1997 Entomology Project Report
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1997 Update – Survey and Methods Development for the Apple Tortrix - *Archips fuscocupreanus* (Lepidoptera: Tortricidae) in Washington State

ERIC LAGASA, MARK HITCHCOX[1], TOM UNRUH[2], AND TOM BOYD[1]

BACKGROUND

The apple tortrix (AT), *Archips fuscocupreanus* Walsingham, was first identified in North America in 1995, by the Washington State Department of Agriculture (WSDA). AT was previously known to occur only in Japan and Korea, where it is an economic pest of apple, pear, and mulberry (Oku 1967).

In general, AT is a small moth in the leafroller family Tortricidae, with larval "leafrolling" habits similar to many other leaf and fruit damaging pest species in this large family. A summary of AT biology from the Japanese literature includes the following:

- AT is univoltine (one generation per year) and overwinters in the egg stage on the tree in protected areas, primarily on trunks and branches.
- Eggs hatch from early April to early May.
- Larvae feed until late May or early June, then pupate on the tree.
- Adults begin to appear in mid June to early July. After mating, eggs are laid until August or September.

1995 Apple Tortrix Detection

Adult AT specimens were first detected as a "non-target" catch in a 1995 WSDA pheromone trap survey for cherry ermine moth (CEM), *Yponomeuta padellus* (L.). Examination of available traps found that AT was present in much of the Puget Sound area of western Washington (E. LaGasa, et. al., 1997a).

Initial field and survey work was complicated by similarities between AT and the European leafroller (ELR), *Archips rosanus* (L.), which was also common at the same sites as AT. The two species are essentially identical in physical appearance, and share similar phenology and feeding behavior. Preliminary diagnostic evaluation found that adult males of these species can be separated by several microscopic characteristics, including the shape and size of the forewing costal fold, and minor differences in the genitalia.

1996 Apple Tortrix Survey

Field projects to evaluate AT in Western Washington conducted in 1996 produced preliminary data on host plants, phenology, and relative abundance. Additional physical traits for identifying female and male adults were also established or identified for further evaluation, including hind wing color and better male genitalia characteristics. Pheromone trap survey confirmed AT establishment in Thurston, King, Pierce, Snohomish, Skagit, and Whatcom counties. Ten monitor sites established in the Olympia area recorded AT adult flight from late June to late August in 1996.

The 1996 pheromone trap survey also evaluated the number of ELR caught with the CEM pheromone lure, an important aspect given the difficulty of separating AT and ELR. Comparison of AT and ELR catch with CEM lures suggested that the CEM lure is very specific for AT, and attracts very few ELR (total catch was 265 AT vs. 2 ELR).

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[1] Project Staff, Laboratory Services Division, WSDA, Olympia, Washington 98504-2560
2 USDA ARS Yakima Area Research Lab, 5230 Konnowac Pass Rd., Wapato, WA 98951

1997 APPLE TORTRIX SURVEY

Goals of the 1997 survey season included:

1) Identify/verify diagnostic (identification) characters for AT larvae, pupae, and adults.
2) Continue evaluation of host plants and biology of AT in the Olympia area.
3) Continue AT population and phenology monitoring at the Olympia-area sites.
4) Assess parasitism in AT larval populations in Pierce and Thurston counties.
5) Evaluate an AT specific pheromone lure produced by the USDA APHIS Otis Methods Lab.
6) Provide text and graphics for a USDA ARS Yakima Area Research Lab web site on AT.

METHODS

Rearing and Identification

Field collected AT egg masses and larvae were reared following procedures used in 1996. Larval collections were from randomly selected host plants in Thurston and Pierce counties. Rearing results reported here also include AT larvae collected during a 1997 general defoliator survey of the Tacoma Port Area (LaGasa, Boyd, 1997b).

Taxonomic identification of reared parasitoids was provided by Paul M. Marsh and Norman E. Woodley at the USDA Systematic Entomology Laboratory (SEL).

Olympia-area Monitor Sites

The 1997 pheromone trap monitoring followed the 1995 and 1996 methods; Pherocon 1-C® type traps and CEM pheromone lure from the USDA APHIS Otis Methods Lab. Traps were hung in early June and inspected approximately every two weeks through mid-September.

AT Pheromone Lure Evaluation

The AT-specific lure produced by the Otis Methods Lab was tested for both AT and ELR catch in a small-scale paired-trap trial. Pherocon 2® type traps, baited with either the CEM or the new AT pheromone lure, were hung on opposite sides of the same tree (2 traps/tree). Trap servicing (i.e. placement, bi-weekly checks) was the same for both trap/lure combinations, but recommended lure replacement intervals were different (4 weeks for AT lures, 12 weeks for CEM) and lures were replaced accordingly. The specific pheromone lure components were:

CEM pheromone -	.035mg e-11 tetradecenyl acetate,
	.4mg z-11 hexadecenyl actetate,
	.1mg z-11tetradecenynl acetate
AT pheromone -	.8mg z-11 tetradecenyl acetate
	.2mg e-11tetradecenyl acetate

RESULTS

Diagnostic Characters

Adult and larval AT identification characters have been identified by WSDA in order to help distinguish it from other similar leafroller species, primarily the filbert or European leafroller (ELR), *Archips rosanus*. Detailed pictures of diagnostic characters used to separate AT and ELR are available on the internet @ http://pwa.ars.usda.gov/yarl/bandi.html. Descriptions of the characters are summarized in the following list.

Diagnostic Characters (Cont.)

Larval differences, most pronounced in later instars, are;

- The mandibles of AT larvae are darkly pigmented (black) in the basal half, quite different than ELR larvae which have mandibles that are uniformly amber-colored throughout. Mandibles of first instar larvae in both species have very little pigmentation.
- The prothoracic shield (the dorsal, chitinous plate behind the head) of AT has an irregular, narrow band of dark pigmentation along the hind edge, while ELR has a wide, smooth-edged dark band.
- AT larvae have verrucae (dorsal, wart-like protuberances bearing setae on the last 2 thoracic segments) that are dark-colored and prominent. ELR larvae possess verrucae that are usually inconspicuous and not darkly pigmented.

Shed pupal case color is consistently different.

- AT pupal cases are brown, while those of ELR are a lighter straw-color.

Adult characters include;

- Male AT genitalia have distinctive ventral lobes on the lateral valves, ELR does not.
- Male AT genitalia have an aedeagus characterized by a robust ventral spine on the terminus, whereas ELR genitalia show a long, thin penisfilum at the terminus.
- Males of both species have distinctly different costal folds (a fold in the leading edge of the fore wing); male AT have a short, wide "taco-shaped" costal fold, and male ELR have a "burrito-like" fold that is longer and narrower. A sample of 30 moths of each species produced the following measurements;

	Length of costal fold	Width of costal fold	Ave. Ratio (and Range) of Length/ Width
AT (apple tortrix)	2.7 – 4.7 mm	0.36 – 0.75 mm	**6.0** (4.9 – 7.8)
ELR (European leafroller)	4.1 – 7.3 mm	0.25 – 0.5 mm	**15.2** (10.0 – 22.0)

- Hind wing, dorsal surface coloration is consistently different for both sexes between species (in Washington State populations). ELR adults have an obvious orange-colored area near the distal tips of the gray hind wings, whereas AT hind wings are uniformly gray or, at most, have only a slight tinge of orange coloration on the tip.

AT Biology

Several new host plants produced AT larvae in 1997, including; oak (*Quercus sp.)*, green ash *(Fraxinus pennsylvanica)*, and aspen *(Populus sp.)*. Previously identified host plants in Washington include; apple, azalea, cascara, filbert, maple, cherry, Asian pear, and english laurel.

First egg hatch was not recorded in 1997. However, in the Olympia area, the first AT larvae were found after April 18th (1997). Pupation in the field was observed as early as May 17th, and as late as June 4th.

Olympia AT Monitor Sites

Flight times for AT in Olympia were recorded from 11 June to 5 Sept., with the highest catch recorded from mid July to early August. Overall, trap catch was lower in 1997 than the previous year, with a total AT catch of 214 moths versus 265 in 1996 (see Table 1). This may be due to 1997 spring and early summer weather conditions, which were generally colder and wetter than in 1996. In 1995, total catch at the same sites was 188 AT.

Olympia AT Monitor Sites (Cont.)

Table 1. AT trapped at Olympia area monitor sites, 1995 - 1997.

Site Number	1995 Catch Total	1996 Catch Total	1997 Catch Total	Change in Catch, '96 to '97
1105 / 1725	1	0	4	4
1143 / 1726	26	38	39	1
1162 / 1727	29	24	12	-12
1164 / 1728	26	18	9	-9
1165 / 1729	27	18	9	-9
1169 / 1730	20	3	11	8
1143 / 1731	6	12	3	-9
1186 / 1732	30	130	117	-13
1194 / 1733	9	20	6	-14
1195 / 1734	14	2	4	2
Totals	188	265	214	-51

Parasitoids Reared from AT in the Olympia Area

From a total of 161 AT larvae collected and reared, 16 produced parasitoids. This indicates a 9.9% rate of parasitism for AT larvae collected from Pierce and Thurston counties in 1997.

Only six of the reared parasitoid specimens have been identified to species or genus as of this date (see Table 3).

Table 3. Parasitoids reared from AT larvae in 1996.

Order	Family	Genus species	# of AT hosts
Hymenoptera	Braconidae	*Apanteles* sp.	1
Hymenoptera	Braconidae	*Microgaster* sp.	1
Hymenoptera	Braconidae	*Oncophane* sp.	1
Hymenoptera		unknown	10
Diptera	Tachinidae	*Hemisturmia parva*	2
Diptera	Tachinidae	*Eumea caesar*	1

AT pheromone lure evaluation

Paired trap trials were conducted in 4 AT infested counties, using CEM and AT lures. A total of 690 AT adults were trapped at 63 sites, of which 60% were attracted to the CEM lure, and 40% to the AT lure. The average number of moths per CEM and AT trap type were 18 and 13, respectively. These overall results suggest that the CEM lure may have slightly greater attraction for AT than the AT lure. Comparison of AT catch at individual paired-trap sites indicates no consistent preference of lure type (see Table 4). This preliminary test suggests no significant difference in AT lure preference; however, a statistically valid evaluation of lure attraction would require significantly greater resources than were available.

AT pheromone lure evaluation (Cont.)

Table 4. 1997 Results - Paired Trap Trials / AT Captured by County and Trap Type.

County - Lure Type	# of Traps	# Positive traps	% Traps Positive	Total # AT	Ave. # AT/ Pos. Trap
King Co. - CEM	8	8	100%	200	25
King Co. - AT	8	7	88%	226	32
Pierce Co. - CEM	21	14	67%	212	15
Pierce Co. - AT	21	12	57%	45	4
Thurston Co. - CEM	15	0	0%	-	-
Thurston Co. - AT	15	2	13%	6	3
Whatcom Co. - CEM	19	1	3%	1	1
Whatcom Co. - AT	19	0	0%	-	-
Total (All Traps)	126	44	35%	690	16
Total - CEM	63	23	37%	413	18
Total - AT	63	21	33%	277	13

Seven specimens of ELR were also collected in this 1997 paired-trap trial, all of which were caught in AT-lure traps. The small number of ELR caught in AT lure-baited traps in 1997 suggest the AT lure may be slightly attractive to ELR. But again, these data were developed in a small scale test, and neither the overall AT catch by lure type or the small number of ELR caught have been evaluated for statistical significant.
In 1996, two specimens of ELR were trapped (when only CEM lure-baited traps were used).

AT Internet Information Page
Through the generous assistance of Drs. Carrol Calkins and Tom Unruh, AT information and identification graphics have been posted to a web page hosted by the USDA ARS Yakima Area Research Lab. URL for the page is: **http://pwa.ars.usda.gov/yarl/bandi.html**

Pertinent Literature

LaGasa, E., D. Hartley and M. Allen, 1997a. Biology and distribution of the apple tortrix (Lepidoptera: Tortricidae) in Washington State, a polyphagous leafroller pest new to North America. WSDA Entomology Program Report; Feb.3, 1997 (10pp. w/ map)

LaGasa, E., T. Boyd 1997b. 1997 Tacoma Port Area Defoliator Survey, Pierce County, Washington State / ArcView 3.0 GIS Evaluation Project, Nov. 20, 1997 (10pp. w/ maps)

Oku, T. 1967. Tortricoidea as agricultural and horticultural pests in Hokkaido, with special reference to the host plants. Bulletin of the Hokkaido Prefecture Agricultural Experiment Station 16: 44-62 (in Japanese with English summary).

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Report prepared by:

Eric LaGasa, State Entomologist
Washington State Department of Agriculture
Lab. Services Division
P.O. Box 42560 Olympia, WA 98504
(360) 902-2063 FAX (360) 902-2094
eMail: elagasa@agr.wa.gov

Mark Hitchcox, Entomology Technician (Project)
PO Box 7181
Olympia, Washington 98507

Dr. Tom Unruh, Research Entomologist
USDA ARS Yakima Area Research Lab
5230 Konnowac Pass Rd.
Wapato, WA 98951
(509) 454-6550

Tom Boyd
Laboratory Technician (Project)
Olympia, Washington 98504