Phenology model for the omnivorous leaftier, *Cnephasia longana*: reviving intensive research from a bygone era

Leonard Coop

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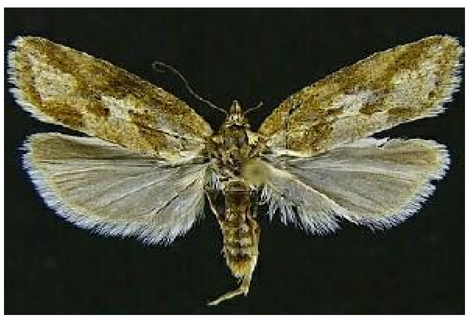

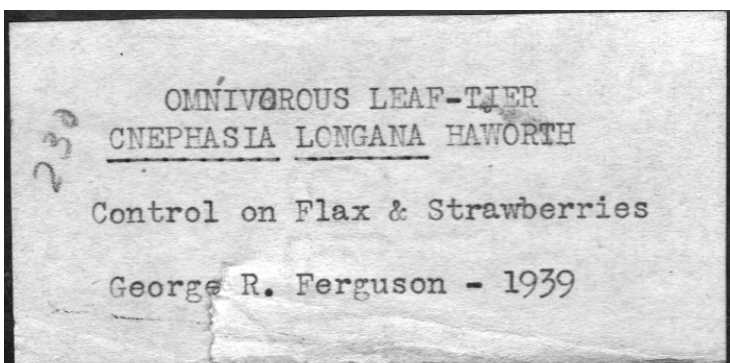
OMNIVOROUS LEAF-TIER
CNEPHASIA LONGANA HAWORTH

Control on Flax & Strawberries

George R. Ferguson - 1939

nnivorous leaftier model - OSU vers. 1.0

cation: 2013 CRVO CORVALLIS OR

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11-13	437	Initial 1st instar larvae out of OW hibernacula (2-5%)
3-28-13	631	Peak 1st instar larvae out of OW hibernacula (50-60%
4-5-13	793	Initial 3rd instars exit leaf mines begin leaf tying (2-5%)
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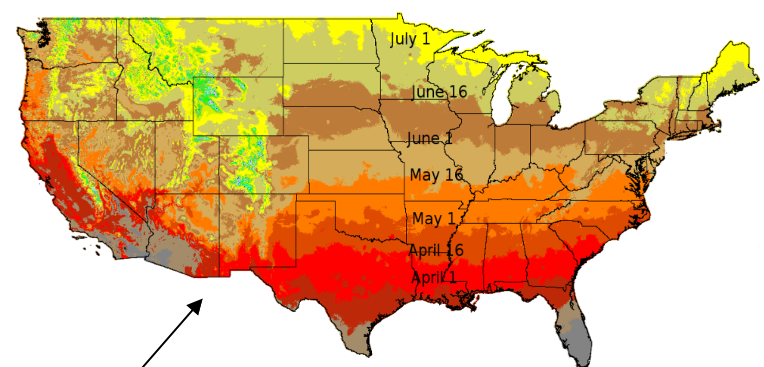

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OLT Facts

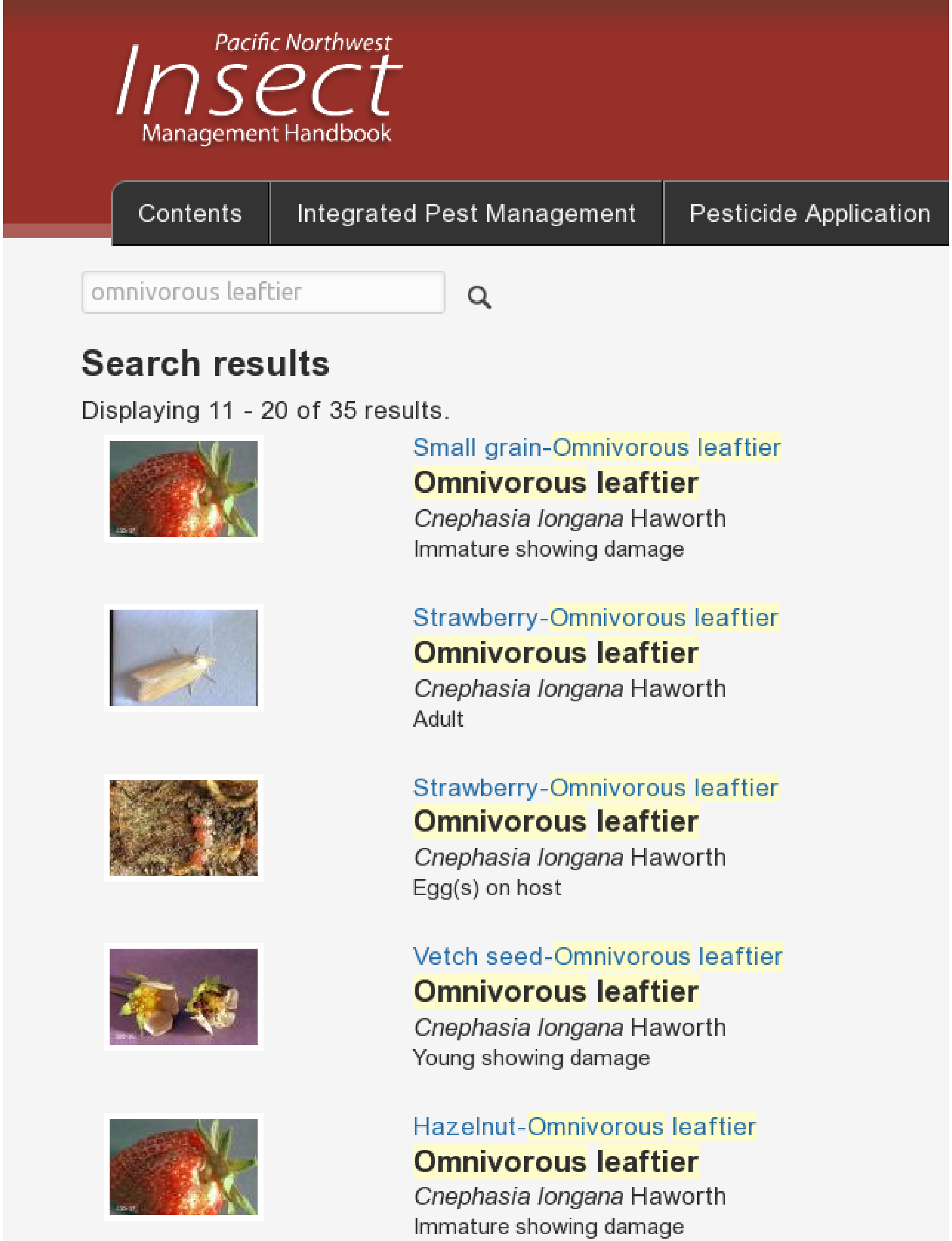
1) *Cnephasia longana* (omnivorous leaftier) known from W. Europe, discovered as an invasive pest in W. Oregon in 1929. A major pest of flax, flowers, strawberries by 1931.
2) 1951-1954 9 parasitoids introduced; none known to have established.

1980-1981: High parasitism found for OLT in caneberries (Coop 1983), All believed to be native parasitoids. Responsible for minor pest status?

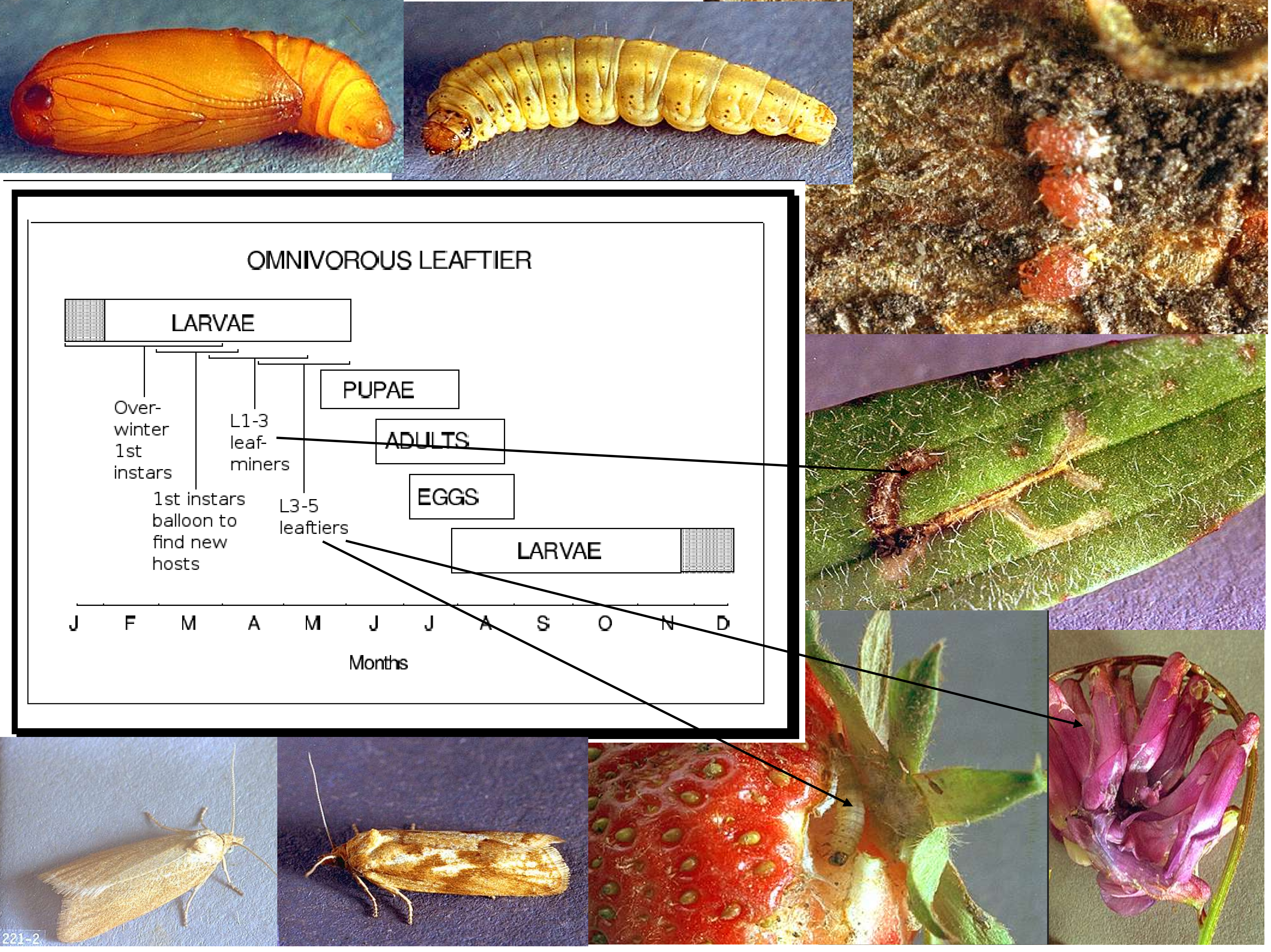
Table 10. Parasitization record for *Cnephasia longana* collected in *Rubus*., Willamette Valley, OR 1980-1981.

Species	Determined by:	Also reared from *Argyrotaenia citrana*	Number reared:	Percent
**Meteorus argyrotaeniae* Johanson	P. Marsh	Yes	11	32.4
Diadegma spp.	H. Townes	Yes	4	11.8
Enytus eureka (Ashmead)	L. Coop	Yes	3	8.8
**Phytodietus vulgaris* (Cresson)	C. Loan	Yes	1	2.9
Oncophanes americanus (Weed)	P. Marsh	Yes	1	2.9
Unknown sp.	--		1	1.9
Total parasitized			21	61.8
Non-parasitized larvae reared			13	
Total			34	

* New host record



OLT – today a pest of NW crops such as nursery crops, small grains, straw-berry, vetch, hazelnuts, hops....


OMNIVOROUS LEAFTIER
LARVAE
Over-winter 1st instars
1st instars balloon to find new hosts
L1-3 leaf-miners
L3-5 leaftiers
PUPAE
ADULTS
EGGS
LARVAE
J F M A M J J A S O N D
Months
221-2

Model built entirely from unpublished experiment station reports, 1930-1951

References on file at OSU IPPC Library (Part of OSU Valley Library, Corvallis, Oregon):

1. Omnivorous leaftier Reports 1930, 31, 34, 35, W. Donald Edwards et al.
2. Insect Pests of Flax and Their Control. Proj. Rep. For 1937. George R. Ferguson
3. Insect Pests of Flax and Their Control. Proj. Rep. For 1938. G. R. Ferguson
4. Omnivorous Leaf-Tier Cnephasia longana Haworth Control on Flax and Strawberries, by G. R. Ferguson – 1939
5. The Omnivorous Leaf-Tier, Cnephasia longana Haworth and its Control on Flax and Strawberries by R. G. Rosenstiel. 1940
6. The Omnivorous Leaf-Tier – 1941. R. G. Rosenstiel
7. The Omnivorous Leaf-Tier, Cnephasia longana Haworth & Its control on Flax and Strawberries by R. G. Rosenstiel. 1942
8. The Control of the Omnivorous Leaf-Tier, Cnephasia longana Haworth, by R. G. Rosenstiel – 1946
9. Control of the Omnivorous Leaf-Tier, Cnephasia longana Haworth by R. G. Rosenstiel -1947
10. Insect Pests of Small Fruit. Proj. Report for 1951. R. G. Rosenstiel

Phenology studies on early spring 1st instar ballooning using tanglefoot/flypaper: 1930-36, 38-41, 51

Figure 13. Tanglefoot on fence post at J. D. Erntson location.

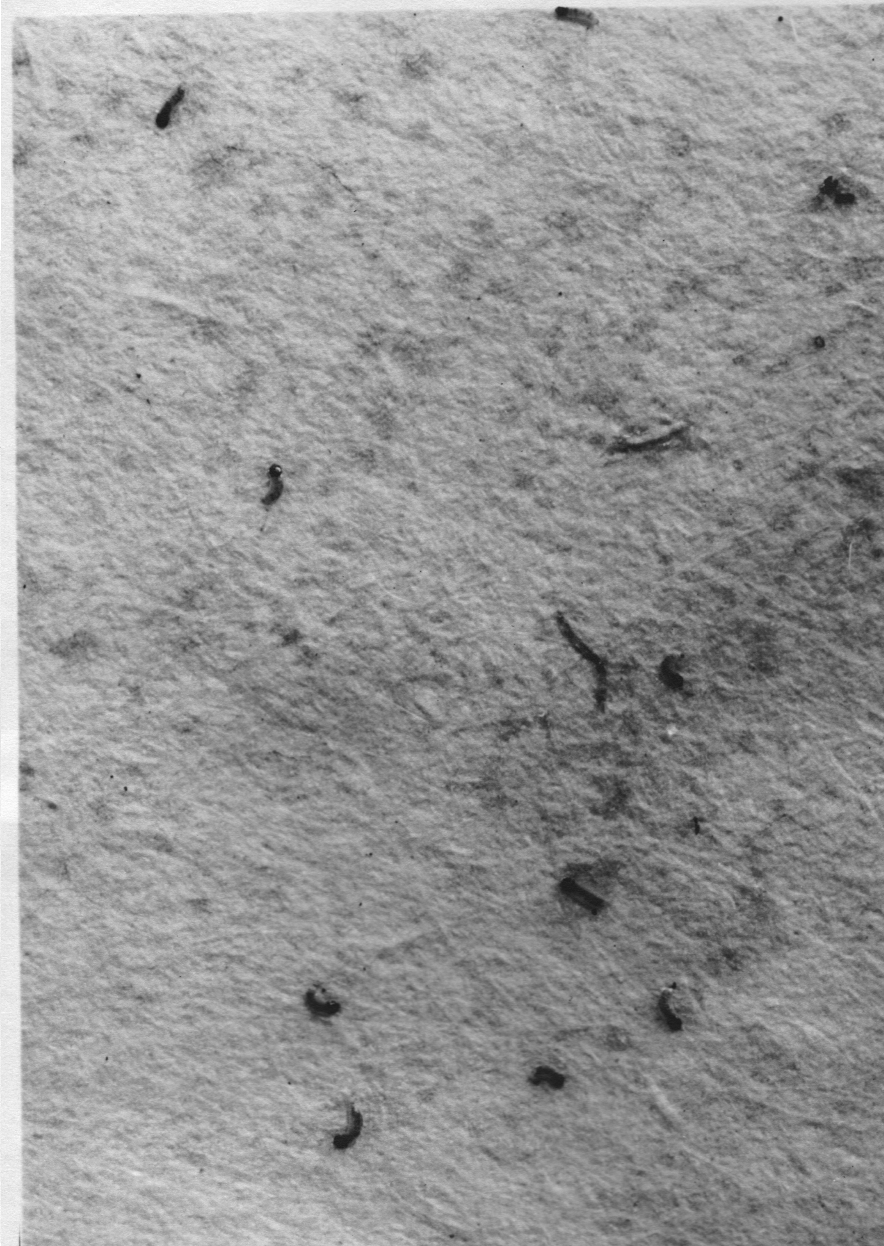
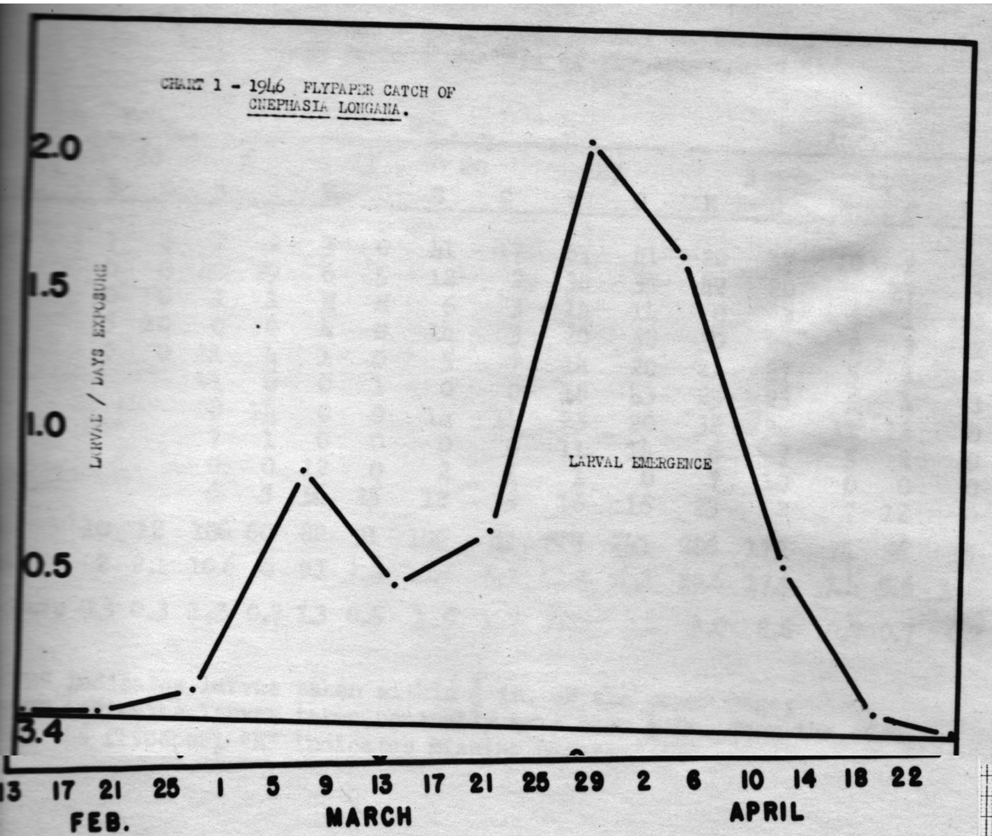
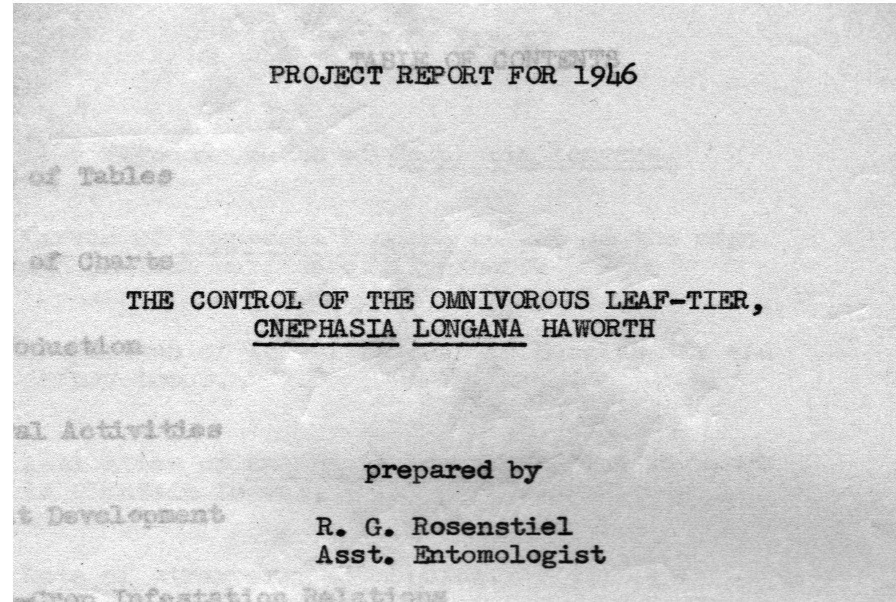


Figure 17. First instar larvae of Cnephasia longana Haw. on Tanglefoot. (X10 approx.)

Example 1st instar balloon sample data using tanglefoot traps

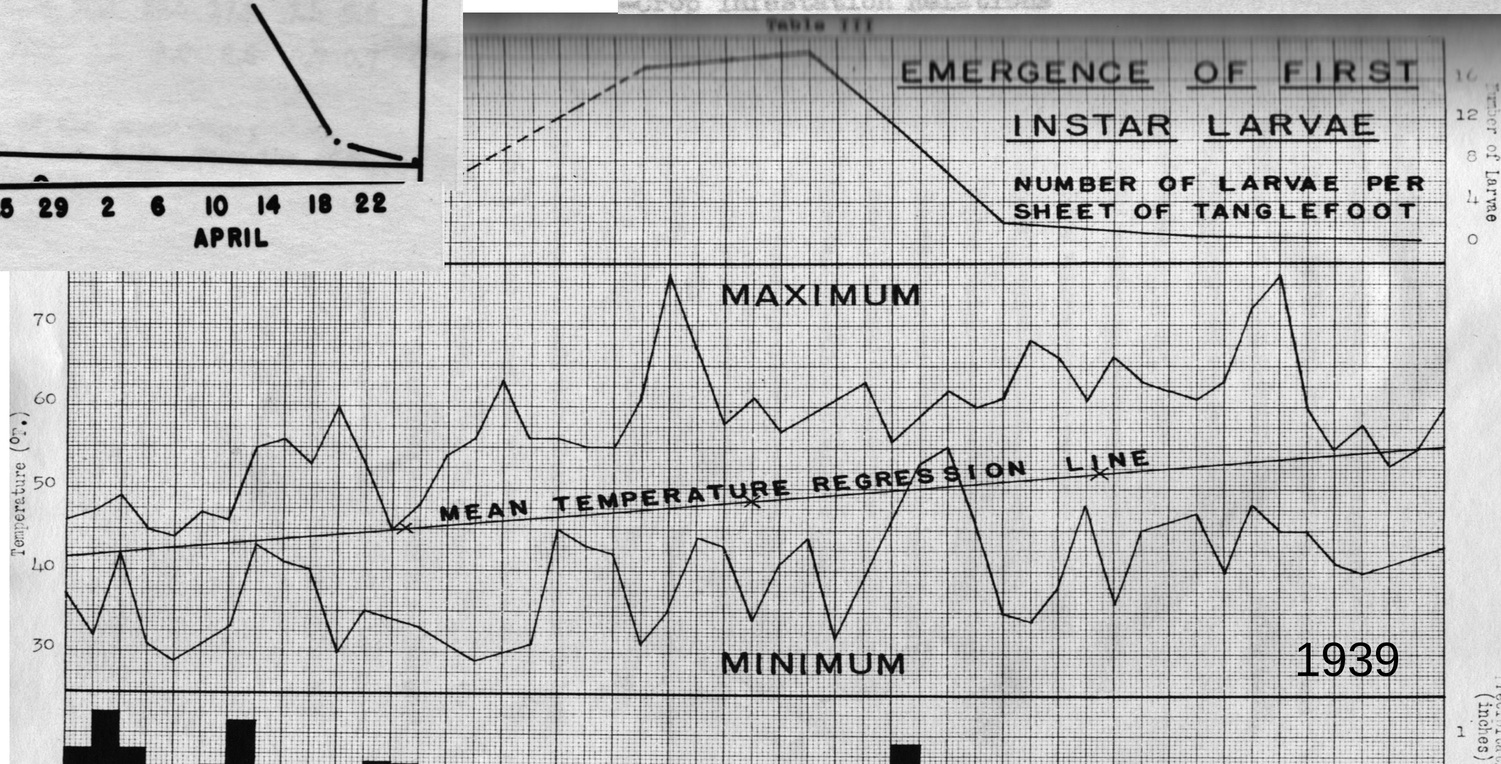



PROJECT REPORT FOR 1946

THE CONTROL OF THE OMNIVOROUS LEAF-TIER,
CNEPHASIA LONGANA HAWORTH

prepared by

R. G. Rosenstiel
Asst. Entomologist



A bygone era (eg OLT spray trial in strawberries in 1939):
- pre-synthetic pesticides (no organo-phosphates, carbamates, pyrethroids)
- horse drawn spray rigs

Figure 3. Side View of Duster Used
in Experimental Dusting of Strawberries

Dusting trials with:
Rotenone
Pyrethrins
Nicotine
Sulfur
Dichlorethylether
(an early
Organochlorine)

Trade names included
“Lethane” and
“Genicide”

“no measurable degree
of control was obtained
by the use of any of the
dusts”

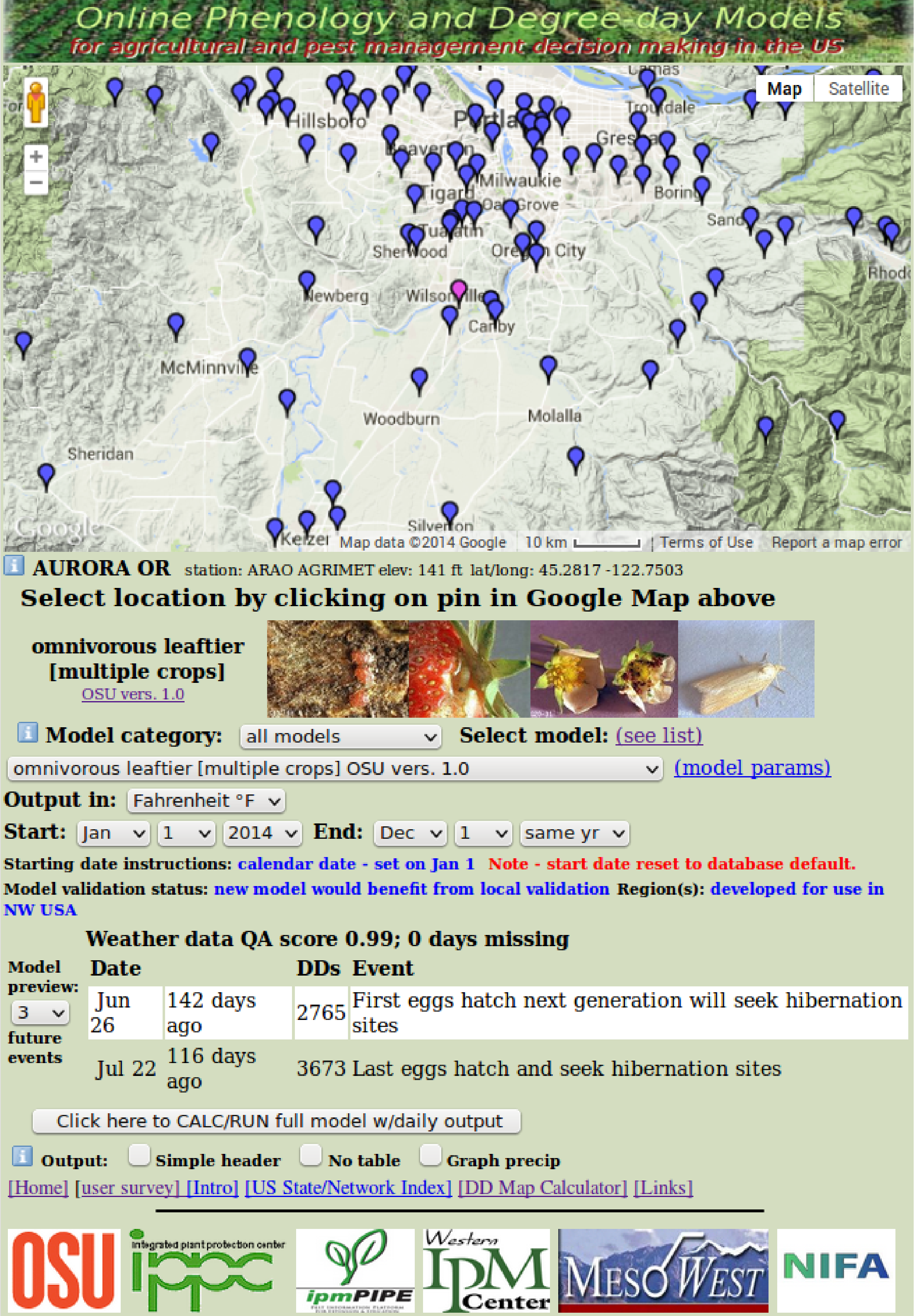
Recommendation:
rotate corn with flax
or strawberries

Model building methodology:

The usual compilation of field (all stages) and lab data (eggs only), select key stages or events in life cycle, find mean Dds with lowest error (lowest C.V. Method) by trying various start dates and lower and upper temperature thresholds.

3. Lowest C.V. Analysis of Thresholds

	Event		Mean DDs	St. Dev.	Co. of Var. (C.V.)			N. Years Avail.
62	**3. Lowest C.V. Analysis of Thresholds**							
63								
64	**Event**		**Mean DDs**	**St. Dev.**	**Co. of Var. (C.V.)**			**N. Years Avail.**
68			Jan1,Tlo=36	Jan1,Tlo=36	Jan1,Tlo=36	Jan1,Tlo=38	Jan1,Tlo=39	Jan1,Tlo=39
69	1st instar	First (2-5%)	435.8	142.88	32.78	35.06	49.43	7
70	balloon	Peak (50-60%)	617.0	91.77	14.87	15.28	17.87	7
71		End (90-100%)	809.5	74.90	9.25	10.10	14.14	7
72	3rd instar	First (2-5%)	775.0	166.17	21.44	22.51	38.50	4
73	emerge	Peak (50-60%)	1210.3	53.74	4.44	5.61	25.13	4
74		End (90-100%)	1559.0				8.95	3
75	1st larvae		1124.8	198.32	17.63	19.11	21.10	6
76	1st pupae		1698.0	97.87	5.76	6.17	9.78	7
77	end larvae		2541.5	171.15	6.73	7.41	9.38	7
78	1st moths		2044.8	92.72	4.53	4.53	7.90	7
79	1st eggs oviposited		2265.3	99.09	4.37	4.41	4.44	4
80	end pupae		2742.2	292.49	10.67	11.47	11.41	7
81	end moths		3074.6	201.51	6.55	7.14	7.25	6
82	last egg hatch		3673.0					1
83	last larvae enter hibernation		3739.0					1
84	1st eggs hatched		2765.3					
85	Mean C.V.				11.59	12.40	17.33	

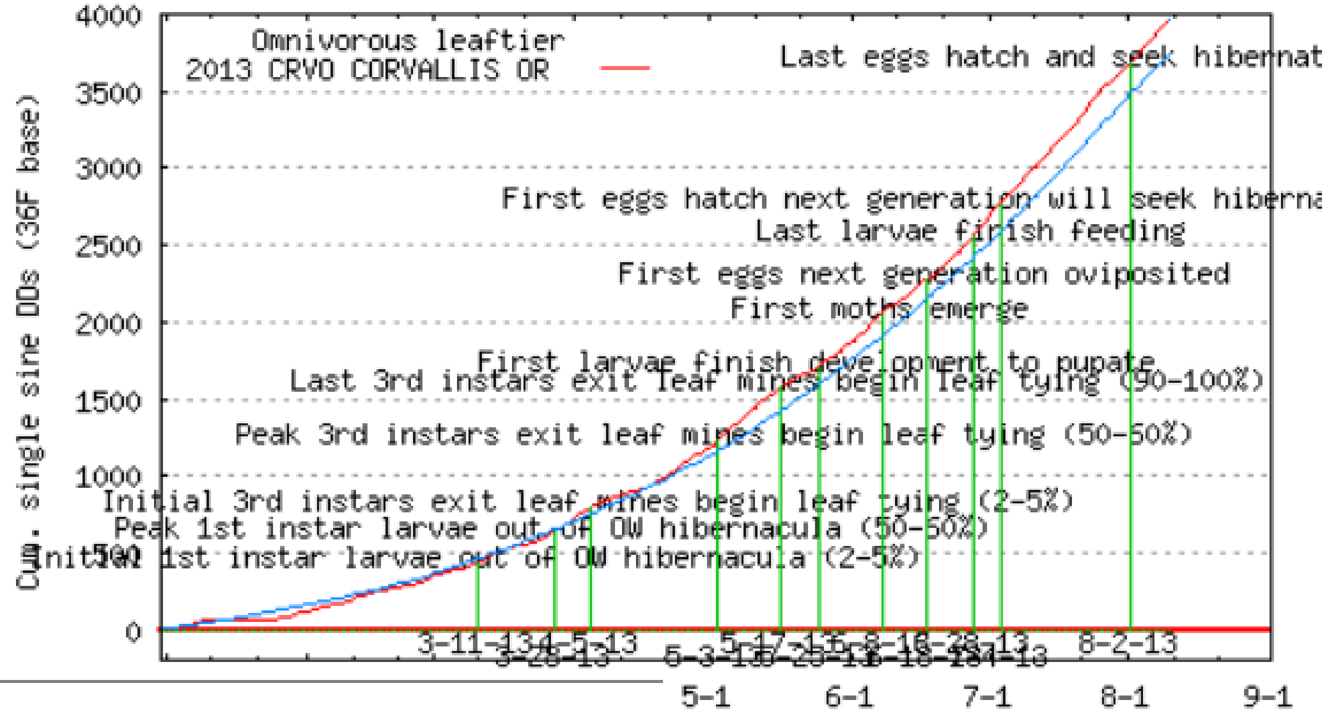


OLT PHENOLOGY MODEL

Usage:
- Main interface at: http://uspest.org/wea

- Specific link for OLT model: http://uspest.org/cgi-bin/ddmodel.us?spp=olt

Model Output



omnivorous leaftier model - OSU vers. 1.0

Location: 2013 CRVO CORVALLIS OR

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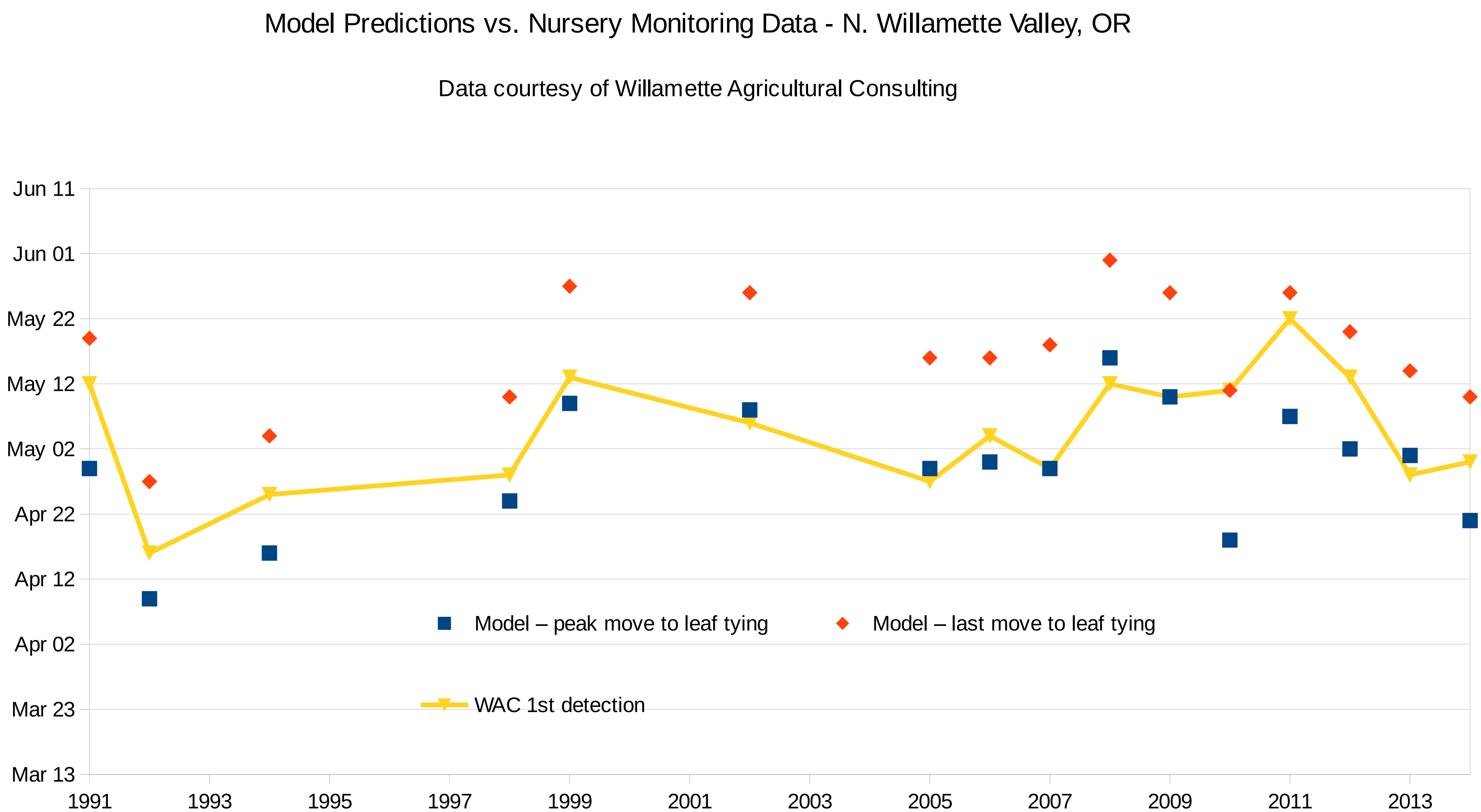
Some Uses:
- Time monitoring programs
- Time control measures

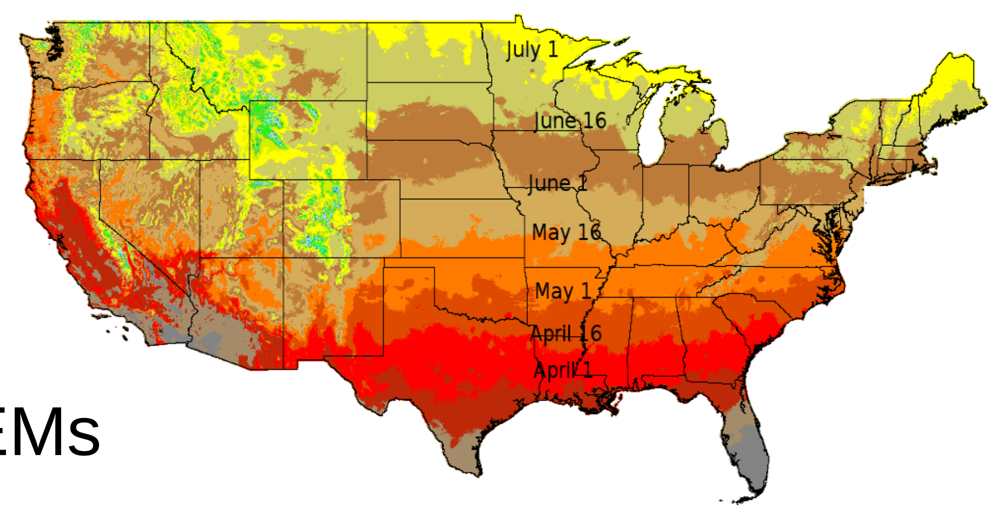
Confronting the model with data – although not research grade, the monitoring data (J. Todd) tends to support the year-to-year phenological variations suggested by the model



PHENOLOGY EVENT MAPPING (PEMs)

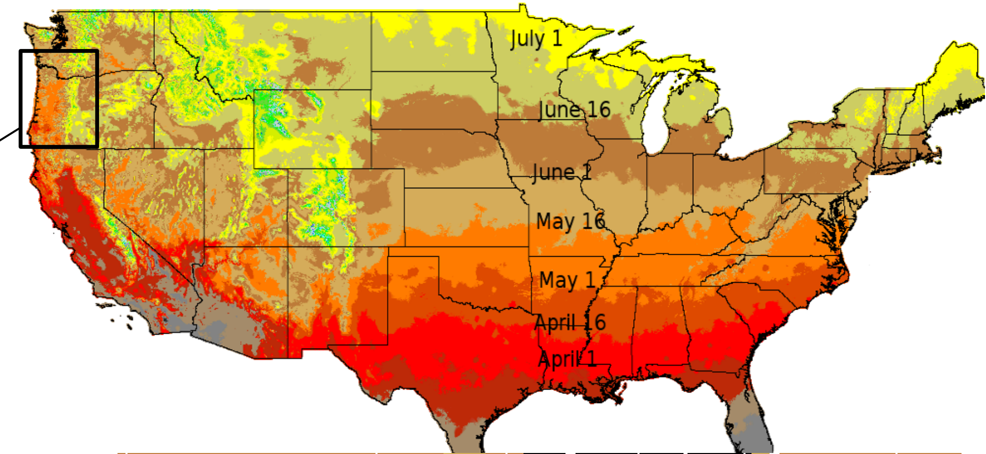
Background:
- USPEST.ORG at IPPC is a phenology and plant disease risk modeling toolkit with >100 models, 16,000+ real-time weather stations, DD mapping, disease risk maps, and much more.
- DD maps can be difficult to use at local (IPM) scales, require expertise to interpret properly.
- PEMs have ability to highlight specific DD – based events using day-of-year or date shown directly on maps.

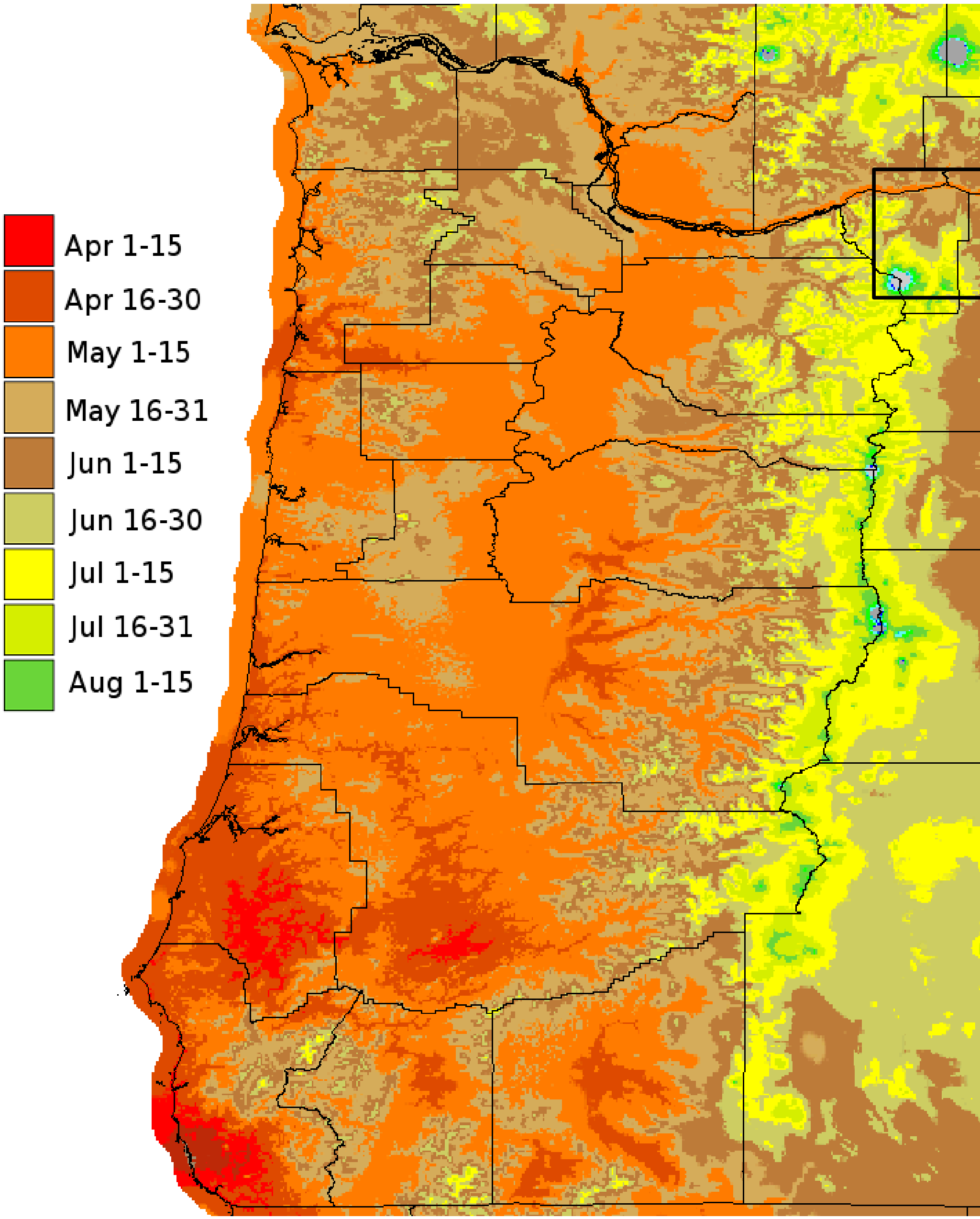
See also talk #2141 rm. F151 4:30 today – Grevstad & Coop
For more applications of PEMs

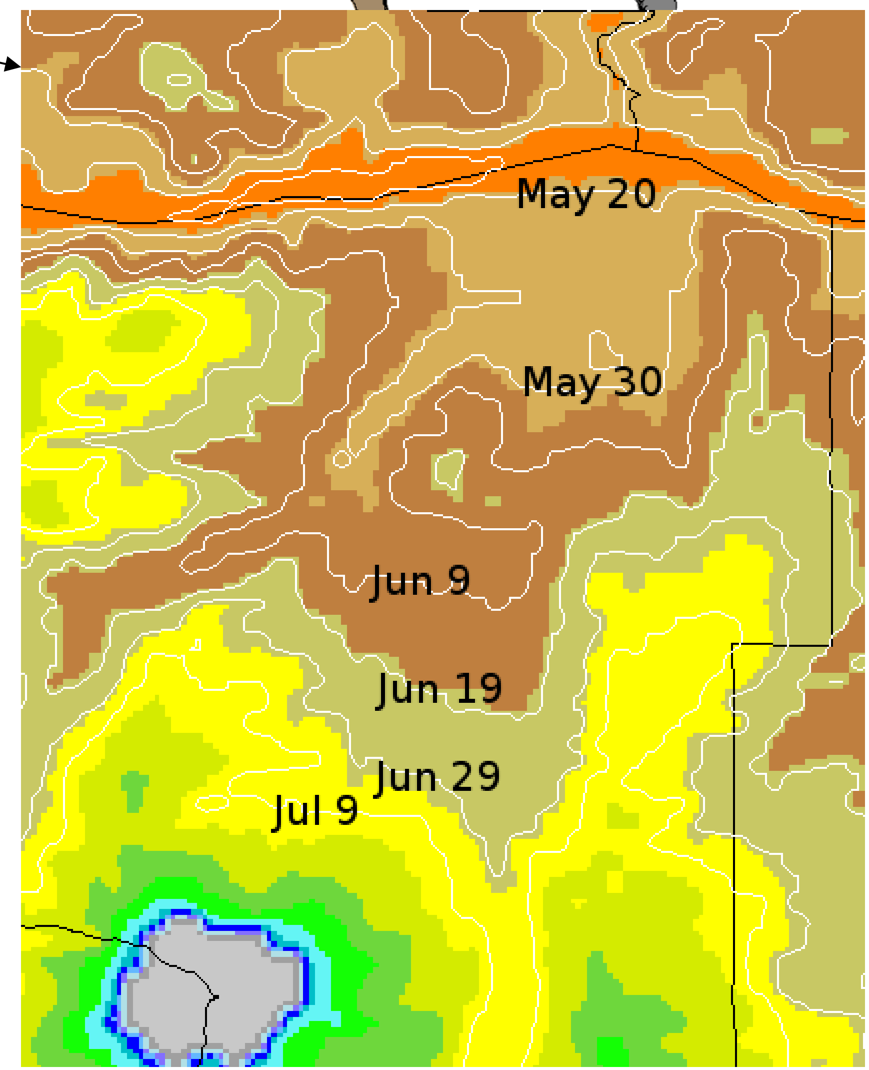


Acknowledgements to
USDA APHIS PPQ CPHST for
providing support to improve PEMs

PEM (Phenology Event Map from uspest.org)
OLT last 3rd instar emergence, exit leaf mines
And move (often balloon) to new resources to
Begin leaf-tying (1559 Dd°F, 866 DD°C)





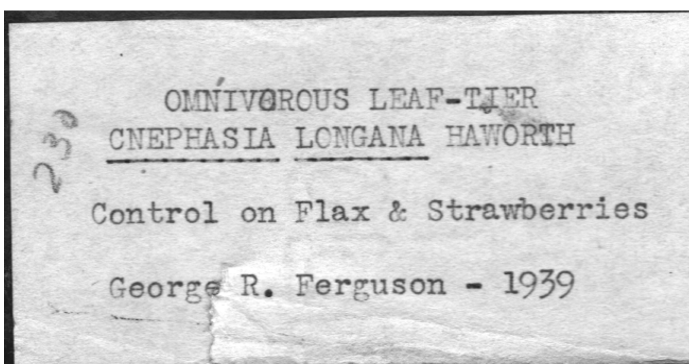


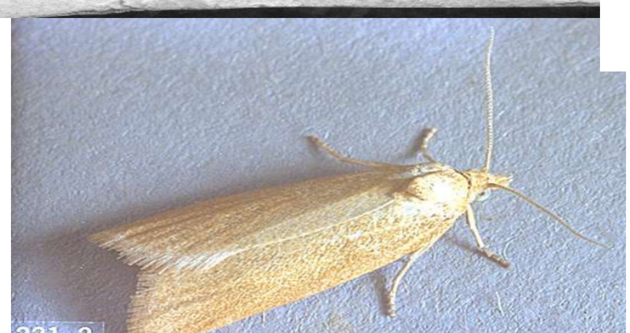
Summary Points

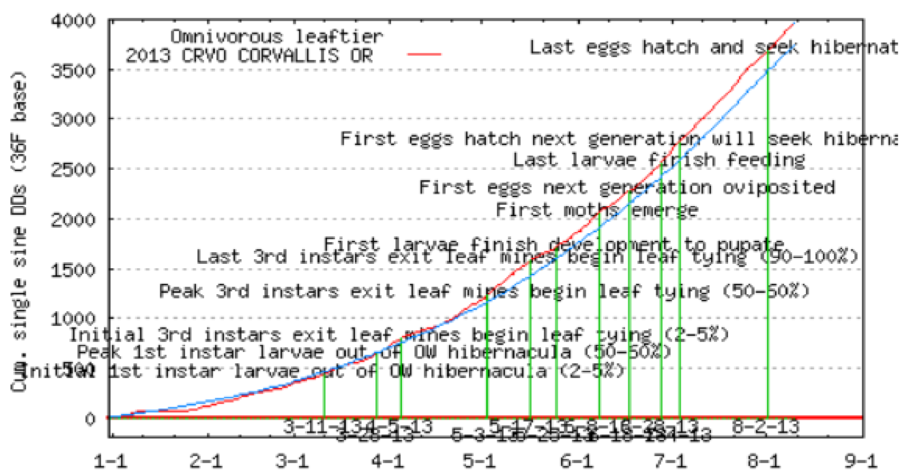
- This model harvests legacy research into one predictive tool that growers and consultants can now use to predict timing of sampling and control operations.

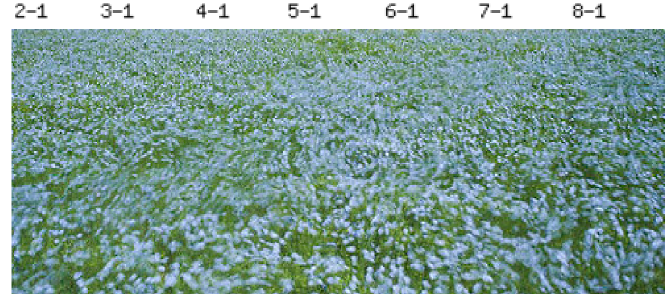
- We are reminded that truly damaging invasive pests, over time, can become just another minor/secondary pest.

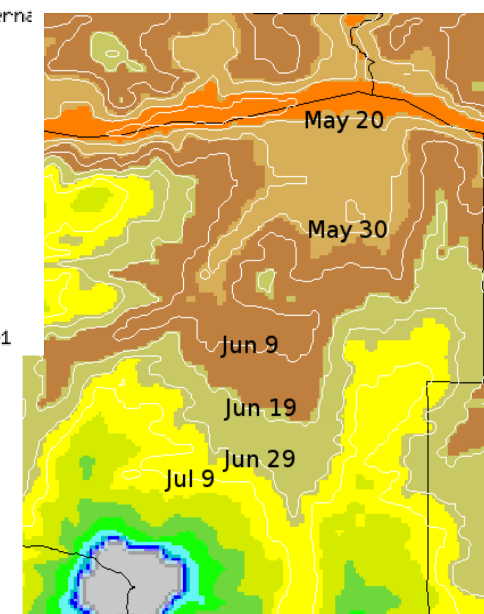
- We introduce PEMs (Phenology Event Maps) that are still under development as a general purpose mapping tool at synoptic (regional) to local (farm) scales.











Flax Facts

1) Flax fibers found with 30,000 year old human remains in Europe
2) Flax a major crop in Oregon 1850s-1950s, peaking during WWII
3) Flax seeds a “superfood”; for omega-3 fatty acids, antioxidants from lignins, and fiber.





Lowest C.V. Detn of Lower Threshold (results shown only for 36F, comparison of 36,38,39,41,43,45 F)					
		Deg. Days (F)			
Omnivorous leaftier stage / event		**Mean**	**St. Dev.**	**C.V.**	**Years contrib. to analysis:**
1st instar	First (2-5%)	436	142.9	32.8	1938,39,40,41,42,46,47
balloon	Peak (50-60%)	617	91.8	14.9	1938,39,40,41,42,46,47
	End (90-100%)	810	74.9	9.3	1938,39,40,41,42,46
3rd instar	First (2-5%)	775	166.2	21.4	1938,46,47,51
emerge	Peak (50-60%)	1210	53.7	4.4	1938,46,47,51,83-2011
	End (90-100%)	1559			1938,46,47,51
1st larvae		1125	198.3	17.6	1930,32,33,34,35,37,38
1st pupae		1698	97.9	5.8	1930,32,33,34,35,37,38
end larvae		2542	171.2	6.7	1930,32,33,34,35,37,38
1st moths		2045	92.7	4.5	1930,32,33,34,35,37,38
1st eggs oviposited		2265	99.1	4.4	1932,33,34,38
end pupae		2742	292.5	10.7	1930,32,33,34,35,37,38
end moths		3075	201.5	6.6	1930,32,33,34,35,37
last egg hatch		3673			1938
last larvae enter hibernation		3739			1938
1st eggs hatched		2765			1938 (temp-devel. Greenhouse data)

Notes: 1. Egg development period determined from temperature development data from Ferguson 1938.
2. 1st instar balloon data from "flypaper catch" studies 1938-42, 46-47
3. 3rd instar leafmining stage emergence data from studies 1938, 46-47, 51
4. First and last stage appearance (larvae, pupae, moths) summarized for early years in 1935 & 37
5. Peak larval emergence data 1983-2011 from private consultant sampling data, Willamette Valley, WAC, Inc.
6. While it is likely that egg and larvae development have a higher temperature threshold than 36F, this value was used to better reflect initial emergence from overwintering, and produced the lowest C.V. for all events evaluated. A more precise model might be produced using a higher threshold (betw. 38-40) and a biofix event such as 1st instar ballooning.

OLT - “The spotted wing Drosophila of its time?”

1930 - “the infestation in Oregon was the first recorded in this country...determine the economic Possibilities of a potentially serious pest.”

REPORT FOR 1930

On the Strawberry Worm, Cnephasis longana

W. Donald Edwards

This work was undertaken during the past spring and summer on the Emergency Fund. The investigation was started because of the fact that the infestation in Oregon is the first recorded in this country. The investigation was also carried out to determine the economic possibilities of a potentially serious pest.

OMNIVOROUS LEAF-TIER
CNEPHASIA LONGANA HAWORTH

Control on Flax & Strawberries

George R. Ferguson - 1939

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Table XXII

CORRELATION OF PRECEDING CROP WITH INJURY TO FLAX BY C. LONGANA

Injured Flax	Previous Crop (1938)	Grower	Location
32.33	Clover	Fred Schwab	Mt. Angel
26.50	Wheat	Stenger	Woodburn
24.75	Clover	F. J. Fessler	Woodburn
21.00	Clover	Geo. Fisher	Woodburn
20.08	Clover	Medack	Mt. Angel
18.83	Clover	F. Geschwill	Mt. Angel

Figure 9

Typical Ragged Appearance of a Heavily Infested Field of Flax