Cherry Ermine Moth (Lepidoptera: Yponomeutidae) Occurrence and Survey Methods Evaluation in Washington State

1995 Project Report - Washington State Department of Agriculture

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INTRODUCTION

The cherry ermine moth (CEM), *Yponomeuta padellus* (L.) is an exotic insect pest recently discovered in British Columbia, Canada, and northwestern Washington State. CEM is native to Europe and Asia, where it is a pest of many rosaceous plants.

The larvae develop in communal webs, enveloping and defoliating host plants in spring. Economic and native hosts for CEM in Washington State include most types of cherry, plum, peach, and other stone fruits, as well as hawthorn, mountain ash, and serviceberry. A 1994 USDA Pest Risk Assessment considered CEM a risk for MODERATE economic, environmental, and social or political impacts if it becomes generally established (Chawkat, 1994).

Another closely related exotic species, the apple ermine moth (AEM) *Yponomeuta malinellus* (Zeller) was found in B.C., Canada, and northwestern Washington State in the early 1980's. AEM and CEM larvae and adults are essentially identical in appearance, biology, and time of occurrence. The primary difference in the two species is their development on different host plants, with AEM larvae feeding exclusively on apple foliage. The AEM has rapidly expanded it's distribution in the Pacific Northwest, and in 1995 is found in most of Washington State and northwestern Oregon in the U.S.. This dispersal, apparently through natural spread of adult AEM, has been monitored by both the Washington State (WSDA) and Oregon Departments of Agriculture (ODA). Surveys for AEM have used an AEM pheromone attractant developed in 1986 by the USDA ARS Yakima Research Lab. Defoliation of apple trees by AEM has been severe in some areas of northwestern Washington, and biological control agents from Europe and Asia have been introduced in an attempt to reduce AEM populations, damage, and pesticide usage (Unruh et al. 1993).

Discovery of CEM in 1993 in B.C., Canada, prompted an initial detection survey in Washington State by WSDA that same year. However, although the pheromone attractant for CEM is known from European research, survey results were obscured by the inability to identify collected adults as either AEM or CEM. Differentiation of AEM and CEM adult moths became possible when DNA-based identification techniques were developed by researchers in 1994 (Sperling et al. 1995).

The presence of CEM in Washington State was first confirmed in 1994, based on larval collections from ornamental hawthorn foliage in Bellingham, Whatcom Co.. Distribution survey and evaluation of survey methods for CEM, using genetic identification techniques, were conducted in 1995.

This paper is intended as a survey and methods report only. Mention of a proprietary product does not constitute an endorsement or recommendation for its use by WSDA or USDA.

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PROJECT OBJECTIVES FOR 1995

Survey / Biological Objectives (WSDA)

1. Conduct delimiting survey in Western Washington and detection survey in areas of Eastern Washington. Eastern Washington detection survey included export nursery production areas, to provide information for regulatory planning.

2 Determine biology and seasonal phenology (timing of development and flight) of CEM in Washington through field observation and pheromone trap monitoring.

3. Begin limited population monitoring of CEM infested areas for trends or changes in populations, host selection, and impact.

Methods Development Objectives (In cooperation with the USDA APHIS, Otis Methods Development Lab.)

4. Determine which of three trap types performs best for CEM survey with the least number of bird and nonspecific catches.

5. Determine the specific attractiveness of CEM and AEM pheromone lures.

6. Determine the utility of established molecular markers for CEM and AEM identification.

DELIMITING and DETECTION SURVEYS

Methods
Pheromone baited traps were placed in counties along the east side of Puget Sound (in Western Washington), from near the Canadian border south to Lewis county Additionally, three counties in Eastern Washington, east of potential mountain-pass immigration routes and in areas of large scale fruit-tree nursery stock production were surveyed. Overall trap placement by county is listed in Table 1. and on Map Figure 1.

Pherocon 1-C® type traps, baited with CEM septa lures (z-11-tetradecenyl acetate) provided by USDA APHIS Otis Methods Development, were deployed from early June through August. Traps were hung in CEM host plants, primarily cherry and hawthorn trees, and inspected approximately every two weeks. Trap sites were evenly spaced at intervals along the I-5 corridor in Western Washington, and throughout the surveyed counties in Eastern Washington.

Sixty sites in the Bellingham area were also trapped for CEM as part of a study of different trap types and pheromone lure specificity (see Methods Projects / Traps - Lures). These sites included CEM hosts as well as AEM hosts (*Malus sp.*), and also utilized two additional trap types (Pherocon 2®, Multiphere®).

Ermine moth specimens collected as non-target catches in survey traps for other pests were also identified to species this year. One survey trap in particular, baited with a pheromone lure for a Pandemis leafroller (85:5:10 / Z,11-14:Ac : Z,9-14:Ac : Z,11-14:OH) attracted significant numbers of AEM, but no CEM.

DELIMITING and DETECTION SURVEYS (Cont.)

Results

CEM were caught in all counties surveyed in western Washington. The southernmost site and county where CEM was found in this survey was in Lewis County, approximately 30 miles south of Olympia. The number of moths captured and percentage of traps catching moths was highest in Whatcom County, decreasing in counties to the south. Moth catch by county, and other relevant trap capture data are presented in Table 1.

No CEM were detected in Eastern Washington. Export nursery production areas of Grant county were well trapped in 1995 (90 traps), establishing the area as currently free from CEM.

Table 1. 1995 CEM Pheromone Trap Survey Results (by County)

Area	County	# Sites Trapped	# Sites Positive	% Sites Positive	Total # CEM Trapped	Ave. # CEM / Positive Site
Western Washington	Whatcom (Bellingham grid)*	60	57	95%	457	8.02
	Whatcom (county survey)	26	19	73%	62	3.26
	Skagit	27	9	33%	16	1.78
	Snohomish	52	23	44%	69	3.00
	King	58	16	28%	23	1.44
	Pierce	61	10	16%	11	1.10
	Thurston	109	7	6%	8	1.14
	Lewis	49	3	6%	3	1.00
Eastern Washington	Okanogan	46	0	-	0	-
	Grant	90	0	-	0	-
	Kittitas	49	0	-	0	-
Totals		627	144		649	

* Trap types used in the Bellingham grid: Pherocon 1-C sticky trap, Pherocon 2 sticky trap, and the Multiphere dry trap. All other areas trapped with only the Pherocon 1-C sticky trap.

BIOLOGY and 1995 SEASONAL PHENOLOGY of CEM in WASHINGTON STATE

Methods

Larval development and pupation were directly observed and recorded in the field where possible. Periodic field examinations for larval activity began April 5 at a known previously infested site. Several sites were found in south Bellingham, Whatcom County, where larval populations could be monitored and pupation observed. Adult flight was recorded through pheromone trap captures of male moths. Pheromone trap monitoring began in mid-June and continued until the end of August, with trap check intervals averaging from one to two weeks. The three month project was expected to collect data for most of the flight season, including first and peak flight times, but not the end of flight. Capture data from traps checked weekly in a trap comparison study in Bellingham were analyzed for CEM seasonal flight phenology and compared to similar data for AEM captures in the same study (see Methods - Trap / Lure Studies)

BIOLOGY and 1995 SEASONAL PHENOLOGY of CEM (Cont.)

Results

The first visual detection of CEM larval activity was on May 4, when small larval webbing tents, 1" - 2" in size, were found on ornamental hawthorn foliage in the south Bellingham area. The earlier spring leaf-mining behavior, characteristic of first instar ermine moth larvae, was not observed. On May 4 most larval tents (on hawthorn) were somewhat difficult to find, hidden among leaves or under clusters of blossom buds which had not yet opened By mid-May larval tents were much more discernible, 2" - 4" in size and beginning to accumulate some larval frass and leaf debris. In June, the CEM larval tents were relatively obvious, particularly in direct sunlight when the webbing is "shiny". Late instar CEM tents and feeding damage observed in ornamental hawthorn are very similar to that of AEM (in apple). When foliage in feeding tents is consumed, larvae move to new sites in the host canopy, creating additional 3"- 5" tents.

The first CEM pupation was observed on June 22. CEM larvae pupate in clusters in the webbing of feeding tents similar to AEM, but unlike AEM do not spin completely opaque white cocoons. Fully formed CEM pupae are easily visible inside loosely spun cocoons suspended within the tent webbing. CEM pupae are also distinctly colored, with black wing covers and light yellowish body, in contrast to the even overall light tan of AEM pupae.

Adult male CEM were first found in pheromone traps on June 29. The first flight recorded from any trap site this year was in the Bellingham trap methods comparisons grids, and was recorded at 12 trap sites the same week. First flight recorded for AEM was also the same week in the same trap grids, with catches at 2 sites. Overall trap catch for both species gradually increased every week until mid-July, then decreased abruptly in late July and early August. Weekly male moth catch results for both species are presented in Table 2.

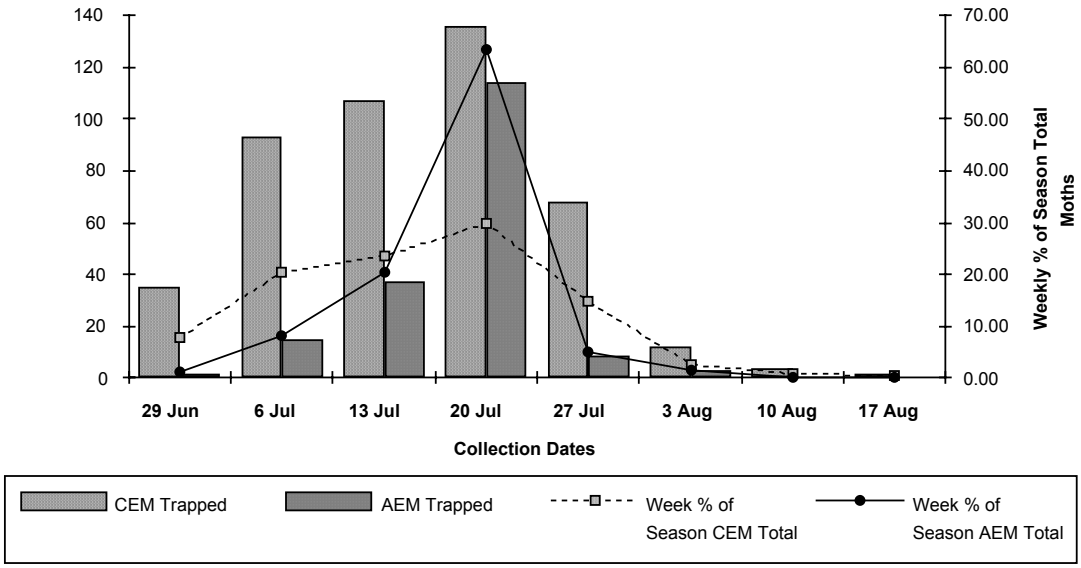
Table 2. 1995 Weekly CEM / AEM Trap Catch Totals - Trap Comparison Grids, Bellingham.

Collection Date	# of Sites w/ CEM	**# of CEM Collected**	% of Yr. Total CEM	# of Sites w/ AEM	**# of AEM Collected**	% of Yr. Total AEM
29 Jun	12	**35**	7.69	2	**2**	1.11
6 Jul	21	**93**	20.44	9	**15**	8.33
13 Jul	22	**107**	23.52	13	**37**	20.56
20 Jul	24	**136**	29.89	15	**114**	63.33
27 Jul	20	**68**	14.95	6	**9**	5.00
3 Aug	10	**12**	2.64	3	**3**	1.67
10 Aug	4	**2**	0.44	0	**0**	-
17 Aug	1	**2**	0.44	0	**0**	-
23 Aug	0	**0**	-	0	**0**	-
29 Aug	0	**0**	-	0	**0**	-
TOTALS	114	**455**	-	48	**180**	-

BIOLOGY and PHENOLOGY (Cont.)

In the Bellingham trap comparison grids, 1995 **peak flight for both CEM and AEM occurred the collection week ending July 20**. However, while the peak flight was synchronous for the two species, the overall seasonal flight pattern was notably different. **CEM flight was relatively evenly spread from late June through July, while AEM flight was much more synchronous**. Over 63% of the seasonal total of AEM trapped were collected during the one week period ending July 20. The patterns of adult CEM and AEM flight phenology are presented in Figure 2.

Figure 2. 1995 Weekly CEM / AEM Trap Catch in Trap Comparison Grids, Bellingham.



The last catches recorded from the Bellingham grid traps in 1995 were during the weeks ending August 17 and August 10 for CEM and AEM respectively. The last CEM catch in any trap was recorded in a delimiting trap on August 29, in Seattle, King County, as traps were being removed at the end of the project survey period.

POPULATION MONITORING / (Baseline) Observations

Methods

Cherry and Hawthorn host trees were examined at intervals from the mid to late larval development period on a more or less random basis throughout the south Bellingham area. Visual examinations included many trapped and untrapped host trees in the areas of the 10 trap methods comparison grids. Sites where larval tents were found tended to form the focus of more intensive inspection of adjacent alternate hosts and were revisited several times during larval development.

Results

Only a few sites with readily observable larval tents were found in the Bellingham area in 1995, and only in thickets of ornamental hawthorn *(Crataegus monogyna* Jacquin*).* CEM was not found on native hawthorn *(Crataegus douglasii* Lindl.) or any cherry (*Prunus spp*) host plants. In general, CEM presence in Whatcom county was not readily noticeable. Even in the areas of highest trap catch numbers, larval tents were still not very conspicuous.

CEM SURVEY TRAP EVALUATION

Methods

Ten pre-selected sites (trap grids) were trapped in south Bellingham, Whatcom County, beginning July 10. Each trap grid consisted of six trees, three apple and three ornamental hawthorn. Trees in the study were located no closer than 20m to each other. Traps were placed in the lower canopy in as exposed a position as possible.

Six traps; two Pherocon 1C (w/ low stickum bottoms), two Multiphere (1 inch diameter round entry holes, w/ ddvp), and two Pherocon 2, were rotated through all sites in each grid. Initial trap placement by site was selected at random. A CEM or AEM lure was placed in each trap type so that one of each trap type contained either a CEM or AEM lure throughout the study. Each trap was checked and moved to the next tree in sequential rotation through each site once a week. All ermine moths collected were sent to the USDA APHIS Otis Methods Development Lab for genetic species identification. All traps were removed on August 24, 1996.

Results

A brief summary of trap performance and moth catch by trap type and site is presented in this report. A detailed analysis of the trap performance data is in preparation and will be reported at a later date (*In Prep. - Analysis of Apple and Cherry Ermine Moth Survey Methods*).

Overall, **the Pherocon 1-C and Pherocon 2 total ermine moth catches were not significantly different (327 vs. 225),** while **the Multiphere caught significantly fewer moths (65 total)**.

By tree type (for all traps combined), CEM catch was very similar in both sites (215 in hawthorn vs. 222 in apple), while AEM catch was greater in apple (172 vs. 48 in hawthorn).

Table 3. Trap Evaluation Catch Results by Tree Site Type, Trap Type, and Lure.

		# of Moths Trapped		
Tree Type	**Trap Type**	**CEM**	**AEM**	**Trap Total**
Hawthorn	Pherocon 1-C	68	36	104
	Pherocon 2	105	3	108
	Multiphere	42	6	48
	Hawthorn Total	215	45	260
Apple	Pherocon 1-C	**136**	**87**	223
	Pherocon 2	73	44	117
	Multiphere	13	4	17
	Apple Total	**222**	**135**	357
Both Types (Combined)	Pherocon 1-C	204	123	**327**
	Pherocon 2	178	47	**225**
	Multiphere	55	10	65
	Combined Total	**437**	**180**	617

TRAP EVALUATION Results (Cont.)

Surprisingly, the total number of CEM captured in all grid traps greatly exceeded AEM (437 CEM vs. 180 AEM). These results suggest **the CEM lure has a much higher attraction/capture rate than the AEM lure** in light of the relative populations present in the study area. AEM is very abundant throughout the study area, with many larval tents conspicuous in most host trees in 1995. CEM larvae, in contrast, were difficult to find (see POPULATION MONITORING).

The overall greatest number of both CEM and AEM were captured in Pherocon 1-C traps placed in apple trees (136 and 87 respectively).

Several small birds were captured and killed by the Pherocon 1-C traps during the course of this study. None were caught in the Pherocon 2 traps.

While these data show a somewhat different total CEM capture between the two Pherocon trap types, it should be noted that the number of test sites and replicated lure/tree/trap combinations in this trial are insufficient for meaningful statistical comparison. However, if the CEM capture rate is assumed roughly equal for the two Pherocon traps, the difference in **bird (non-target) captures suggest the Pherocon 2 is preferable to the Pherocon 1-C for CEM survey**. Additionally, field staff found the one-piece Pherocon 2 trap much easier and quicker to place and service than the multi-component Pherocon 1-C. This **utility and a lower initial purchase cost also make the Pherocon 2 trap more economical overall than the Pherocon 1-C for CEM survey**.

PHEROMONE LURE SPECIFICITY / MOLECULAR MARKER UTILITY

The CEM and AEM pheromone lures are highly species-specific. The species of over 640 specimens were determined using genotypic analyses, which otherwise could not be distinguished using morphometric methods. Sperling *et.al.* 1965 showed the two species can be differentiated by comparing restriction site polymorphisms in the mitochondrial DNAs of the two species. Table 4 shows the specificity of the CEM and AEM lures are 99.4% and 98.6%, respectively. These high specificities indicate there is very little cross contamination when counting adults in traps containing one of these lures. Thus, no genotype analyses will be required to determine species in subsequent surveys.

Table 4. Genotype Analyses of Trapped Ermine Moths.

Lure Type	# Specimens CEM	# Specimens AEM	# Specimens Total
CEM	644 (99.4%)	4	648
AEM	2	183 (98.9%)	185
Data provided by the Molecular Diagnostics Group of the USDA, APHIS, PPQ, Otis Methods Development Center			

SUMMARY / DISCUSSION

Survey results clearly demonstrate that CEM is now well established and widespread in Western Washington. The contiguous catch sites and gradual decreasing moth catch in the more southerly counties suggest the current distribution is the result of natural spread of CEM south from the Canadian border. The inconspicuous presence of CEM, particularly in the Bellingham area, also suggests that CEM has spread throughout Western Washington while still at relatively low population levels.

The Bellingham trap evaluation results and overall trap catch data show the CEM pheromone lure is a very effective and species specific detection survey tool. The Pherocon 2 type sticky trap was also found to be an effective, more economical and easier trap to use than the (current standard) Pherocon 1-C type wing trap for CEM survey.

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Citations

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