on insects associated with pear understory.

Mowing frequency was shown to affect plant and insect abundance and diversity in the pear orchard understory. This study summarized in **PROGRESS REPORT**.

(4) Effects of insect growth regulators on larvae of obliquebanded leafroller.

Diapause and survival of neonate larvae were both affected by growth regulators, depending upon type of growth regulator, photoperiod, and temperature. See **PROGRESS REPORT** for summary.

PUBLICATIONS:

Peer-reviewed journals

Higbee, B.S., D.R. Horton & J.L. Krysan. 1995. Reduction of egg hatch in pear psylla (Homoptera: Psyllidae) after contact by adults with insect growth regulators. J. Econ. Entomol. 88: 1420-1424. **[A]**

Horton, D.R., T.M. Lewis & T.J. Weissling. 1995. Reduction in feeding by diapausing and postdiapause pear psylla (Homoptera: Psyllidae) caused by extract from buffalo gourd. J. Entomol. Soc. Brit. Col. 92 (Dec.): 9-15. **[B]**

Horton, D.R., T.M. Lewis & L.G. Neven. 1996. Reduced cold-hardiness of pear psylla (Homoptera: Psyllidae) caused by exposure to external water and surfactants. Can. Entomol. 128: 825-830. **[C]**

Horton, D.R. & T.M. Lewis. 1996. Effects of fenoxycarb on ovarian development, spring fecundity and longevity in winterform pear psylla. Entomol. Exp. Appl. 81: 181- 187. **[D]**

Horton, D.R. & T.M. Lewis. 1997. Quantitative relationship between sticky trap catch and beat tray counts of pear psylla (Homoptera: Psyllidae): seasonal, sex, and morphotypic effects. J. Econ. Entomol. 90: 170-177.

Weissling, T.J., T.M. Lewis, L.M. McDonough & D.R. Horton. 1997. Reduction in pear psylla (Homoptera: Psyllidae) oviposition and feeding by foliar application of various materials. Can. Entomol. 129: 637-643. **[E]**

Horton, D.R., T.M. Lewis, T. Hinojosa and D.A. Broers. 1998. Photoperiod and reproductive diapause in the predatory bugs *Anthocoris tomentosus*, *A. antevolens*, and *Deraeocoris brevis* with information on overwintering sex ratios (Heteroptera: Anthocoridae and Miridae). Ann. Entomol. Soc. Am. (in press). **[F]**

Horton, D.R. and D.A. Broers. 1998. Movement by fenoxycarb from sprayed to unsprayed surfaces due to water drench: effects on eggs of pear psylla (Homoptera: Psyllidae). J. Entomol. Soc. British Columbia (in press). **[G]**

Presentations

Horton, D.R., T.M. Lewis & L.G. Neven. 1995. Misting with water and surfactants reduces coldhardiness in pear psylla (Homoptera: Psyllidae). Pacific Branch, Entomol. Society of America. San Diego, California. **[H]**

Horton, D.R. 1995. Timing of spring fenoxycarb application and effects on first generation pear psylla. Washington State Horticultural Assoc., Wenatchee, Washington. **[I]**

Horton, D.R. and T.M. Lewis. 1995. Timing of prebloom fenoxycarb sprays and effects on first generation pear psylla. Entomological Society of America. Las Vegas, Nevada. **[J]**

Horton, D.R. and T.M. Lewis. 1996. Factors prompting diapause in anthocorid predators of pear psylla. Pacific Branch, Entomol. Society of America. Big Sky, Montana. **[K]**

Horton, D.R., D. Broers and T. Hinojosa. 1996. Movement by fenoxycarb from treated to untreated surfaces and effects on pear psylla eggs. Canadian Entomol. Soc., Fredericton, N.B., Canada. **[L]**

Horton, D.R. and D. Broers. 1996. Movement by fenoxycarb from sprayed to unsprayed surfaces due to water drench: effects on eggs of pear psylla. Washington State Hort. Assoc., Yakima, Washington. **[M]**

Horton, D.R., T. Hinojosa, D. Broers and T. Lewis. 1996. Seasonal change in use of non-orchard "host plants" by anthocorid and mirid predators of pear psylla. Entomological Soc. America, Louisville, Kentucky. (abstract published in The IPM Practitioner 19(#5): 13) **[N]**

Horton, D.R. 1997. Susceptibility of pear psylla eggs to Comply: field residual activity and effects of egg-age. Wash. State Hort. Assoc., Wenatchee, WA. **[O]**

Horton, D.R. 1997. Biology and management of pear psylla. 1997 Annual G.S. Long Tree Fruit Seminar, Yakima, WA.

Trade journals

Horton, D.R. 1996. Timing of prebloom 'Comply' sprays and effects on first generation pear psylla. Good Fruit Grower 47 (#4): 50-51. **[P]**

Horton, D.R., T.R. Unruh and B.S. Higbee. 1997. Predatory bugs for biological control of pear psylla. Good Fruit Grower 48 (#13): 29-32. **[Q]**