TWENTIETH REPORT

OF THE

STATE ENTOMOLOGIST

OF

CONNECTICUT

FOR THE YEAR 1920

(Being Bulletin 226 Connecticut Agricultural Experiment Station)

BY

W. E. BRITTON, PH. D.

State Entomologist

NEW HAVEN, CONN.

1921

CONNECTICUT AGRICULTURAL EXPERIMENT STATION.

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Vegetable Growing.
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TABLE OF CONTENTS.

NOTE REGARDING AUTHORSHIP.

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BULLETIN 226

TWENTIETH REPORT

OF THE

State Entomologist of Connecticut

To the Director and Board of Control of the Connecticut Agricultural Experiment Station:

I transmit, herewith, my twentieth report as State Entomologist of Connecticut, covering the activities of the year of 1920. The financial statements are for the state fiscal year ending June 30, 1920. This report contains an account of the various lines of work placed upon the office by Statute such as inspecting nurseries and apiaries, and suppressing the gipsy moth, and articles dealing with the mosquito work of the year, the European red mite and the apple and thorn skeletonizer, two new orchard pests, life history notes on the false apple red bug, a sawfly feeding upon Austrian pine and miscellaneous notes on various economic insects.

Respectfully submitted,

W. E. BRITTON,
State and Station Entomologist.

REPORT OF THE RECEIPTS AND EXPENDITURES OF THE STATE ENTOMOLOGIST FROM JULY 1, 1919, TO JUNE 30, 1920.

RECEIPTS.

From E. H. Jenkins, Treasurer	$7,500.00	
Account of 1919, Balance	1,889.75	
State Comptroller, Gipsy Moth Account	729.21	
M. P. Zappe, Automobile Mileage	10.68	
W. E. Britton, Automobile Mileage	5.10	
Interest on Bank Deposits	40.06	
Sale of old paper	3.45	
		$10,178.25

EXPENDITURES.

For Field, Office and Laboratory Assistance:		
B. H. Walden,* salary	$1,499.97	
M. P. Zappe, salary	1,750.00	
Philip Garman, salary	1,666.62	
K. F. Chamberlain,† salary	800.00	

*For nine months: remainder paid from mosquito appropriation.
†For eight months: resigned March 1, 1920.

Gladys M. Finley, salary	$704.00		
George D. Stone, salary	359.78		
Other assistance	217.60		
		$6,997.97	
Printing and Illustrations		36.10	
Postage		80.46	
Stationery		21.69	
Telegraph and Telephone		1.80	
Office Supplies		82.24	
Library		183.46	
Laboratory Supplies		611.65	
Express, Freight and Cartage		26.40	
Rental and Storage		1.45	
Traveling Expenses		719.23	
Insurance		65.85	
Automobile tires and repairs		499.51	
Balance, Cash on Hand		850.44	
			$10,178.25

Memorandum:—This account of the State Entomologist has been audited by the State Auditors of Public Accounts. The item of $729.21, credited as having been received from the State Comptroller is really a transfer from the appropriation for suppressing gipsy and brown-tail moths and for inspecting imported nursery stock, and covers the time and automobile mileage of members of the department staff while engaged in inspecting imported nursery stock.

Summary of Inspection and Office Work.

256 samples of insects received for identification.
95 nurseries inspected.
92 regular certificates granted.
35 parcels of nursery stock inspected and certified.
65 orchards and gardens examined.
17 shipments, containing 87 cases, 814,491 plants imported nursery stock inspected.
11 shipments, or 64 per cent. found infested with insects or fungi.
762 apiaries, containing 4,797 colonies, inspected.
33 apiaries, containing 72 colonies, found infested with European foul brood.
9 apiaries, containing 12 colonies, found infested with American foul brood.
2,576 letters written on official work.
646 circular letters.
454 post cards.
17 reports of inspection to Federal Horticultural Board.
1,007 bulletins, etc., mailed on request or to answer inquiries.
66 packages, sent by mail or express.
25 lectures and addresses at institutes, granges, etc.

Publications of Entomological Department, 1920.

By W. E. Britton:

Nineteenth Report of the State Entomologist (Bulletin 218), 100 pages, 5 figures, 24 plates, 10,500 copies distributed in May, 1920.

Insects Attacking Squash, Cucumber and Allied Plants in Connecticut (Bulletin 216), 21 pages, 9 figures, 8 plates; 10,000 copies distributed in February, 1920.

Report of Committee on Injurious Insects, Report of Connecticut Vegetable Growers' Association for 1919, page 51, 1920.

Report of Committee on Injurious Insects, Proceedings Twenty-Eighth Annual Meeting Connecticut Pomological Society, page 15, 1920.
Some Phases of Beekeeping in Connecticut, Journal of Economic Entomology, Vol. 13, page 91, February, 1920.
A Connecticut Cornfield Injured by *Crambus præfectellus* Zinck, Journal of Economic Entomology, Vol. 13, page 222, April, 1920.
More About the Cyclamen Mite, Florists' Exchange, Vol. XLIX, page 285, February 7, 1920.

DEPARTMENT STAFF AND WORK.

W. E. BRITTON, PH.D., *State and Station Entomologist.*
B. H. WALDEN, B.AGR., *Photographic and General Work.*
IRVING W. DAVIS, B.SC.* *Deputy in Charge of Moth Work.*
M. P. ZAPPE, B.S., *Inspection and General Work.*
KENYON F. CHAMBERLAIN,† *Inspection and General Work.*
PHILIP GARMAN, PH.D., *Research Work.*
JOHN T. ASHWORTH,‡ *Acting Deputy in Charge of Moth Work.*
SAMUEL T. SEALY,§ *Deputy in Charge of Mosquito Work.*
MISS GLADYS M. FINLEY, *Clerk and Stenographer.*
} *Assistant Entomologists.*

H. W. COLEY, Westport,
A. W. YATES, Hartford,
} *Apiary Inspectors.*

There have been a few changes in the department staff during the year. Mr. Chamberlain resigned March 1, after a year's service. Mr. Davis, who for nearly seven years has been in charge of the work of suppressing the gipsy and brown-tail moths, resigned June 10 to accept a position with the Danielson Trust Company, of Danielson. Mr. Davis was very successful in his work and it was with much regret that we accepted his resignation. Mr. Ashworth has been placed temporarily in charge of the gipsy moth work.

Mr. Sealy was appointed deputy to the Director in charge of mosquito drainage work and began his duties April 19. Mr. Sealy formerly was employed in this kind of work by the Nassau County, N. Y., Mosquito Extermination Association.

Mr. Walden, who has been in charge of mosquito work for about four years, has this season been engaged in photographic work, inspection, and general work, and has been in charge of the department in the absence of the Entomologist. He has made photographic illustrations for the plates of the Connecticut Hemiptera and has collected an excellent series of leafhoppers from various hosts in different parts of the state.

Mr. Zappe has been in charge of the inspection of nurseries and of imported nursery stock. He has also aided in some orchard spraying and dusting experiments, and has studied the life histories of the false apple red bug, a leafhopper on apple, and a sawfly, (*Itycorsia zappei* Rohwer) feeding on Austrian pine.

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*Resigned June 10.
†Resigned March 1.
‡Beginning June 10.
§Beginning April 19.

Dr. Garman has been engaged in studying the life history of the bulb mite, the results of which have been published as Bulletin No. 225. He has also commenced an interesting study of the life history of the frog hoppers or spittle insects (family Cercopidae) and is also at work on the mites of Connecticut and the Odonata or dragonflies of Connecticut, the results of which will be published by the Geological and Natural History Survey of the State.

The Entomologist has spent considerable time in revising manuscript and reading proof on the Check List of the Insects of Connecticut, which has appeared as Bulletin 31 of the Geological and Natural History Survey, and in editing and writing a portion of the manuscript of the Hemiptera of Connecticut which will also be published as a later bulletin of the Survey.

Miss Finley has continued as clerk and stenographer, and during a part of May when on her vacation, the necessary work was done by a substitute, Miss Marion D. Pickett.

Messrs. Coley and Yates as heretofore have inspected the apiaries, working by the day.

From August 7 to September 11, Mr. Edward R. Barton and Mr. F. D. Luddington were employed to assist in inspecting nurseries.

All members of the staff have rendered efficient and faithful services.

INSPECTION OF NURSERIES.

Mr. Zappe was placed in charge of this work and began on August 5. There was much rainy weather and the spraying and dusting experiments required that the dropped fruit be scored, as well as the picked fruit later. The work somewhat interfered with the inspection of nurseries. Nevertheless all was finished on October 18. Messrs. Zappe and Walden did most of this inspection work but were assisted at times by Messrs. Garman, Britton and Sealy, and Mr. F. D. Luddington and Mr. E. R. Barton were employed from August 7 to September 11, and helped inspect the larger nurseries. No one from the gipsy moth force was pressed into service inspecting nurseries, except that Mr. Ashworth helped the Entomologist inspect two nurseries in Windham County on September 2.

The same system of inspection in vogue in preceding years was continued in 1920, and most of the inspection trips were made in the department automobile.

In 46 nurseries no pests were found.

The principal pests, with the number of nurseries infested by each are as follows:

Insects:—Oyster-shell scale 38; San José scale 11; Scurfy scale 7; pine leaf scale 7; tulip tree scale 3; rose scale 2; spruce gall aphid 21; *Chermes cooleyi* 2; green apple aphid 2; woolly apple aphid 2; elm scale, euonymus scale, pine weevil, lilac borer, peach borer and Rhododendron lace bug, one each.

Plant Diseases:—Poplar canker 13; fire blight 6; crown gall 1.

On the whole about the same pests were found as last year though the oyster-shell scale and the San José scale were not present in as many nurseries, and 46 nurseries were found uninfested as against 32 last year.

Two new nurseries started in the spring and were inspected then and again inspected in the fall. These are marked (2) after the name on the list. Five nurseries have gone out of business, two have changed in name, and eight new ones have started during the year. Five old ones did not clean out the infested stock in time to obtain certificates and consequently were not on the list last year. Two nurseries have not cleaned out the infested stock, this year, and consequently have not received certificates.

Thirty-five separate parcels of nursery stock have been inspected and certificates granted.

The list for the season contains 90 names as follows:

NURSERY FIRMS IN CONNECTICUT RECEIVING CERTIFICATES IN 1920.

Name of Firm	Address.	Acreage.	Certificate Issued.	No. of Certificate.
Barnes Bros. Nursery Co.	Yalesville	150	Sept. 23	1115
Barnes Nursery & Orchard Co.	Wallingford	12	Aug. 30	1073
Beattie, Wm. H.	New Haven	1	Sept. 13	1091
Bertolf Bros.	Sound Beach	25	Sept. 18	1106
Brainard Nursery & Seed Co.	Thompsonville	6	Sept. 15	1094
Braley & Co.	Burnside	1	Sept. 17	1102
Bretschneider, A.	Danielson	1	Sept. 3	1081
Bristol Nurseries, Inc.	Bristol	5	Oct. 13	1132
Burr & Co., C. R.	Manchester, Ellington and Durham	500	Aug. 20	1075
Burroughs, Thos. E.	Deep River	3	Oct. 5	1129
Chapman, C. B.	Groton	1	Sept. 21	1110
Chapman, C. E.	North Stonington	4	Sept. 16	1098
Coari & Co.	Norwalk	2	Sept. 9	1085
Conine Nursery Co.	Stratford	50	Oct. 8	1131
Conley, L. D.	Ridgefield	8	Oct. 2	1124
Conn. Agricultural College (Prof. S. P. Hollister)	Storrs	1	Aug. 7	1072
Conn. Agr. Experiment Station (W. O. Filley, State Forester)	New Haven	1	Oct. 18	1140
Crofut & Knapp Farm	Norwalk	20	Dec. 30	1159
Cross Highway Nurseries	Westport	6	Nov. 27	1151
Dallas, Inc., Alexander	Waterbury	1	Nov. 23	1149
Dowd, F. C.	Madison	1	Sept. 22	1112
Elm City Nursery Co., Woodmont Nurseries, Inc	Woodmont and New Haven	155	Sept. 7	1082
Evergreen Nursery Co.	South Wilton	1	Sept. 10	1088
Fairfield Landscape & Nurseries Co.	Cannondale	5	Dec. 31	1160
Falcon's Flight Farms Nursery (B. Austin Cheney, Prop.)	Litchfield	1	Oct. 2	1123
Gardner's Nurseries	Cromwell	5	Aug. 31	1078
Geduldigs Greenhouses	Norwich	1	Nov. 5	1147
Glenn Terrace Ornamental Nursery (James H. Everett, Prop.)	Mount Carmel	4	Oct. 29	1146
Goodwin Associates, Inc., the James L.	Hartford	1	Sept. 29	1122

NURSERY FIRMS IN CONNECTICUT RECEIVING CERTIFICATES IN 1920—*Cont'd.*

Name of Firm.	Address.	Average.	Certificate Issued.	No. of Certificate.
Hartford Park Commissioners	Hartford	1	Dec. 31	1161
Heath & Co.	Manchester	5	Aug. 20	1077
Hilliard, H. J.	Sound View	1	Sept. 16	1100
Hiti Nurseries (J. H. Bowditch, Prop.)	Pomfret Center	8	Sept. 3	1080
Holcomb, Irving	Simsbury	1	Sept. 15	1092
Horan & Son, Jas.	Bridgeport	1	Sept. 9	1086
Houstons' Nurseries	Mansfield	4	Dec. 23	1157
Hoyt's Sons Co. Inc., The Stephen	New Canaan	300	Oct. 19	1141
Hunt & Co., W. W.	Hartford	10	Sept. 28	1119
Intravaia, Joseph	Middletown	1	Aug. 31	1079
Isselee, Charles	Darien	10	Nov. 30	1152
Kelley, James J.	New Canaan	1	Sept. 9	1084
Kellner, Herman H.	Danbury	1	Oct. 2	1126
Keso Nursery (J. J. Kelsey, Prop.)	Clinton	1	Sept. 22	1113
Ladd & Nichols, Inc.	Greenwich	2	Nov. 23	1150
Laddin's Rock Nursery (W. L. Marks, Prop.)	Stamford	5	Oct. 13	1133
Larkin Bros., The	New London	2	Sept. 15	1095
Long, Mrs. J. A.	East Haven	1	Oct. 23	1144
Mallett Co., George A.	Bridgeport	1	Oct. 28	1145
Maplewood Nurseries (T. A. Peabody, Mgr.)	Norwich	1	Sept. 16	1099
Marigold Farm (H. Kelley, Prop.)	New Canaan	2	Sept. 21	1111
Meier & Gillette	West Hartford	2	Oct. 16	1136
Millane Tree Expert Co.	Middletown	1	Sept. 15	1093
New Haven Nurseries	New Haven	10	Nov. 30	1153
New Haven Park Commissioners (G. X. Amrhyn, Supt.)	New Haven	30	Dec. 29	1158
New London Cemetery Association (Ernest E. Rogers, Pres.)	New London	1	Sept. 15	1096
New London County Nurseries (W. J. Schoonman, Prop.)	New London and Stonington	5	Dec. 3	1154
North-Eastern Forestry Co.	Cheshire	20	Sept. 9	1083
Oakland Nurseries	Manchester	5	Aug. 20	1076
Ouwerkerk & Van der Stam (2)	Yalesville	1	Oct. 16	1137
Palmer, Est. of L. M.	Stamford	5	Sept. 28	1120
Park Gardens	Bridgeport	1	Sept. 21	1107
Pequod Nursery Co.	Yalesville	15	Sept. 23	1116
Phelps, J. Wesson	Bolton	1	Sept. 17	1103
Phelps & V. T. Hammer Co., The J. W.	Branford	2	Dec. 13	1155
Pierson, A. N., Inc.	Cromwell	50	Sept. 11	1089
Polish Orphanage (Rev. L. Bojnowski, Mgr.)	New Britain	1	Oct. 13	1134
Pomeroy, Edwin C.	Northville	1	Oct. 2	1127
Quality Seed Store	Stamford	1	Oct. 5	1128
Reck, Julius	Bridgeport	1	Sept. 21	1109
Rockfall Nursery Co. (P. Marotta, Prop.)	Rockfall	2	Aug. 30	1074
Saxe & Floto	Waterbury	1	Oct. 16	1139
Scheepers, Inc., John (2)	Sound Beach	6	Sept. 28	1121
Schleichert, F. C.	Bridgeport	1	Sept. 21	1108
Scott, J. W.	Hartford	5	Nov. 11	1148
Seely, C. H.	Darien	1	Oct. 20	1142

NURSERY FIRMS IN CONNECTICUT RECEIVING CERTIFICATES IN 1920—*Cont'd.*

Name of Firm.	Address.	Average.	Certificate Issued.	No. of Certificate.
Sierman, C. H.	Hartford	5	Oct. 22	1143
South Wilton Nurseries	South Wilton	5	Sept. 10	1087
Stannard Hill Greenhouses (J. E. Brooks, Prop.)	Westbrook	1	Sept. 22	1114
Steck, Charles A.	Bethel	2	Oct. 2	1125
Stratfield Nursery Co.	Bridgeport	4	Dec. 21	1156
Traendly & Schenck	Rowayton	2	Sept. 24	1117
Upson, R. E.	Marion	1	Oct. 16	1135
VanWilgen & Co.	Branford	3	Sept. 18	1105
Verkades Nurseries	New London	8	Sept. 15	1097
Vidbourne & Co., J.	Hartford	7	Oct. 7	1130
Wallace, Arthur T.	Wallingford	2	Oct. 16	1138
Wild, Henry	Riverside	1	Sept. 27	1118
Wilson & Co., C. E.	Manchester	10	Sept. 17	1101
Yale University Forest School	New Haven	1	Sept. 13	1090
Young, Mrs. Nellie A.	Pine Orchard	1	Sept. 18	1104
Total acreage		1,553		

INSPECTION OF IMPORTED NURSERY STOCK.

The establishment of Federal Quarantine, No. 37, which became effective June 30, 1919, has greatly reduced the quantity of nursery stock entering Connecticut from foreign countries. In fact it has prohibited general importation and the only kind now entering the state directly and needing inspection by state inspectors is stock for propagating purposes. This is nearly all Manetti rose stock, which is consigned to the larger florists' establishments, and fruit seedlings purchased by the larger nurseries that grow fruit trees. As these plants are small, a large number of them can be packed in a case of ordinary size. As only a few firms import such stock, the number of shipments received was much smaller than in preceding years, but the number of plants was in much greater proportion, as the following figures for 1919 and 1920 will show:

Year.	No. of Shipments.	No. of Cases.	No. of Plants.
1919	131	1,075	1,164,701
1920	17	87	814,491

Most of this stock was inspected by Messrs. Zappe, Chamberlain and Walden, and the time required amounts to 133 hours, or 17.7 days of seven and one-half hours each, or .68 months of 26 working days each. The cost according to the office accounts amounted to $825.83, including time of men and traveling expenses, and was paid out of the state appropriation for suppressing gipsy and brown-tail moths and inspecting nursery stock.

The sources of this imported nursery stock were as follows:—

SOURCES OF IMPORTED NURSERY STOCK, 1919–1920.

Country.	No. of Shipments.	No. of Cases.	No. of Plants.
France	8	31	359,300
Holland	4	20	152,691
England	4	28	290,000
Scotland	1	8	12,500
Total	17	87	814,491

The following table shows quantity of stock as inspected by months:—

Month.	No. of Shipments.	No. of Cases.	No. of Plants.
January	1	2	15,500
February	4	15	111,700
March	4	16	208,100
April	7	52	467,500
May	1	2	11,691
Total	17	87	814,491

Of the 17 shipments, 11 shipments or 64.8 per cent. were found to be infested with insects or plant diseases, some of which are pests.

Last year many imported bulbs were inspected, but this is now all done by Federal inspectors at the ports of entry.

Details regarding the infestations on imported nursery stock are as follows:—

PESTS FOUND ON IMPORTED NURSERY STOCK.

11 Shipments Infested.

Insects, etc.

Bulb Mite on Manetti rose. (1 shipment) Thos. Smith & Son, Stranraer, Scotland.

Emphytus cinctus Linn. on Rose. (7 shipments) R. H. Both, Wisbech, England. Franco-American Seedling Co., Angers, France. Thos. Smith & Son, Stranraer, Scotland. Levasseur & Fils, Ussy, France. S. Bide & Sons, Ltd., Farnham, Surrey, England. W. Fromow & Sons, Windlesham Surrey, England. As. Ouwerkerk, Boskoop, Holland.

Lepidopterous cocoons. (2 shipments) Kings Acre Nurseries, Henford, England. S. Bide & Sons, Ltd., Farnham, Surrey, England. Larva. (1 shipment) Felix & Dykhuis, Boskoop, Holland.

Sow bugs. (1 shipment) Levasseur & Fils, Ussy, France.

Spider. (2 shipments) Levasseur & Fils, Ussy, France. S. Bide & Sons, Ltd., Farnham, Surrey, England.

Staphalinid beetle on rose. (2 shipments) Thos. Smith & Son, Stranraer, Scotland. Felix & Dykhuis, Boskoop, Holland.

Vespula germanica Fabr. (1 shipment) Franco-American Seedling Co., Angers, France.

Woolly aphis on apple. (1 shipment) Franco-American Seedling Co., Angers, France.

Plant Diseases.

Crown Gall on rose. (5 shipments) Vincent Lebreton's Nurseries, La Pyramide, France. Franco-American Seedling Co., Angers, France. Felix & Dykhuis, Boskoop, Holland. W. Fromow & Sons, Windlesham Surrey, England.

INSPECTION OF APIARIES.

There has been no change in the system of apiary inspection or in the personnel of the inspectors since last year. The new law passed by the last General Assembly requiring beekeepers to register with their town clerks was generally though not fully observed, and proved quite a help to the inspectors in locating apiaries.

Mr. H. W. Coley of Westport has continued to inspect in Fairfield, New Haven, Middlesex and New London counties, and Mr. A. W. Yates of Hartford likewise has continued to inspect in Litchfield, Hartford, Tolland and Windham counties, each working on a basis of six dollars per day and expenses.

Many colonies of bees did not survive the winter, and though more apiaries were inspected than in 1919, the number of colonies was considerably smaller.

During the summer of 1920, 762 apiaries, containing 4,797 colonies of bees, were inspected as against 723 apiaries and 6,070 colonies in 1919. In making these inspections, 119 towns were visited in 1920 and 102 towns in 1919.

Inspections have never been made in the towns of Union (Tolland County) and Eastford (Windham County).

The following ten towns were visited in inspection work in 1920 for the first time:

Fairfield County—Sherman and New Fairfield.
New Haven County—East Haven.
Middlesex County—Essex, Chester and Middlefield.
New London County—Lebanon, Preston and Voluntown.

Inspections were made in the following 38 towns not visited in 1919:

Fairfield County—Brookfield, New Fairfield, Sherman and Trumbull.
New Haven County—Bethany, East Haven North Haven and Woodbridge.
Middlesex County—Chester, Clinton, Cromwell, Essex, Haddam and Middlefield.
New London County—Bozrah, Colchester, Franklin, Griswold, Preston and Voluntown.
Litchfield County—Barkhamsted, Canaan, Colebrook, Cornwall, Goshen, Morris, New Hartford, Norfolk, North Canaan, Roxbury, Salisbury, Sharon and Winchester.
Hartford County—Hartland and Simsbury.
Tolland County—Columbia, Ellington and Hebron.

On the other hand, inspections were made in 1919 in the following 29 towns, not visited in 1920:

Fairfield County—Bethel and Redding.
New Haven County—Oxford and Wolcott.
Middlesex County—East Hampton and Killingworth.
New London County—Groton, Old Lyme and Stonington.
Litchfield County—Bethlehem, Plymouth and Warren.

Hartford County—Avon, Canton, Manchester, Windsor and Windsor Locks.
Tolland County—Stafford, Tolland and Willington.
Windham County—Brooklyn, Killingly, Plainfield, Pomfret, Putnam, Scotland, Sterling, Thompson and Woodstock.

The percentage of apiaries infested with European foul brood has decreased each year since the inspection service was established. In 1920 it was only 4.3 per cent. as against 6.6 in 1919. The percentage of colonies, however, was 1.5 per cent. in 1920, slightly larger than the 1.2 per cent. found infested in 1919. This is due, not to any increase in the disease as the percentages of infested apiaries show, but to the smaller number of colonies in the average apiary, which is only 6.5 in 1920, as against 11.2 in 1919, on account of so many bees dying in the winter. During 1920, the European foul brood was found in the following 22 towns:

Fairfield County—Darien, Fairfield and Sherman.
New Haven County—North Haven, Prospect and Wallingford.
Middlesex County—Essex, Durham and Haddam.
New London County—Waterford.
Litchfield County—Barkhamsted, Bridgewater, Thomaston, Washington, Watertown and Winchester.
Hartford County—Glastonbury, Hartland, Marlborough and Southington.
Tolland County—Ellington and Mansfield.

American foul brood was found in nine apiaries and in five towns and was much less prevalent than in 1919, when it occurred in 22 apiaries in eight towns. In 1920, this disease was found in Wallingford (New Haven County), Durham (Middlesex County), East Lyme (New London County), Winchester (Litchfield County), and Wethersfield (Hartford County). Wallingford and East Lyme were infested in 1919.

The percentage of apiaries infested with American foul brood in 1920 is 1.18 and of colonies .25, as against 3.00 per cent. and 1.1 per cent. respectively in 1919.

The statistics of the apiaries inspected in 1920 in each of the 119 towns visited, are arranged by counties in the following pages and summarized on page 149:

APIARIES INSPECTED IN 1920.

	No. Apiaries		No. Colonies	
	Inspected.	Diseased.	Inspected.	Diseased.
Fairfield County:				
Bridgeport	2	1	55	2‡
Brookfield	6	1	54	1‡
Danbury	18	0	163	0
Darien	3	1	28	1†

* American Foul Brood.
† European Foul Brood.
‡ Sacbrood.

	No. Apiaries Inspected.	Diseased.	No. Colonies Inspected.	Diseased.
Easton	1	0	56	0
Fairfield	8	2	93	2‖†
Greenwich	7	0	102	0
Monroe	4	0	44	0
New Canaan	2	0	22	0
New Fairfield	4	0	34	0
Norwalk	7	0	66	0
Ridgefield	3	0	11	0
Shelton	2	0	24	0
Sherman	10	2	80	2†
Stamford	7	0	40	0
Stratford	3	0	33	0
Trumbull	2	0	14	0
Weston	2	0	2	0
Westport	8	0	76	0
Wilton	16	0	159	0
	115	7	1156	8
New Haven County:				
Beacon Falls	1	0	0	0
Bethany	3	0	7	0
Branford	4	1	45	1‡
Cheshire	2	0	26	0
Derby	4	0	31	0
East Haven	4	0	17	0
Guilford	3	0	18	0
Hamden	12	0	46	0
Madison	2	0	3	0
Meriden	26	0	155	0
Middlebury	2	0	14	0
Milford	3	0	32	0
Naugatuck	6	0	32	0
New Haven	3	0	10	0
North Haven	2	1	31	1†
Prospect	4	1	29	3†
Seymour	1	0	11	0
Wallingford°	17	7	106	9°
Waterbury	8	0	34	0
Woodbridge	4	0	16	0
	111	10	663	14
Middlesex County:				
Chester	4	0	15	0
Clinton§	1	0	0	0
Cromwell	7	1	26	1‡
Durham	6	3	65	4**
East Haddam	2	0	5	0

* American Foul Brood.
† European Foul Brood.
‡ Sacbrood.
‖ Paralysis.
° 3 apiaries with 1 A. F. B. each, 3 with 1 E. F. B. each, 1 with 2 A. F. B. and 1 E. F. B.
** 1 A. F. B., 1 E. F. B. and 2 Sacbrood.

	No. Apiaries Inspected.	No. Apiaries Diseased.	No. Colonies Inspected.	No. Colonies Diseased.
Essex	4	2	16	2†
Haddam	3	1	16	2†
Middlefield	5	0	30	0
Middletown	19	0	85	0
Old Saybrook	2	0	7	0
Saybrook	6	0	24	0
Westbrook	2	0	8	0
	61	7	297	9
New London County:				
Bozrah	4	1	40	1‡
Colchester	14	1	30	1‡
East Lyme	4	1	15	1*
Franklin	1	0	6	0
Griswold§	4	0	1	0
Lebanon	4	1	10	1‡
Lisbon	3	0	7	0
Montville	7	0	18	0
New London	1	0	10	0
Norwich	6	0	369	0
Preston	5	1	19	1‡
Voluntown‖	4	0	2	0
Waterford	3	1	18	4†
	60	6	545	9
Litchfield County:				
Barkhamsted	4	2	74	5†
Bridgewater	7	2	37	3†
Canaan	6	0	29	0
Colebrook	1	0	10	0
Cornwall	2	0	2	0
Goshen	4	0	20	0
Harwinton	1	0	3	0
Litchfield	7	0	27	0
Morris	6	0	27	0
New Hartford	5	0	24	0
New Milford	14	0	101	0
Norfolk	5	0	10	0
North Canaan	10	0	88	0
Roxbury	5	0	22	0
Salisbury	6	0	42	0
Sharon	8	0	66	0
Thomaston	6	1	38	3†
Torrington	6	1	84	1‖
Washington	10	1	86	2†
Watertown	13	2	70	3†
Winchester	19	5	54	8§
	145	14	914	25

* American Foul Brood.
† European Foul Brood.
‡ Sacbrood.
‖ All bees killed in 3 aparies.
§ 4 A. F. B. and 4 E. F. B.

	No. Apiaries		No. Colonies	
	Inspected.	Diseased.	Inspected.	Diseased.
Hartford County:				
Berlin	18	0	136	0
Bloomfield	11	0	85	0
Bristol§	1	0	0	0
Burlington	1	0	5	0
East Granby	6	0	28	0
East Hartford	15	0	58	0
East Windsor	9	0	97	0
Enfield	3	0	22	0
Farmington	22	0	49	0
Glastonbury	17	1	55	2†
Granby	4	0	47	0
Hartford	26	0	92	0
Hartland	2	1	4	2†
Marlborough	2	1	22	3†
New Britain	17	0	69	0
Newington	10	0	51	0
Plainville	5	0	35	0
Rocky Hill	8	0	10	0
Simsbury	3	0	6	0
Southington	12	2	65	7†
South Windsor	8	0	22	0
Suffield	1	0	7	0
West Hartford	24	0	57	0
Wethersfield	13	1	44	1*
	238	6	1066	15
Tolland County:				
Andover	1	0	1	0
Bolton	1	0	4	0
Columbia	3	0	10	0
Coventry	2	0	10	0
Ellington	13	1	49	1†
Hebron	3	0	6	0
Mansfield	3	2	36	16†
Vernon	5	0	36	0
	31	3	152	17
Windham County:				
Windham	1	0	4	0

SUMMARY.

County.	No. of Towns.	No. Apiaries Inspected.	No. Apiaries Diseased.	No. Colonies Inspected.	No. Colonies Diseased.
Fairfield	20	115	7	1156	8
New Haven	20	111	10	663	14
Middlesex	12	61	7	297	9
New London	13	60	6	545	9
Litchfield	21	145	14	914	25
Hartford	24	238	6	1066	15
Tolland	8	31	3	152	17
Windham	1	1	0	4	0
	119	762	53	4797	97

* American Foul Brood.
† European Foul Brood.
§ 6 colonies winter killed.

	No. Apiaries	No. Colonies
Inspected	762	4,797
Infested with European foul brood	33	72
Per cent. infested	4.3	1.5
Infested with American foul brood	9	12
Per cent. infested	1.18	.25
Sacbrood	9	11
Bee Paralysis	2	2
Average number of colonies per apiary		6.5
Cost of inspection		$1,954.55
Average cost per apiary		$2.565
Average cost per colony		.41

REPORT OF WORK IN SUPPRESSING THE GIPSY AND BROWN-TAIL MOTHS.

Season of 1919-1920.

By W. E. Britton, Irving W. Davis and John T. Ashworth.*

The plan and methods developed in preceding years has been followed with satisfactory results. Full and hearty co-operation between the Federal Bureau of Entomology and the state forces has resulted beneficially to both parties. Most effort has been directed against the gipsy moth as the brown-tail moth has not been abundant for several years. The gipsy moth has been held well in check and except in the towns of Thompson, Woodstock, Killingly, Brooklyn and Griswold, the number of infestations has been smaller than last year.

The gipsy moth work was considerably handicapped on account of labor and weather conditions. The former was mainly a lack of experienced men. New men were taken on the work, but before they had become at all proficient would leave for more remunerative positions. August was the beginning of a rainy spell which virtually lasted until the heavy snows came in February. The depth of the snow caused so much delay, that twelve pairs of snow-shoes were purchased and did excellent service while the snow lasted.

No new towns were found infested and no trace of the gipsy moth was found in seven of the towns that were infested a few years ago. These towns are as follows: Ashford, Mansfield, Windham, Scotland, Franklin, Sprague and Stonington.

As in the last two years, in the older infested towns, single egg-clusters were not counted as infestations. In the border towns and in the towns not previously known to be infested, single egg-clusters have been reckoned as infestations.

No special work was done against the brown-tail moth this winter, but during scouting for the gipsy moth the men kept a sharp lookout for brown-tail webs, but none were found.

New Equipment.

In 1918 a truck body was mounted on a Ford chassis, as was noted in the report for that year and this proved so satisfactory that during the summer of 1919 two new Fords with delivery bodies were purchased. These have given excellent service during

*Note.—Mr. Davis who has been in charge of this field work for nearly seven years, resigned June 10, 1920, to accept a position with the Danielson Trust Company of Danielson. Mr. Ashworth who has been employed under Mr. Davis for nearly three years is now in charge of the field work. The details of the work in each town, table of statistics and new equipment have been prepared by Messrs. Davis and Ashworth, and I have written the introduction, the chapter on parasites and prepared the financial statements and recommendations, etc.—W. E. Britton.

the year past. The second-hand Buick car which was purchased in 1918 gave us considerable trouble, and in January, 1920, it was sold and a new Ford touring car purchased to replace it. This has been very satisfactory.

Each year we have had to borrow one or more spraying machines from the Federal Government. This year it seemed advisable for the State to purchase apparatus, and a new automobile truck power sprayer was obtained similar to the one purchased in 1918 (for description see Report for 1918, page 273). As the price of spraying hose had advanced so much it was not thought wise to purchase more than twelve hundred feet of 1-in. hose and 50 feet of 2½-in. suction hose. (This hose has not proved satisfactory and much of it will have to be replaced.)

By the middle of February the snow was so deep that it was useless to continue scouting. An effort was made to borrow some snow-shoes for experiment, but as these could not be obtained, twelve pairs were purchased and during the rest of the winter were used with a great saving of time and effort.

Labor and Board.

At the close of the war practically all of the men who left this work to enter the service returned to it as soon as discharged. These men were all experienced and made a valuable addition to the force. With the trades advancing wages in all lines many of the men left to obtain higher wages elsewhere. This was particularly true of the new men who received the minimum wage, in the graduated wage-scale now in force. This shortage of men was felt keenly, especially as the winter came on for it proved to be the most severe of any winter we have had since this work started. With the aid of the Government forces, however, the scouting was completed, although it had to be continued so late that there was little time for the work of banding the trees.

Obtaining board continued to be one of the handicaps to the work. Such high wages were paid, that people who had formerly taken boarders found more money and shorter hours in the mills. It was therefore almost impossible to obtain board and when obtained, the price was so high as to be prohibitive to the men at the wages they were receiving. The men were therefore transported from the towns where they lived (in most cases Killingly) and brought back at night. For this purpose the Ford delivery trucks were a necessity, and have been used continuously since they were purchased.

Financial Statement.

Appropriation for biennial period ending June 30, 1921	$70,000.00
Expended year ending June 30, 1920	33,081.11
Balance for current year	$36,918.89

CLASSIFIED EXPENDITURES FOR THE YEAR ENDING JUNE 30, 1920.

Salaries and Wages:		
I. W. Davis	$1,766.62	
J. T. Ashworth	1,435.00	
J. A. McEvoy	1,241.92	
K. E. Buffington	1,198.80	
C. A. Burdick	1,218.32	
F. C. Rich	1,222.84	
J. Knight	400.88	
W. P. Colvin	1,073.25	
C. W. Roth	472.23	
A. J. Gilbert	1,019.33	
R. F. Franklin	856.60	
C. Ladd	454.44	
D. La Belle	858.82	
J. W. Longo	979.91	
R. G. Newton	798.70	
P. H. Shea	1,000.36	
T. Perreault	651.66	
G. D. Stone	620.32	
A. J. Duprey	541.51	
Other labor	2,534.46	
		$20,345.97
Printing and Illustrations		29.91
Postage		18.24
Stationery		12.28
Telegraph and Telephone		54.66
Office Supplies		71.05
Express, Freight and Cartage		10.92
Machinery, Tools and Supplies		8,433.69
Insurance		608.49
Rental and Storage		220.77
Traveling Expenses, Gasoline, etc.		1,262.19
Automobile Tires and Repairs		1,120.54
Inspection of Imported Nursery Stock		825.83
Heat and Light		58.57
Miscellaneous		8.00
Total		$33,081.11

Details of Gipsy Moth Work by Towns

The following pages give a detailed account of the gipsy moth work in each of the towns infested:

Thompson—134 Infestations—4,342 Egg-clusters.

As was true of the scouting in many of the towns this past winter, the work in Thompson was greatly handicapped by the heavy snows and stormy weather. The work was finished about the last of March, and resulted in finding one hundred and thirty-four infestations containing four thousand three hundred and forty-two egg-clusters.

These colonies were spread over the entire town, but were a little more scattered in the western part than in the central and eastern portions. Where so many colonies are present it is diffi-

cult to indicate which are the most serious, but some of the larger may be mentioned.

One on land of Warren Logee about a mile from Brandy Hill, contained three hundred and twenty egg-clusters. These were found on three trees and a nearby stone wall.

A colony in woodland owned by Mrs. J. M. Robinson was found to contain one hundred and eighty-nine egg-clusters, and the examination of an infested stone wall about two miles further north resulted in the finding of two hundred and eighteen more.

In the western part of the town the largest colony was in pasture land owned by Mr. Fred Parker and situated near Fabyan. At this colony the one hundred and ninety egg-clusters were found in a stone wall and four oak trees.

Some tanglefoot was applied in this town, but as it was one of the last to be banded, larvae were observed before the work was quite completed.

During June, eighty-nine of the largest colonies and those most exposed to wind-spread, were sprayed with one of the truck sprayers, and after the spraying season was over, scouts were sent out to visit and inspect all colonies in the town and note the results from spraying; one thousand eighty-two larvae were found and destroyed.

Woodstock—41 Infestations—882 Egg-clusters.

Woodstock, besides being one of the largest towns in Connecticut, has a large road mileage. Many of these roads are old and have been discontinued for several years so that they are no longer passable, but in the gipsy moth work we have always considered them as thoroughfares and scouted them accordingly. From this fact it will be seen that the area of Woodstock is well covered in each years' scouting. This year proved no exception as this was the first town scouted and the work was largely done by the older men. As soon as it was deemed practicable all of the older men who could be spared were sent to work in the western part of Woodstock, and new men were added as fast as they were trained. One crew was withdrawn in the middle of October for work in Canterbury, and another the first of November to scout Eastford.

The rainy weather during the autumn months caused many delays in the work both from the actual time lost and from the poor roads. The scouting was completed on the twenty-eighth day of November, and resulted in finding forty-one colonies of the gipsy moth. These colonies were mostly found in the northeast and southwest portions of the town, with scattering ones in the southeast corner, while the northwest portion was very free from this pest. The majority of these colonies contained less than twenty egg-clusters, while the largest colony contained two hundred and twenty-eight. The latter was a woodland colony and found on land of Mr. Shead near the Thompson line. While this colony

was scattered over several acres, the timber was cut late in the fall and no further work was deemed necessary this winter.

Other large colonies were on land of Samuel Ide in the northerly part of the town, on land owned by Sidney P. Butler and Irving Perry in West Woodstock, and that on land of Charles Clark near Eastford.

At sixteen of the forty-one colonies, tanglefoot bands were placed around the trees as they were on land that was open and high, and therefore gave a good chance for wind-spread.

Thirty-one of the larger colonies were sprayed during the season using about 425 pounds of arsenate of lead. In all three hundred and twenty-five larvae were found and destroyed; only six, however, were found alive after spraying, four of which were found at infestation No. 35, where one hundred and twenty-five dead larvae were found at the same time.

Union—1 Infestation—1 Egg-cluster.

Union was scouted by the state men this year, and as there was but little time remaining before the eggs would hatch, only the eastern portion of the town was covered. One egg-cluster was found, and that on a small oak near the Massachusetts line. The nearby growth was carefully scouted, but no other evidences of the pest were found. No spraying was done, but the territory around the infestation was watched during the larval season and nothing found.

Putnam—15 Infestations—482 Egg-clusters.

There was a notable decrease in the gipsy moth colonies in this town this past year. Only fifteen colonies containing four hundred and eighty-two egg-clusters were located, and the most of these lay to the west of the city of Putnam.

The largest colonies were found in woodland during the early fall and contained nearly half of the egg-clusters found in the town. These, two in number, were both in the eastern part of the town and covered a large area; in one case, forty trees being infested and in the other ninety-four. The danger of spread from these infestations is very small, as they are located so that they are not exposed to the wind.

A group of four colonies found on the hill to the east of the Grove Street cemetery are in an exposed location. While these colonies contained only forty-eight egg-clusters in all, they will need careful attention because the growth on this hill is rather light and therefore is badly wind-swept.

Several of these colonies were banded with tanglefoot during May, and in June ten of the fifteen colonies were sprayed. In looking over the colonies during the latter part of July and the first of August, one thousand six hundred sixteen larvae were found and destroyed, over half of them being just outside in-

festation No. 14, along a stone-wall containing a number of egg-clusters which were covered with snow when the country was scouted last winter.

POMFRET—22 Infestations—274 Egg-clusters.

The western half of this town was scouted just before the heavy snows of last winter. These storms caused the work in this town to be stopped about the first of February. It was later resumed, however, and the town finished the last part of April.

Only twenty-two infestations were found and these may be roughly divided into three groups, one in each of the three corners of the town, while the fourth, the northeast, contained but one colony.

The colonies were all small, considering that Pomfret has been infested for seven years, the largest having only thirty-six egg-clusters. In several of the colonies the trees were banded with tanglefoot and following that were examined for larvae prior to spraying.

In June, eleven of the largest colonies were sprayed with arsenate of lead, and after the spraying season was over all colonies were inspected to determine the results obtained, and in all colonies sprayed and not sprayed a total of only six hundred sixty larvae were found and destroyed.

EASTFORD—10 Infestations—178 Egg-clusters.

A glance at the map of Connecticut will show the peculiar shape of the town of Eastford. A long narrow portion, bounded by Ashford, Union and Woodstock, extends northward, while the southern part is broader and more rectangular in shape. In this northern portion was located only one of the one hundred and seventy-eight egg-clusters found in this town. The majority of both colonies and egg-clusters were found in a group to the north and northeast of Phoenixville.

All of the gipsy moth colonies found in Eastford were in either pasture or woodland. None were considered serious, and the largest colony contained only forty egg-clusters. This was in some woodland owned by Mr. Charles Wheaton and situated to the east of the road which leads past Crystal Lake.

Several of the colonies were banded early in May, and nine of the ten were sprayed during the month of June, three thousand gallons of spray mixture being used. In checking up the results after spraying, the men were unable to find a single larva at any of the colonies, although six hundred fifteen were destroyed before spraying.

KILLINGLY—46 Infestations—1,579 Egg-clusters.

Late in the summer of 1919, considerable woodland scouting was done in Killingly, and three infestations were located on the

ridge about a mile east of the Borough of Danielson. This woodland was cut over during the winter and it is doubtful if it would pay to spray it.

In the winter scouting, the entire town proved to be infested, the only locality which was free of colonies being in the southwest corner of the town. This is explained by the fact that this section is rather open, the growth being mostly scrub-oak and pine.

Two of the colonies are worth noting, both of which were found in the northeastern corner of the town. One of these contained three hundred and thirty and the other three hundred and twenty-nine egg-clusters. The former was on land owned by William Roberts and situated a little south of the Putnam line. The infested growth was three apple trees in a pasture, but was so located that the spraying could be done with a hand-sprayer.

The latter was at the northern end of Chestnut Hill on land belonging to Mrs. Roxy Bartlett. This is about a mile south of the former infestation "as the crow flies." The egg-clusters here were found mostly in a stone wall by the roadside, although an oak and apple tree were also infested.

During the latter part of May, six hundred and fourteen tanglefoot bands were applied to trees at twenty-nine of the infestations, following which thirty-eight of the forty-six infestations were sprayed, one truck sprayer and a small hand sprayer being used. Two thousand forty-five larvae were found and destroyed; of this number, only thirty-four were located after the colonies had been sprayed.

Brooklyn—20 Infestations—499 Egg-clusters.

When the snow became so deep in February, one of the scouting crews were sent into Brooklyn. As the scouts were all living in Danielson, the eastern part of the town was scouted first, most of the work being done on snow-shoes. After the snow had disappeared, many of the colonies were examined again for egg-clusters which might be found beneath the snow line.

The eastern section of the town contained most of the colonies, only one being found in the extreme western part. This one, however, was the largest found in Brooklyn, and contained one hundred and thirteen egg-clusters. This colony was on a high elevation in a wooded pasture owned by Joseph Stetson. As this was a wind-swept area, careful work was done to prevent spread from it.

Most of the other colonies were small, and not of great importance. Two colonies which contained seventy-six and one hundred and thirteen egg-clusters, respectively, were so situated that control measures were easily accomplished. The former was in an old apple tree which was cut down, and the latter was in a swamp to the west of Tatnic Hill, where spread by means of wind would be largely eliminated.

At twelve of the colonies, three hundred ninety-four bands of tanglefoot were put around the trees the early part of May, and in June fifteen were sprayed, two thousand three hundred gallons of spray mixture being used. A total of five living larvae were found at four of the colonies when the men looked them over during the latter part of July.

HAMPTON—5 Infestations—6 Egg-clusters.

Though the number of gipsy moth egg-clusters found in the various towns of this state has remained about the same as last year, in Hampton there has been a marked decrease. This year fewer infestations and fewer egg-clusters were found than in 1914, when the town was first found infested.

In three of the five colonies, the trees were banded with tanglefoot, and as there were so few egg-clusters, spraying was not considered necessary.

CHAPLIN—1 Infestation—3 Egg-clusters.

Only one infestation of gipsy moths was found in Chaplin during the past season's scouting. This was a small colony and was found in an orchard on land owned by Mr. Murphy near the northeastern part of the town. The trees were banded with tanglefoot during the latter part of May. It was not thought necessary to spray this colony. A close watch was kept but no larvae were found.

STERLING—9 Infestations—177 Egg-clusters.

The Moosup River flowing to the west from Rhode Island divides Sterling into a north and south portion of very nearly equal areas. All of the colonies of the gipsy moth found in Sterling this year were to the north of this river. None of these colonies contained a very large number of egg-clusters, the largest colony being that found on land of Mr. G. R. Brown, which totaled fifty-eight. This was located in an apple tree by the roadside and adjacent stone wall. Another colony about a mile northwest of this one, was that on land of John Dixon. This was on a hill which has an elevation of six hundred forty feet, and as that is rather high for that locality, the danger from wind-spread is great.

The trees in most of the colonies in Sterling were banded with tanglefoot early in May. All but one of the colonies in Sterling were sprayed, that being one on land of the Hillside Farm near North Sterling, twenty-two of the twenty-four egg-clusters being old ones, it was not thought advisable to spend the time that could be used to advantage elsewhere.

PLAINFIELD—10 Infestations—398 Egg-clusters.

This was one of the last towns scouted this year, and as the season was so far advanced only the southern portion of the town

was well covered. In the northern section, the scouting was done only around the infestations of the previous year.

The largest colony located was on the western slope of Black Hill in the western part of the town. This colony contained two hundred and eleven egg-clusters and was in some pasture apple trees. While this infestation is in a wind-swept locality it is rather easy to control, as there is but little growth near it. The few trees which are there were banded with tanglefoot early in May.

Another colony of importance was found on what is known as the Green Hollow road near the Killingly Line. This was found in a group of pasture oaks on land owned by Mr. Charles A. Tillinghast, and contained sixty-one egg-clusters. In several of the most open and wind-swept colonies, the trees were tanglefooted and later all of them were sprayed, the hand sprayer being used at two of the colonies; very few larvae were found after spraying and a large portion of them were dead.

CANTERBURY—9 Infestations—126 Egg-clusters.

One of the crews started scouting in Canterbury about the middle of October and finished the first of December. This was more time than it was planned to spend in this town, but the delay was largely due to the excessive rains.

Nine infestations were the result of this scouting, and these were scattered throughout the town. They contained a total of one hundred and twenty-six egg-clusters, about half of which were a year old. The colonies were all rather small, the largest containing thirty egg-clusters. This colony was found in an old orchard in the northern part of the town near the village of Wauregan.

The most serious infestation was probably one located near the Brooklyn line on land owned by Mr. Kerr. This consisted of twenty-three egg-clusters and was found in some oaks on a rather high elevation about half a mile from the nearest traveled road. During the month of May the trees in six of the infestations in this town were banded with tanglefoot.

Eight of the nine infestations were sprayed in June, one thousand eight hundred gallons of solution being used. It was not thought advisable to spray infestation No. 6, as there was only one new egg-cluster found. Three hundred and twenty-four larvae were found and destroyed during the season.

VOLUNTOWN—2 Infestations—2 Egg-clusters.

During the past winter, only two egg-clusters of the gipsy moth were found in this town, and both of these were in the northern part, but about three miles apart. These were not considered serious enough to warrant further work.

GRISWOLD—11 Infestations—33 Egg-clusters.

The colonies of the gipsy moth found in Griswold were all small, the largest containing only ten egg-clusters. All but two of these were found to the north of the Griswold Post Office. In the most serious of these colonies the trees were banded early in May.

Three colonies in Griswold were sprayed, four hundred and seventy-five gallons of solution being used. No larvae were found at the colonies during the season.

LISBON—1 Infestation—1 Egg-cluster.

The Federal men scouted Lisbon during the past winter and found but a single egg-cluster. This occurred in the western part of the town near the Sprague line. It was not thought serious enough to warrant the banding of the trees with tanglefoot and no spraying was done.

PRESTON—6 Infestations—127 Egg-clusters.

Though one hundred and twenty-seven gipsy moth egg-clusters were found in Preston during the past winter, one hundred and twenty-two of them were in two colonies. These two colonies were close together and a little to the north of the state road leading from Norwich to Preston City.

One of these infestations was located on land of Frank Ayer and contained one hundred and ten egg-clusters. This was in open woodland on some large oaks, but on rather low ground and from which there is little danger of wind-spread.

The other large colony was in an orchard belonging to Steve Stanewiez. There were but few trees found infested, but all of the trees in the orchard have cavities in them which make control measures difficult.

At four of the colonies the trees were banded with tanglefoot in May, and in the early part of June the two above-mentioned infestations were sprayed.

NORWICH—5 Infestations—74 Egg-clusters.

The result of the winters' scouting in the town of Norwich was the discovery of five colonies. Three of these contained but a single egg-cluster each and all of this group were located in the northeastern part of the town. The largest colony of forty-two egg-clusters was just inside the city limits, in the south part of the city. These were in an oak tree and stone wall, but there was very little growth near it. The most serious colony was in the western part of the town near the Bozrah line on the top of Wawecus Hill, which has an elevation of over four hundred feet. The colony is in roadside maples and apple trees and therefore is badly wind-swept

which may cause spread. The trees in this vicinity were banded early in May with tree tanglefoot, and were watched during the summer but no larvae found.

In the early part of June two of the colonies were sprayed.

BOZRAH—1 Infestation—4 Egg-clusters.

Only one infestation was found in Bozrah and that on land owned by Mr. R. A. Bethan and located near the Norwich line. The trees in this colony were banded during the month of May, and sprayed in June.

NORTH STONINGTON—1 Infestation—29 Egg-clusters.

Although only one infestation is listed as being found within the limits of this town, there were several single egg-clusters which were not counted as infestations. These were found well scattered throughout the town. The infestation noted was found close to the Hopkinton, R. I., line on land owned by Mr. Thomas Wheeler and the trees in this vicinity were banded early in the month of May. This infestation was sprayed on June 9th and during July most of singles were inspected at the same time as the above-described infestation and thirty-six larvae were found and destroyed; twenty-six of these larvae were at a single egg-cluster infestation situated near the Stonington line.

LEDYARD—3 Infestations—4 Egg-clusters.

All of the gipsy moth colonies found in Ledyard were in apple orchards, and all were small, there being only four egg-clusters found in the entire town. The trees near two of these infestations were banded with tanglefoot, and one was sprayed in June.

GROTON—1 Infestation—1 Egg-cluster.

Only one egg-cluster was found in Groton, and this was in the extreme northern part of the town. Aside from the creosoting of the egg-cluster no other work was considered necessary.

The statistics of this work as applies to each town and given in the preceding pages are summarized in the following table:

STATISTICS OF INFESTATION.

Town.	Infestations.	Egg-clusters.	Tanglefoot Bands.	Sprayed.	Larvae.
Thompson	134	4,342	216	89	1,082
Woodstock	41	882	83	31	328
Putnam	15	482	264	10	1,616
Pomfret	22	274	53	11	660
Eastford	10	178	20	9	615
Ashford	0	0	0	0	0
Killingly	46	1,579	614	38	2,045
Brooklyn	20	499	394	15	251

STATISTICS OF INFESTATION—*Cont'd.*

Town.	Infestations.	Egg-clusters.	Tanglefoot Bands.	Sprayed.	Larvae.
Hampton	5	6	35	0	0
Chaplin	1	3	10	0	0
Sterling	6	177	133	5	17
Plainfield	10	398	78	10	614
Canterbury	9	126	129	8	324
Scotland	0	0	0	0	0
Mansfield	0	0	0	0	0
Voluntown	0	0	0	0	0
Griswold	11	33	81	3	0
Lisbon	1	1	0	0	0
Sprague	0	0	0	0	0
North Stonington	2	29	24	1	36
Stonington	0	0	0	0	0
Groton	1	1	0	0	0
Union	1	1	0	0	0
Windham	0	0	0	0	0
Preston	6	127	51	2	24
Norwich	5	74	111	2	0
Ledyard	3	8	13	1	0
Bozrah	1	4	5	1	0
Franklin	0	0	0	0	0
21 Towns Infested	350	9,224	2,314	236	7,612

PARASITES.

In preceding years, an attempt has been made each year to liberate one or more species of the different parasites in some of the infested towns of the state, but owing to the weather and the labor conditions, we were unable to do it in 1920. However, collections of gipsy moth larvae were made in Thompson, Woodstock, Putnam, Pomfret, Killingly, Plainfield, Canterbury and Brooklyn, and sent to the Government laboratory at Melrose Highlands, Mass., in order to determine if any species of parasites could be recovered as a result of planting colonies. We are indebted to Mr. A. F. Burgess for much of the information regarding the planting and recovery of parasites, a full report up to that time being included in the Report of this Station for 1917, page 250. The following resumé brings the subject up to date, so far as Connecticut is concerned.

Calosoma sycophanta Linn.

Though not a parasite, both adults and larvae of this large ground beetle devour the caterpillars of the gipsy moth and it is therefore quite an important agency for holding that species in check. It was liberated in Stonington in 1914, in Thompson in 1915, and in Killingly in 1917. This species now seems to be fairly well distributed over the state, as it has been collected or observed in Thompson, Putnam, Killingly, Scotland, Plainfield, Groton, Lyme, Clinton, New Haven, Meriden and Darien. Our employees have reported observing these beetles feeding upon gipsy moth larvae in Thompson and Killingly in 1920.

Anastatus bifasciatus Fonsc.

This very minute Hymenopterous egg parasite was first liberated in Connecticut in 1917, when colonies were placed in Thompson, Woodstock, Putnam, Killingly, Pomfret, Eastford, Brooklyn, Hampton, Chaplin, Mansfield and Canterbury. More colonies were planted in Brooklyn in 1918, Canterbury 1919, Eastford 1918 and 1919, Griswold in 1918, Hampton in 1918 and 1919, Killingly in 1918 and 1919, Ledyard in 1919, Mansfield in 1918, Norwich in 1919, Plainfield in 1918 and 1919, Pomfret in 1919, Putnam in 1918 and 1919, Scotland in 1918, Sterling in 1918 and 1919, Thompson in 1919, Voluntown in 1918 and 1919, and Woodstock in 1918.

This insect was recovered from Eastford in 1917, and from Voluntown in 1918.

Apanteles lacteicolor Vier.

This is a small Hymenopterous parasite of the brown-tail moth larvae. It has been colonized in Connecticut as follows: Putnam in 1912, Suffield, Hartford, Mansfield, Norwich, Stonington, Griswold, Plainfield, Killingly and Hampton in 1913, Manchester Chester, Colchester and Lebanon in 1915, East Lyme and Canterbury in 1916, Montville and Groton in 1917.

This species has been recovered as follows: Brooklyn 1916, Canterbury 1917, East Hartford 1916, Groton 1918, Hartford 1913 and 1914, Killingly 1916, Lebanon 1915, Pomfret 1913, Putnam 1917, Stafford 1917, Stonington 1915, Suffield 1915, Thompson 1913 and 1916, Waterford 1914, 1916 and 1917, Wethersfield 1916, Woodstock 1913, 1915 and 1916.

Pteromalus egregius Forst.

A minute Hymenopterous parasite of the brown-tail caterpillars not colonized in Connecticut, but recovered from Hartford in 1913 and 1914, and Putnam in 1915.

Monodontomerus aereus Walker.

A minute Hymenopterous parasite of the pupae of both gipsy and brown-tail moths. Not colonized in Connecticut but recovered from Putnam in 1911 and 1915, Hartford and Suffield in 1912.

Meteorus versicolor Wesm.

This is a minute Hymenopterous parasite of the brown-tail caterpillars, and though no attempt was ever made to colonize the species in Connecticut, probably some cocoons were mixed with those of *Apanteles lacteicolor* and thus it became distributed. It was recovered from Hartford in 1914, and from Brooklyn, Killingly, Thompson, and Woodstock in 1916, and from Groton in 1918.

Compsilura concinnata Meigen.

This is a medium-sized Dipterous parasite or two-winged fly of the family Tachinidae attacking both the gipsy and brown-tail moths. It was colonized at Putnam in 1912, Hartford in 1913, Mansfield, Plainfield and Stonington in 1914, Stafford, Suffield, Colchester, Norwich and Old Lyme in 1915, and Hampton and Scotland in 1917. It has been recovered from Woodstock in 1915, Stonington in 1916, Putnam, Stafford, Plainfield and North Stonington in 1917, Pomfret, Putnam and Stonington in 1918, Killingly,

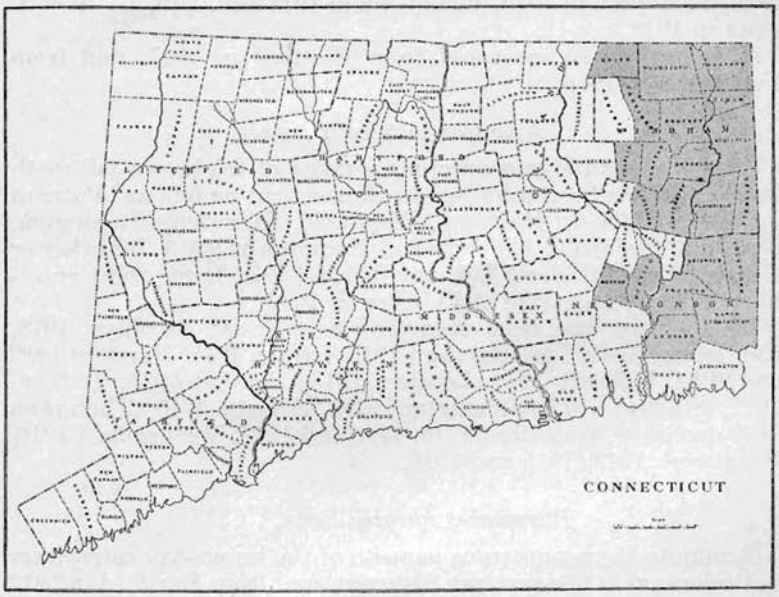

Figure 4. Map of Connecticut showing area quarantined on account of gipsy moth.

Plainfield, Pomfret, Putnam, Scotland and Thompson in 1919, and from Plainfield, North Stonington and Putnam in 1920.

Sturmia (*Zygobothria*) *nidicola* Townsend.

This is another Tachinid fly of medium size parasitizing the larvae of both gipsy and brown-tail moths, and though never colonized in Connecticut, it was recovered from Canterbury and Waterford in 1917, and from Groton and Stonington in 1918.

The foregoing records of parasites lead us to believe that most of these species have become fairly well distributed around the infested portion of the state even though not actually planted

there. Some help may therefore be expected from them in the years to come. The effectiveness of parasites depends much upon conditions, and is usually more pronounced in localities where the host is extremely abundant, and on account of the suppression work done, this has never been the case in Connecticut. Though parasites play an important part as a natural agency in controlling or holding in check a given species, they never exterminate their hosts. Of course, where conditions are like those in Connecticut, where their hosts are not very abundant and suppressive measures are being carried on, the parasites do not have the best kind of a chance. However, we are glad to know that they are still present.

Quarantine.

During 1919 eight Connecticut towns were removed from the Federal quarantined area as no traces of the gipsy moth had been found in them. This past winter three of these towns, Preston, Norwich and Bozrah, were again found to be infested and were added to the quarantined area.

The spread in the states of northern New England was very heavy and this gave rise to erroneous newspaper reports that there had been a great increase of the gipsy moth in Connecticut.

Only two towns, Groton and Stonington, were quarantined against the brown-tail moth, and as there were no webs of this insect found in this state last winter, it is doubtful if they are quarantined this year.

Under the Federal regulations, shipments going from the infested area to another state were inspected by the Federal agents, but shipments to another point within the state were not subject to inspection. This left the greater part of the state subject to infestation from the colonies in the eastern portion. Accordingly, after due notice, a hearing was held in Hartford on March 3, 1920, after which the following quarantine regulations were established:

State of Connecticut
Office of State Entomologist
Agricultural Experiment Station
New Haven, Conn.

Quarantine Order No. 2.

Concerning Gipsy and Brown-Tail Moths.

In order to protect uninfested parts of Connecticut from danger of infestation by the gipsy moth and the brown-tail moth, under authority given in Section 2106 of the General Statutes, the following regulations are hereby established.

1. The towns of Union, Woodstock, Thompson, Eastford, Pomfret, Putnam, Chaplin, Hampton, Brooklyn, Killingly, Scotland, Canterbury, Plainfield, Sterling, Lisbon, Griswold, Voluntown, Ledyard and North Stonington because of the gipsy moth, and all the above-named towns and Groton and Stonington because of the brown-tail moth are now under

quarantine by the Federal Horticultural Board of the United States Department of Agriculture, and it shall be unlawful to remove from this quarantined area any woody nursery stock, lumber, cordwood, telegraph or telephone poles, railroad ties, or other forest plant products, unless the products shall have been inspected and certified by an authorized state or Federal inspector.

2. In view of possible future changes in the lines between the infested and non-infested areas of the State, the areas quarantined by the State shall conform to those quarantined by the United States Department of Agriculture; furthermore the regulations established by the Federal Horticultural Board of the United States Department of Agriculture for interstate shipments, are hereby adopted for the inspection and certification of similar shipments from the quarantined area to points outside of this area within the State of Connecticut.

3. This order shall take effect from its date.

Dated March 23, 1920.

E. H. JENKINS,
Director, Connecticut Agricultural Experiment Station.

Approved
M. H. HOLCOMB,
Governor.

Instructions to Nurserymen, Lumbermen, Wood Dealers, Shippers and Transportation Companies.

Any shipments of nursery stock, or forest products originating within the quarantined area must not be shipped out of that area into the territory not infested, unless inspected and accompanied by the inspector's certificate. All shipments going into other States must be examined by a Federal Inspector, and the Federal Inspectors have also been authorized to inspect shipments consigned to points within the State: the State inspector can also examine such shipments in case of convenience or if the Federal Inspectors are busy elsewhere.

Transportation companies must not accept nursery stock or forest products consigned to points outside of the infested area unless accompanied by certificate of inspection.

INSPECTORS.

Federal Inspectors.

Herbert J. Miles, P. O. Box 62, Putnam, Conn. Telephone 321-14, Putnam. Inspector for Windham and Tolland Counties.

William J. Ahearn, Box 63, Westerly, R. I. Telephone 2277, Westerly. Inspector for New London County.

State Inspector.

John T. Ashworth, 26 Reynolds St., Danielson, Conn. Telephone 28-3, Danielson. Inspector for any shipments not going outside of the State.

So far the inspections have all been made by the Federal inspectors, and reports of all shipments to uninfested parts of Connecticut are sent to the office of the State Entomologist, where they are placed on file. The Federal quarantine also covers field stone and quarry products, but apparantly our state law (Section 2106) provides only for the control of shipments of plants or plant products.

Infestations Discovered in New Jersey and New York.

In midsummer an infestation of about one hundred square miles in extent was discovered on the Duke estate at Somerville, N. J. From a nursery on this estate many shipments had been sent during the past few years and in following up the destinations of these shipments several smaller infestations were found in New Jersey and one in Brooklyn, N. Y. Through the kindness of Mr. A. F. Burgess of the Bureau of Entomology, reports were received of eleven shipments of nursery stock from the Duke estate consigned to six parties in Connecticut. Most of these shipments were made between 1913 and 1916 and were sent to Greenwich, Stamford, Fairfield, Bridgeport, Ridgefield and Sharon.

Messrs. B. H. Walden and M. P. Zappe, Assistant Entomologists of the Station visited all of these places and inspected the plantations in and around the places where these plants were set. No indications were found of the presence of the gipsy moth in any of these places.

Recommendations.

On account of the existing conditions, we have reason to believe that the gipsy moth is now well in hand in Connecticut. If the work should be stopped, the pest would soon become sufficiently abundant to cause noticeable damage to trees by stripping them in June. State action would then be demanded. Such a possibility should not for a moment be considered, because the experience of Massachusetts shows its folly. Though confined to a rather small area in Massachusetts when the work stopped in 1900, the pest became so troublesome that the work was again taken up in 1905, but it was found to have spread over an area more than six times its former size and the difficulty and cost of control correspondingly increased. In Connecticut, the gipsy moth should be held just where it now is or the infested area reduced if possible.

Federal co-operation has been most cordial and satisfactory, but the Federal appropriation was reduced, and on account of the rather rapid spread northward, extra work was needed in Maine, New Hampshire and Vermont. Then, too, during the past summer new infestations were discovered in the states of New Jersey and New York, thus requiring that a portion of the Federal appropriation be used in those States.

The Connecticut forces are now fairly well equipped with spraying machinery and supplies, and with motor vehicles. The initial outlay for new apparatus should, therefore, not be very heavy for the next two years. Federal quarantine No. 37 has resulted in keeping out much of the imported nursery stock which formerly had to be inspected out of this appropriation. There will still be considerable fruit stock and Manetti rose stock for propagating, that must be inspected, but the quantity will be relatively

small, and the cost of inspection considerably less than in former years. As will be seen from the financial statement on page five, the cost of this work for the past year was $825.83, and it will probably be about the same for each season.

The appropriation for gipsy moth work should be sufficiently large, together with the possible Federal aid, to cope with any emergency such as a serious wind-spread. All things considered, we therefore respectfully request that sixty thousand dollars ($60,000.00) be appropriated for the biennial period ending June 30, 1923, for the purpose of suppressing the gipsy moth, the brown-tail moth, and for inspecting imported nursery stock.

EXPERIMENTS IN DUSTING IN COMPARISON WITH SPRAYING TO CONTROL APPLE INSECTS.

On March 30, 1920, entomologists from New York, New Jersey, Pennsylvania, Connecticut, and the U. S. Department of Agriculture held a conference at the Grand Central Station in New York City to consider a common plan for the testing of dust mixtures. It was agreed that it seemed desirable to conduct experiments in each of the states represented, to ascertain whether the common pests of the apple orchard could be satisfactorily controlled by dusting operations, and especially to learn if the addition of nicotine sulphate to the dust would control apple aphids and red bug.

The secretary afterwards prepared copies of the general plan of experiment and sent them with the minutes of the conference, to each entomologist who had been in attendance. In general the plans called for a dust containing 90 per cent. sulphur, and 10 per cent. arsenate of lead, to which nicotine sulphate was to be added in three different proportions, *viz.*, one-half of one per cent., one per cent., and three per cent. It was also recommended that one plot should be sprayed and one left untreated for purposes of comparison; that not less than 100 trees be included in the experiment; that standard varieties and rather large trees be used if feasible; and that at least four treatments be given (delayed dormant; pre-pink, calyx, and young fruit). In other respects the operations were to be conducted in conformity with the demands of the orchard and practices of the region where the work was conducted.

After examining several orchards, one owned by Mr. William F. Platt of Milford seemed to meet most fully the requirements. This orchard contained 30 acres, most of the trees having been planted 26 years, was in sod and was situated just over the line in the town of Orange. Consequently arrangements were made with the owner, to allow us to experiment on his trees and to furnish team and help where needed. The Station was to furnish materials and the owner was to have the fruit crop. The owner had given the entire orchard a dormant treatment with "Scalecide," one part in fifteen parts of water.

The detailed plan of the experiment was developed through the co-operation of the Entomological and Botanical Departments of this Station and the Division of Deciduous Fruit Insect Investigations of the Federal Bureau of Entomology, which has for several years maintained at Wallingford, Conn., a field station for the study of orchard insects.

To the owner, Mr. William F. Platt, to the Bureau of Entomology, to The Niagara Sprayer Company, and to the Botanical Department of this Station, our thanks are due for help and co-operation to make this work possible.

Most of the actual work was done by Messrs. B. A. Porter and C. H. Alden, of the Wallingford field station of the Bureau of Entomology, E. M. Stoddard and G. E. Graham of the Botanical Department, and M. P. Zappe, B. H. Walden, P. Garman and W. E. Britton of the Entomological Department of this Station.

The dust was applied with a Niagara power duster, owned by the Federal Bureau of Entomology and used in the experiments last year at Wallingford. Dr. Quaintance and Mr. Porter kindly granted us permission to use this machine. It was hauled about the orchard with a pair of horses owned by Mr. Platt as is shown on Plates IV and V, a. The liquid spray was applied with the owner's regular sprayer (a Friend power outfit) which is shown on Plate V, b.

The dust mixtures were prepared by the Niagara Sprayer Co., Middleport, N. Y., and 300 lbs. each of Formulas 1, 2, and 3, were furnished gratis for the experiments. These amounts were not sufficient, and later 100 lbs. Formula 1, 100 lbs. Formula 2, and 200 lbs. Formula 3, were purchased from this firm.

MIXTURES USED.

Formula 1 Dust	Powdered sulphur, 90 per cent. Powdered lead arsenate, 10 per cent. Nicotine sulphate, one-half per cent.
Formula 2 Dust	Powdered sulphur, 90 per cent. Powdered lead arsenate, 10 per cent. Nicotine sulphate, 1 per cent.
Formula 3 Dust	Powdered sulphur, 90 per cent. Powdered lead arsenate, 10 per cent. Nicotine sulphate, 3 per cent.
Formula 4 Liquid Spray	Liquid lime-sulphur, 1 part. Water, 9 parts. Nicotine sulphate, ¾ pint per 100 gallons.

Formula 4 was modified by diluting the liquid lime-sulphur at the rate of 1 part to 33 parts of water for the 2nd, 3rd and 4th treatments which were applied to the foliage, and 3 lbs. of powdered lead arsenate, per 100 gallons, was added.

The plan of that portion of the orchard where the experiments were conducted, showing the location of the plots and trees, is reproduced in figure 5.

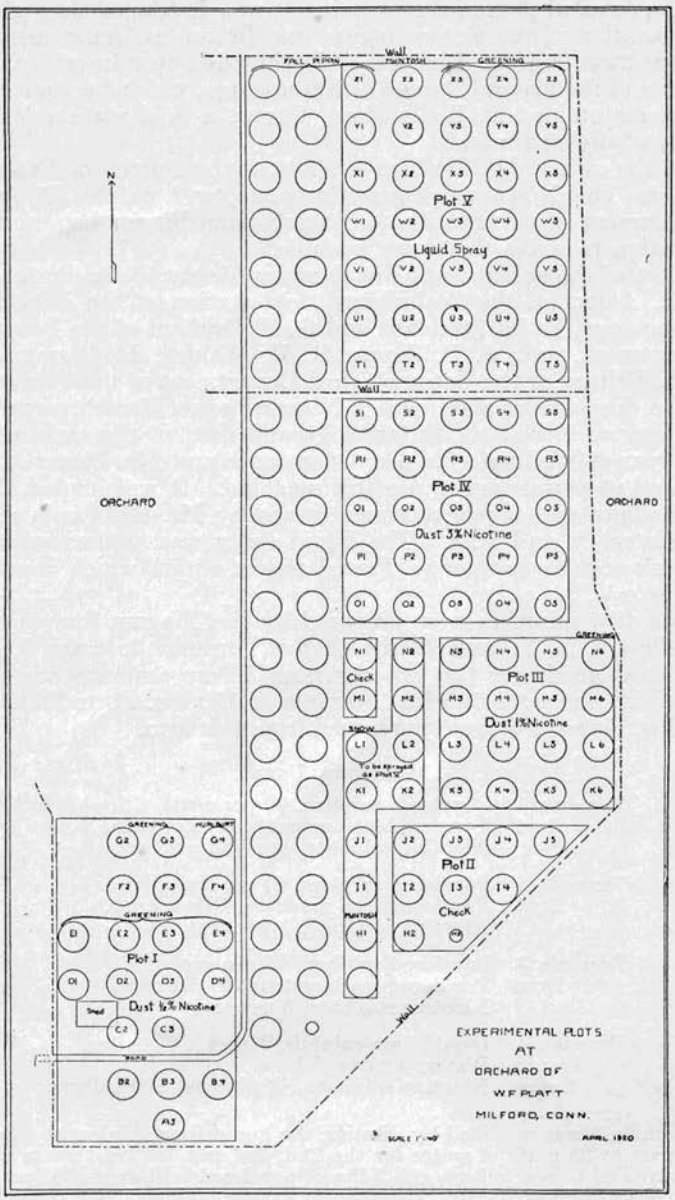

Figure 5. Plan showing arrangement of experiment plots, in orchard of W. F. Platt, Milford, where experiments in dusting and spraying were conducted.

As to varieties, most of the trees were Greening; plot I had 18 Greening and 2 Hurlburt trees; plots II and III were all Greening; plot IV contained 15 Greening, 5 McIntosh and 5 Fall Pippin; plot V contained 21 Greening, 7 McIntosh and 7 Fall Pippin. In all, 104 trees were included in the experiment, and the remaining portion of the thirty acre orchard was sprayed by the owner with a weaker lime-sulphur (1 part to 66 parts of water), but at about the same time and in the same manner as plot V, and was available for collecting data and making observations.

This paper concerns only the treatments and their effects on the insect pests of the orchard. The effect on apple scab and other fungous diseases will be treated separately elsewhere by the Botanical Department.

The treatments given the trees on the different plots were as follows:—

TREATMENTS APPLIED.

Plot I.	Dust, Formula 1.....	20 trees.
Plot II.	Check. No treatment.....	8 "
Plot III.	Dust, Formula 2.....	16 "
Plot IV.	Dust, Formula 3.....	25 "
Plot V.	Liquid Spray, Formula 4.....	35 "
		104 trees.

Additional trees in rows adjoining plots II and III on the west were sprayed like plot V, with two trees saved as checks, to obtain data regarding effect on apple scab, by the Botanical Department.

The applications were made on the following dates:

1st Application	Delayed Dormant	April 22.
2nd "	Pre-pink	May 11
3rd "	Calyx	June 2
4th "	Young fruit	June 25

FIRST, OR DELAYED DORMANT TREATMENT.

Arrangements were completed to make the first application on the morning of April 22. It had rained all of the day preceding, and the trees were moist but not dripping. It was cloudy on the 22nd, with a gentle breeze from the northwest. The treatment began about 8 o'clock A. M., and was finished about 12.30. Messrs. Zappe, Stoddard and Porter made the application. The leaf buds showed a little green at the tips and green apple aphids had hatched and were present on the buds. The trees appeared to be well covered with dust. Living green apple aphids were observed partly covered with dust, about three hours after applying. Rain fell the following day.

For this treatment about 55 lbs. of formula 1; 60 lbs. of formula 2; 75 lbs. of formula 3; and about 150 gallons of formula 4 were used.

This first treatment was followed by cold weather and cold rains which retarded the normal progress of growth for this season of the year.

SECOND, OR PRE-PINK TREATMENT.

The second treatment was made on May 11. At this time the very foremost blossom buds began to show pink, but the others did not. The leaves were only partly developed, but enough so to catch and hold the dust and spray. The weather was ideal for making the application; it had rained a little the day before and it was still and partly cloudy. The work commenced about 8 A. M., and by 9.30 the dusting was finished. The spraying was finished about 11.20. About 4 P. M., a light rain set in which continued during a part of the night.

We ran out of materials of formula 3, before finishing plot IV, and used a little of formula 2, in order to finish. For the spray mixture liquid lime-sulphur was diluted at the rate of 3 gallons, with 3 lbs. of powerded lead arsenate for each 100 gallons. About 225 gallons of the liquid spray mixture were used in this treatment.

The applications were made by Messrs. Zappe, Porter and Stoddard. Very few aphids were present even on the untreated trees. No red bugs had yet appeared and the apple leafhopper, *Empoa rosae* Linn. was just beginning to hatch.

On May 12, a visit to the orchard revealed the fact that the dust was not appreciably washed off by the rains, and though it had collected in low places, or along the mid-rib, or at the tip, was still abundant on the leaves. No injury could be detected on any of the sprayed or dusted trees.

On May 17, another visit was made to the orchard. Bud worms were at work and there were only a few aphids present. Lady beetles were present in moderate numbers.

On May 25, visited orchard again. Greening trees were in full bloom and a few petals beginning to fall. There seemed to be more green apple aphids present than at any preceding visit and a few winged ones were seen. Only one nymph of the false red bug *Lygidea mendax* Reut. was seen, though in the orchard of F. N. Platt, perhaps a mile distant, they were rather common, and most of them were in the second instar.

THIRD, OR CALYX TREATMENT.

This was made on June 2. The petals had all fallen except here and there a late flower remained. Began dusting about 7:30 A. M. It was quite still with a slight southwest breeze. Material was applied by Messrs. Zappe, Porter and Stoddard.

On June 4, visited the orchard. A light shower came on the afternoon of June 3, but it did not seem to wash off the dust. Found five red bugs in 3rd instar, one of which had left the terminal leaves and was on a cluster of four young apples, each of which had

been punctured several times. One colony of rosy aphid was noticed on one of the sprayed trees; green aphid had nearly all disappeared.

Visited orchard on June 8. Could not find any red bugs. A few leaf-eating larvae were found, dead. Also visited the orchard of F. N. Platt, and found plenty of red bugs on one tree in northwest corner of the orchard next to a piece of woodland. There was a bug on nearly every terminal shoot, and some of the bugs were already on the fruit clusters and beginning to puncture the young apples which were then about the size of small marbles. These bugs were in the 4th instar.

Fourth, or Young Fruit Treatment.

This was the final application and was made on June 25. There was a light breeze from the northwest. Apparently it required about four pounds of dust per tree, and about 300 gallons of the spray mixture was used. For this application the dusting machine was towed about the orchard with a Ford truck. Messrs. Zappe, Porter and Stoddard did the work. The McIntosh apples were about an inch in diameter at this time. A little of the rosy apple aphid was noticed, but red bugs were scarce. Leafhoppers (*Empoa rosae* Linn.) were present. In afternoon, visited F. N. Platt's orchard and found red bugs just transforming to the adult stage.

Messrs. Britton and Zappe visited orchard on July 2. There were many nymphs and adults of apple leafhopper present causing whitish spots on the leaves. Also visited F. N. Platt's orchard. Most of the red bugs had gone and only a few adults were seen.

General Seasonal Appearance of Trees.

There was little if any difference in appearance between the sprayed and dusted trees during the early part of the season. Both treatments controlled the leaf feeders in a fairly satisfactory manner. Now and then we found the bud worm at work on the tender terminal leaves. The check or untreated trees were not in such good condition though they were not eaten badly.

A slight difference became noticeable late in the season, for at harvest time the dusted trees seemed to have matured or ripened up earlier and had shed more leaves than the sprayed trees. Thus the sprayed trees were slightly greener. This applied to the foliage rather than to the fruit. No injury from any of the applications was noticed during the season. Nearly all of the trees produced fruit.

Scoring and Counting the Fruit

In order to obtain definite and accurate results on the effect of the treatment it was necessary to count and examine the fruit for

insect injuries from a certain number of trees in each plot. We attempted to select count trees from the center of each plot. Such trees would be less likely to be affected by the treatments given adjoining plots, because the dust and spray will sometimes be blown upon nearby trees. The following number of count trees were selected in each plot: plot I, 4 trees; plot II, 8 trees; plot III, 4 trees; plot IV, 8 trees, and plot V, 8 trees.

As most of the fruit falls which is badly injured by insects it was thought desirable to gather and score the dropped fruit as well as that remaining at harvest time. The drops from the count trees were therefore gathered about once each fortnight, counted, examined for insect and fungus injuries and a record kept. As the Fall Pippin and McIntosh apples matured earlier than the Greening, they were gathered and examined before the Greenings were harvested. On September 30, a few days before harvest time a severe storm took off a large proportion of the apples and these were also picked up, counted and scored separately.

It is interesting to note that the percentage of apples which were brought to the ground from the count trees by this storm varied considerably in the different plots as the following table shows:

FRUIT REMOVED BY STORM SEPTEMBER 30.

Plot.	No. Count Trees.	Percentage fruit dropped.	Treatment.
I	4	8.3	Dusted ½% nicotine.
II	8	25	Check No treatment
III	4	30	Dusted 1% nicotine
IV	8	23	Dusted 3% nicotine
V	8	17	Sprayed

On account of plot I being in the corner of the orchard, it was unquestionably somewhat protected by the nearby woodland trees and by the packing shed which stands amongst the trees of this plot. It is also on slightly lower ground than any of the others with the possible exception of plot II. With the exception of plot I, the sprayed trees (plot V) lost a slightly smaller proportion of fruit from the storm than the other plots.

The picking was done mostly by Mr. Platt's men, and the counting and scoring was done by Messrs. Porter, Alden, Stoddard, Graham, Zappe, Walden, Garman and Britton.

The dropped fruit was gathered four times for scoring and counting, on July 7, July 23, August 9, and August 30. The Fall Pippins were harvested September 10-15, and the McIntosh and Greening apples were harvested soon after October 1, the work being finished on October 13. This work involved the counting, separate handling, examination, and making record of each, of 159,668 individual apples.

Results of Treatments.

The results of the experiments might be given in detail as concerns each of the principal insect pests occurring in the orchard and attacking the fruit, but they are summarized in the accompanying table. It should be noted that the sum of the percentages for each treatment does not equal 100, because the records of percentages for fungous diseases are not included in this table, and even if they were included, in most cases the percentages would total more than 100 because some fruits showed marks indicating that more than one pest had attacked them.

Statistics of Results.

Treatment.	Total No. of Apples.	Good per cent.	Red Bug per cent.	Aphis per cent.	Codling Moth per cent.	Curculio per cent.	Other Insects per cent.
Check.....	34,273	38.6	7.5	.85	4.77	21.00	5.3
Dusted:							
½% Nicotine.	20,290	60.8	7.1	2.31	.306	19.8	7.4
1% Nicotine.	23,972	86.5	2.05	2.82	.505	6.7	6.8
3% Nicotine.	44,486	82.6	1.66	.795	.398	5.25	4.5
Sprayed	36,647	88.0	1.66	1.665	.326	7.45	4.54

Discussion of Results.

It should be borne in mind that these tests represent only one season's work in one locality, and that quite different results might be obtained if the experiments were continued over a period of several years, or if duplicated in a number of orchards in different sections of the state. However, they are given here for what they are worth, and with certain reservations which are noted, may serve as a guide for future work. The percentage of good fruit was somewhat greater on the sprayed trees (plot V) than on any of the dusted trees though those containing one per cent., and three per cent. of nicotine (plots III and IV) were not very far below. The check or untreated trees gave only 38.6 per cent. of good fruit. The results as applied to the chief insect pests of the orchard are as follows:

Red Bug.—This insect was rather scarce in this orchard in 1920, but its injury was detected here and there throughout the orchard and the bugs were seen on a number of occasions. In all cases it was the false red bug *Lygidea mendax* Reut. The figures show that there was little difference between the sprayed trees (plot V) and those treated with one per cent. or more of nicotine in the dust (plots III and IV) but both those having less than one per cent. nicotine in the dust (plot I) and the check or untreated trees (plot II) gave more than three times as much red bug injury on the fruit as each of the other three plots.

Aphids.—Both the green apple aphid, *Aphis pomi* DeGeer, and the rosy aphid, *Anuraphis malifoliae* Fitch (*Aphis sorbi* Kalt.) were present in the orchard but not in sufficient numbers to make them very destructive. No doubt they were somewhat held in

check by the cold and rainy weather during the first half of the summer, and also by the lady beetles which were present. The percentage figures in the table as applied to aphids, appear to have no value, as the untreated trees (plot II) had less aphid injury than any of the other plots except that having three per cent.of nicotine in the dust (plot IV).

Codling Moth.—The codling moth *Carpocapsa pomonella* Linn. was held in check satisfactorily by both liquid spray and dust. Even the untreated trees (plot II) showed less than five per cent. of injured apples.

Curculio.—There was a large amount of injury (21 per cent.) attributed to the plum curculio, *Conotrachelus nenuphar* Herbst., on the untreated trees (plot II), and on the dusted trees containing only one-half of one per cent. of nicotine (plot I) it was only slightly less or 19.8 per cent. As it is a question if nicotine is of any value in controlling this pest and as the trees in plot I were treated with lead arsenate like those in plots III and IV, where the injury was less than one-third as great, some factor other than the treatment must be considered if an explanation is found. The trees of plot I surrounded the packing shed, and were separated only by a stone wall from a pasture partly covered with a growth of brush and some wood had recently been cut there. Possibly these conditions may have furnished better hibernating quarters for the beetles than obtained in the close vicinity of the other plots. The untreated trees (plot II) were only slightly nearer plot I, than was plot III, but it was on the southeast corner of the orchard. A stone wall extended along one side, not only of this plot, but also plots III, IV, and V, in which there was little difference in the amount of curculio injury.

Other Insects.—This category contains minor injuries by chewing insects which could not with reasonable certainty be attributed to codling moth or curculio, though it is possible that both these pests contributed. By far the major portion was due to gnawing of the fruit rather late in the season by Lepidopterous larvae, of which the bud moth *Tmetocera ocellana* Schiff., the lesser apple worm *Enarmonia prunivora* Walsh, and the red banded leaf-roller *Eulia velutinana* Walker, were recognized. The first was reared. There is practically no difference between the plots in regard to this kind of injury, but we believe that it might have been reduced considerably by one or two late applications. (See Plate VI, a).

Recommendations.

It would be unfair to draw final conclusions from these tests of a single season in one locality, and it is hoped that more work may be carried on the coming summer. We cannot advise orchardists to discard their spray outfits to take up dusting, though it is apparently possible to hold the chewing insects in fairly satisfactory control by the use of the dust treatment.

With the addition of nicotine solution some of the sucking insects, particularly false red bug, seem to have been checked, but the data are too meager upon which to base conclusions. The nicotine makes the dusting mixture very much more expensive.

The chief advantage of dusting over spraying is in the saving of time and labor. The disadvantage is in the cost of the materials and apparently this more than offsets the saving in time and labor, as the approximate cost of one treatment per tree was fully three times as great for dusting as for spraying.

If varieties are grown which are not susceptible to scab, and if sucking insects are not troublesome, dusting may give good results, but if these pests are serious in the orchard, better control will probably be obtained by spraying,—a method which has been in common practice long enough so that we know its possibilities. So many experiments have been conducted, that there is an abundance of data to show the value of spraying.

Probably new and more efficient, and possibly cheaper dust mixtures will be devised, but until that time the Connecticut orchardist may as well continue to spray.

Our experience in 1920, not only in Mr. Platt's orchard, but from observations in other orchards, leads us to advise strongly one or two additional and later treatments, in order to forestall the injury from codling moth larvae and other chewing insects late in the season.

NOTES ON THE LIFE HISTORY OF THE FALSE APPLE RED BUG IN CONNECTICUT.

Lygidea mendax Reuter.

By M. P. Zappe.

During recent years this insect has become quite a serious pest in some of the Connecticut apple orchards. It is rather local in its appearance and consequently the injury which it causes is also local. During the summer of 1920, it caused considerable damage to both foliage and fruit in certain orchards. See Plate VII.

The eggs of this species are laid in the lenticels of the apple twigs and hatch at the time when the earliest blossom buds begin to show pink at the tips; most of the buds do not show any color at this time.

When first hatched the young nymphs crawl to the tip of the twig and begin to puncture the young tender leaves which at this time are about one inch long and there are an average of four uncurled ones on each cluster. In a short time the punctured leaves show reddish spots and the sides curl upward. See Plate VII, a.

When the nymphs are in the third instar a few of them begin to leave the terminal twigs and go to the fruit to feed, but the

majority of the young bugs do not leave the terminal shoots until they reach the fourth instar. At this time the apples are about the size of marbles. The nymphs when disturbed have the curious habit of dodging around to the back or opposite side of the leaf or twig. After they become winged they drop readily, spreading their wings as they drop. As a rule they do not fly far, usually alighting on a nearby branch. They do not live long as adults. Out of doors they were transforming to the adult stage on June 25, and on the 2nd of July very few adults could be found. Mating and oviposition were not observed.

Moults.

This insect passes through five moults before it reaches the adult stage. The length of time varies with the weather. The spring of 1920 was rather cold and backward and it took an average of 37 days from the time the eggs hatched until the adult stage was reached. The first newly hatched nymphs were seen on May 22 and the first adults on June 28.

First Instar. One day after hatching.

Color, carmine*, eyes darker red, with white margins. Antennae darker than body except last segment which is lighter. Legs colorless, rather transparent, and covered with small black spines. Beak colorless except tip, which is black. Black spot on middle of dorsal part of abdomen between third and fourth segments. Head with median groove. Dark oval pattern on dorsal part of thorax with median line running through the center. Abdomen one-third wider than thorax. Length 1.8 mm; width across thorax .33 mm; width across widest part of abdomen .66 mm.

Second Instar.

Abdomen not so wide in comparison to length but still a little wider than thorax and a little darker. Eyes much darker than rest of insect with paler margins. Legs darker than first instar. Black oval pattern of thorax seen in first instar is gone. Thoracic segments darker at edges Length 2 mm; width across thorax .5 mm.

Third Instar. Resembles second instar.

Body covered with fine white pubescence which becomes darker a few hours after moulting. Tylus black, antennae and legs darker than rest of body. Length 2.5 mm; width .87 mm.

Fourth Instar.

Wing pads appear in this stage and extend to cover the sides of the first abdominal segment. A deep fovea on each side of middle of second thoracic segment. Length 3.5 mm; width 1.33 mm.

Fifth Instar.

Wings in this stage extend to the sixth abdominal segment. Posterior third of wings and tip of abdomen dusky, also a dark line on the sides of the scutellum. Length 4 mm; width 2 mm.

Sixth Instar.

Adult stage. Bright orange red, antennae and narrow bar across the base of pronotum, black. Clavus, inner angles of corium, and membrane, fuscous; in dark specimens the scutellum and all but the narrow margin of the hemelytra fuscous; legs greenish yellow with fuscous on the tibiae. Length 6 mm; width 2.33 mm. The adult is shown on Plate VII, a.

*Windsor and Newton's water colors in Smith's Explanation of Terms Used in Entomology.

Control.

This insect may be controlled by spraying the trees just before the blossom buds open. Nicotine solution, 1 pint to 100 gallons of water, will hold the insect in check, especially if the tree can be sprayed from both sides at once. If only one side is sprayed at a time the young bugs have a chance to go to the opposite side of a leaf or twig and dodge the spray. This spraying may be combined with what is commonly known as the "pink spray,," which consists of arsenate of lead and commercial lime and sulphur.

As all of the red bugs probably will not be killed at this time, nicotine should be added to later sprays, especially the first calyx spray, soon after the petals fall.

Literature.

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NOTES ON THE LIFE HISTORY OF A SAWFLY FEEDING ON AUSTRIAN PINE.

Itycorsia zappei Rohwer.

By M. P. Zappe.

On June 23, 1915, while collecting insects in New Haven, near some Austrian pines, a large sawfly was taken that looked different from anything in the Station collection. A special effort was made to collect a few more specimens which were flying around Austrian pines.

Several of these specimens were sent for determination to Mr. S. A. Rohwer of the Bureau of Entomology, who is a specialist in this family. He pronounced them an undescribed species of the genus *Itycorsia*, which he afterward named *zappei*. In the Proceedings of the U. S. National Museum, No. 2312, Vol. 57, page

209, Mr. Rohwer published the descriptions of both sexes of the adults.

The next summer larvae were found feeding in small silken webs on the new growth of the Austrian pines. The writer suspected that these larvae might have some connection with the adults that had been present on the trees, so a number were collected and reared. The following summer adults emerged and proved to be the same as those captured from the trees.

The Egg.

The eggs are laid singly on the needles of the new growth late in June and early in July. They are about 4 mm. long and are of a pale clay yellow color. They are crescent-shaped and are laid lengthwise on the needle, being fastened at the back. Both ends are up-turned and pointed, one tapering a little more than the other. When the young larva hatches it emerges from the end which tapers the least. See Plate VIII, a.

The Larva.

First Instar.

Length about 3 mm., body greenish yellow, first thoracic segment with a black marking extending from middle of one side to middle of opposite side with a black spot at each end. A black crescent-shaped mark at base of each leg. Two elongated black spots between each pair of legs on ventral surface of thorax. Legs black. Cerci at end of body with three segments, two distal segments black. Head rufous with appendages lighter. Antennae black with white rings at joints, last segment pointed at tip. Eyes black. Body covered with minute hairs. The eleventh segment bears a pair of atrophied prolegs.

Second Instar.

Length 6 mm. Head light brown with appendages black. Body greenish yellow, legs black. A narrow black stripe extends from base of first pair of legs to under side of head. Other markings same as in first instar.

Third Instar.

No change in markings or other characters from preceding moult.

Fourth Instar.

Head orange brown. Crescent–shaped marks at base of legs not so distinct except on first segment which still shows plainly though not so distinct as in preceding instar. Body becoming more or less glabrous except anal segment which has a number of rather long hairs.

Fifth Instar.

Markings above base of legs gone. Color of body darker green than in preceding instars except head and the first three segments and last two segments which are brownish. First segment has a dark brown bar on the dorsal surface.

Sixth Instar. (See Plate VIII, b.)

Larva entirely green except head which is still brown. There is a dorsal stripe of green darker than rest of body. In this instar the larvae stop feeding and go into the ground where they hollow out a small cell and pass the winter. In the late spring they transform to pupae and emerge as adults about the latter part of June.

The feeding period of the larva is just about one month.

Habits of the Larva.

When the young larvae hatch from the eggs they begin to spin a loose web around themselves, fastening the outer threads to the needles. As the larvae reach full size these webs are often four to five inches long and the larvae move up and down inside them by wriggling the body. The larvae have no prolegs and when removed from their webs and placed on a smooth surface, are unable to crawl until they have spun a sort of a web over themselves.

Their method of feeding is rather interesting. They usually begin at the top of their web and with their strong jaws bite off a needle at its base, just above the bundle sheath, very much as a cut-worm cuts off a plant. Then they proceed to eat it, beginning at the cut off end until they have devoured the entire severed needle. Then they take the next one. They have never been observed to leave their web and go to another twig. The larva in its case is shown on Plate VIII, c, and an empty case at d, of the same Plate.

The Adult.

In order to bring together in one publication the descriptions of all stages of this insect, the original descriptions of the adults as published by Rohwer, in the Proceedings of the U. S. National Museum, Vol. 57, page 209, 1920, are given below.

Itycorsia zappei Rohwer.

"Of the North American species, this new species is probably most closely allied to *maculiventris* (Norton), but the male differs in a number of ways from the description given for that species, and the description of the female given by MacGillivray does not agree in all details with the female of the species described here. In MacGillivray's key to the species of *Itycorsia* of Connecticut (Bull. 22, Conn. Geol. and Nat. Hist. Survey, p. 33) this species runs to couplet 6, but differs from both *luteomaculata* (Cresson) and *albomaculata* (Cresson) in the black cypeus and other minor characters. Of the European species it seems to be more closely allied to *stellata*, but differs from the descriptions of that species in the color of both adult and larva."

"Female.—Length 13 mm. Anterior margin of the clypeus truncate; medianly the clypeus is strongly raised by the extension of the antennal carina; its surface is shining, impuncate; median fovea deep, elongate; area above the frontal crest with rather close, small punctures; median ocellus in a diamond-shaped depression; posterior ocellus bordered laterad and caudad by a deep furrow; posterior orbits and vertex shining, with large widely separated punctures, frontal crest obsolete; antennae 31-jointed, the third joint slightly longer than the fourth and fifth combined; prescutum shining, practically impunctate; scutum shining, with a median area of close, large punctures; scutellum shining, practically impunctate; mesepisternum subopaque, with sparse, rather large, setigerous punctures. Black; spot on the mandibles at base, spot on the superior orbits, two spots on the vortex, spot on the occiput behind the eye, and with a line-like projection toward the supraorbital spot, the posterior margin of the pronotum, tegulae, two spots near the posterior margin of the prescutum, two spots along the notauli on the scutum, two large spots on the scutum posteriorly, a small spot on the lower posterior orbits, an elongate spot on the mesepisternum dorsally, circular spot on the sides of the pronotum,

most of the metepisternum, dorsal and ventral margins of tergites, the apical margin of the sternites 3, 4, 5, and 6, yellowish-white; legs black; the tibiae and basal joints of the anterior tarsi rufous; wings hyaline basally, fuliginous beyond the basal margin of the stigma; venation dark brown."

"Paratype females show that this species may vary as follows: the spot on the metepisternum may be greatly reduced; the line projecting toward the supraorbital spot may be complete or entirely absent; the yellow spot on the lower margin of the posterior orbits is usually wanting."

"Male.—Length 8.5 mm. In puncturation and characters of the head, the male agrees with the above description of the female, except the declivous face is a little more sharply defined on the frontal crest, however, the frontal crest is rounded and not margined; antennae 31-jointed; the third joint slightly longer than the fourth and fifth; hypopygidium broadly rounded apically. Black and yellow; antennae yellowish-ferruginous, apical half brownish; scape above black; head black; mandibles except apices, clypeus except two points medianly, lateral supraclypeal area, area between the antennae and extending caudad in two lines to the level of the anterior ocellus, the lateral orbits near the top of the eye where they narrow and extend almost to the middle of the occiput, supraorbital spot, connected with the line extending posteriorly to meet the line of the occiput, two spots on the vertex, yellow; thorax black, the posterior dorsal margins of the pronotum, tegulae, most of the prescutum, two spots on the scutum anteriorly, spots on the scutum posteriorly, the scutellum, most of the metepisternum, sternum, metepimerun, and episternum, yellow; sternites, and tergites ventrally, and the lateral margin of the tergites dorsally yellow; the rest of the tergites black; legs yellow with the base of the coxae posteriorly, line of the femora and trochanters posteriorly black; wings hyaline; venation dark brown; costa and also margin of the stigma yellowish."

"Type Locality.—New Haven, Connecticut. Described from eight females and two males collected by M. P. Zappe for whom the species is named. The type female was collected as a larva August 2, 1916, on Austrian pine and emerged June 7, 1917. It is recorded under No. 670 Connecticut Agricultural Experiment Station. The type male and the paratype male were collected as larvae on August 2, 1916, on white pine, and emerged June 26, 1917, and are recorded under No. 669 Connecticut Agricultural Experiment Station. The other females were collected in June and July, 1915."

"Type, Allotype, and four female Paratypes.—Cat. No. 21605, U. S. N. M."

"Three female paratypes and the male paratype returned to the Connecticut Agricultural Experiment Station."

TESTS OF SOAP SPRAYS TO KILL THE PINK AND GREEN POTATO APHID.

Macrosiphum solanifolii Ashmead.

By M. P. Zappe.

During the summer of 1920 there was a local outbreak around New Haven of the pink and green potato aphid which has done considerable damage during the last three or four years. At Woodmont there was a rather heavy infestation in two large fields of about sixty acres of potatoes. The owner came to the Station for advice. He did not wish to spray unless it was absolutely neces-

sary. In one of the fields there were large numbers of parasites and parasitized aphids present, also many lady-beetles and their larvae. A fungous disease was also present and had killed quite a large number of the aphids, consequently it did not seem worth while to spray the potatoes in this field. In the other field, however, the infestation on the Green Mountain variety was rather heavy, and though parasites were also present, they were not nearly as abundant as in the first field.

It was decided to spray the second field and keep a close watch on the other. The usual spray of nicotine solution and soap was recommended, but on account of the scarcity of labor the owner wished to avoid the task of dissolving the soap. But if he did have to dissolve soap, he felt that he might better use a little more soap in the spray and omit the nicotine solution (which had advanced in price from $10.75 to $13.75 per ten pound package).

Soft soaps were suggested and a cheap kind of soft soap was procured at one and one-half cents a pound and tried on a small scale. A chemical analysis showed the soap to be 93 per cent. water with a very large excess of free alkali. There was so much free alkali that it would burn one's hands. This soap proved to be of little value for killing aphids even when used as strong as one part soap to two parts water.

Another soft soap which was intended for washing automobiles was tried with much better results. This soap was a better grade of soap than that just mentioned. It was made with a linseed oil base and contained only 56.2 per cent. of water. This soap cost twenty-five cents a pound wholesale in twenty-five pound pails. When used at the rate of one-half ounce to one gallon of water, this soap was 100 per cent. effective in killing the aphids on dipped potato plants. Part of the second field of potatoes was sprayed with this soap with very good results. The sprayer was of the four-row type with three nozzles to each row. The lower nozzles could be turned up at any angle desired so that the underside of the leaves could be easily sprayed. See Plate VI, b.

Still another brand of automobile soft soap was tried. This was claimed by the dealer to be just the same as the soap described above, but the price was much higher (thirty-eight cents a pound in five pound pails) and it was not nearly so effective in killing aphids. To get the same result, over twice as much soap had to be used.

THE EUROPEAN RED MITE, A NEW ORCHARD PEST IN CONNECTICUT.

Paratetranychus pilosus Can. and Fanz.

Order Acarina Family Tetranychidae

By Philip Garman.

A number of Connecticut orchardists observed with no little concern during the past season, the damage caused by the European red mite. Most of them had little success with the ordinary insect control measures which consisted for the most part of lime-sulphur, nicotine and lead arsenate preparations applied in accordance with the usual spray calendar recommendations. In consequence, it is important to state what is known of the habits and control of the mite under local conditions as well as to indicate what measures have been successful for similar troubles in other localities. Considering the fact that the pest is often mistaken for others less injurious, it is also important to describe its structure and indicate characters for its recognition. These facts together with a history of the pest in Connecticut will form the present statement regarding the European red mite.

Discovery in Connecticut.

About July 2, 1920, Doctor Britton, State Entomologist, visited the orchard of Mr. Frank N. Platt, of Milford. He noted there a tree which had brown leaves, and thought from appearances, that the red spider (*Tetranychus bimaculatus* Harvey) was responsible. Examination of leaves brought by him to the laboratory showed them to be infested with the European red mite, a species not hitherto reported from Connecticut. Examination of material brought from Milford earlier in the season by Mr. Zappe led to the suspicion that there was something different in hand, but the pest was identified from material obtained later. Referring then to the Experiment Station collection of unidentified mites, a single slide was found which contained the same species. This was collected by Mr. Zappe at Clintonville, in the town of North Haven, April 17, 1917. Eggs were also received in the fall of 1919 on a small peach twig. These were allowed to hatch and a comparison of the larvae with those obtained later showed that they are the same.

Distribution.

The above observations indicate that the European red mite has been in Connecticut at least three years. During the last year it has been found in Greenwich, Danbury, Milford, Branford, Wallingford, Middletown and Meriden. It is reported from Canada (Ontario), Pennsylvania, and is thought to occur in New

Jersey. Probably it has a much wider distribution and has in many cases been mistaken for the red spider (*Tetranychus bimaculatus* Harvey) or the clover mite (*Bryobia pratensis* Garman).

Description.

Adult mites are dark velvety red in color, the young somewhat brighter. The eggs are dull red.

The egg is slightly flattened above, is radially grooved and has a short stalk arising from the center, the stalk being slightly longer than the vertical diameter of the egg. It measures .15 mm. in diameter when fresh. See figure 6, 2, and for appearance of eggs on twig, Plate IX, b.

The larval and nymphal stages are similar to the adult female in general appearance; but are smaller in size and the larva has only three pairs of legs instead of four.

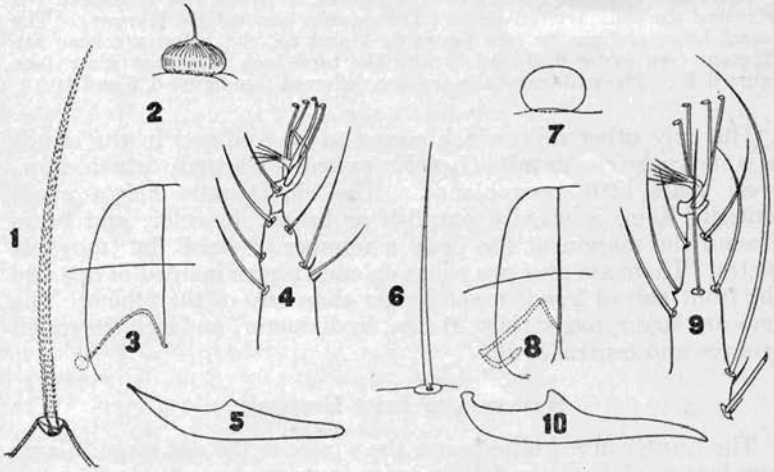

Figure 6. Structures of European red mite *Paratetranychus pilosus* Can. and Fanz. and common red spider *Tetranychus bimaculatus* Harvey.

1, *Paratetranychus pilosus*, seta of dorsum 846 times enlarged; 2, egg, 14 times enlarged; 3, collar trachea and mandibular plate, 714 times enlarged; 4, tarsus of first pair of legs of female, 921 times enlarged; 5, penis, 1400 times enlarged.

6, *Tetranychus bimaculatus*, seta of dorsum, 846 times enlarged; 7, egg, 14 times enlarged; 8, collar trachea and mandibular plate, 714 times enlarged; 9, tarsus of first pair of legs of female, 921 times enlarged; 10, penis, 1400 times enlarged.

The adult female is about .31 mm. in length. There are 26 setose dorsal bristles arising from small tubercles (see figure 6, 1) which when viewed with a lens of small magnifying power appear as white dots. The tarsi, or last segment of the legs, is provided with a single claw, widest at the mid point and with apparently five (there are probably six) appendiculate spurs projecting at right angles (see figure 6, 4). There are also four tenent hairs with hooked tips arising from the base of the claw and exceeding it considerably in length. The mandibular plate (see figure 6, 3) is similar to that of most other red spiders, but the collar

trachea consists of a simple tube suddenly dilated at the tip to form a nearly spherical chamber. The maxillae consist of about four segments, each of which is tipped with a short spatulate body probably representing an additional one. The next to the last segment has a strong hook, and the last has five setae (two apical, two basal on the dorsum, and one lateral) and a clavate hair between the two dorsal pairs.

The male is much smaller in size and the tip of the abdomen is more pointed than in the female. The male genitalia of the different species of red spiders are characteristic of each.

Probably the most closely related representative of the red spider family is the west coast mite, known as the citrus red spider (*Paratetranychus citri* McGregor[1]). This mite does similar damage to fruit trees in Oregon and differs from the European red mite only in minute characters of the male genitalia, and the mandibular plate. The egg, however, seems to have a longer central stalk and the guy fibrils reported on the citrus mite egg have not been seen in the egg of the European red mite.

There are abundant differences, however, between the European red mite and the ordinary red spider (*Tetranychus bimaculatus* Harvey). The dorsal hairs are smaller (see figure 6, 1 and 6), the collar tracheae are different (see figure 6, 3 and 8) and the tarsi lack the large claw (see figure 6, 9). The male genitalia are also different (see figure 6, 5 and 10.)

The only other mite which seems to be confused in the minds of some is the clover mite (*Bryobia pratensis* Garman) which, however, bears little resemblance. The clover mite has a much wrinkled skin, is usually purplish or brown in color, and bears around the margin of the body a number of small flat movable plates. There are also two claws on each tarsus instead of one and the front pair of legs is much longer than any of the others. The eggs are larger, measuring .20 mm. in diameter, and lack the radial grooves and central stalk.

Habits and Life History.

The European red mite passes the winter in the egg stage. Large numbers are laid in the fall on twigs from the size of a lead pencil to three-fourths of an inch in diameter. They are frequently found several layers deep about bud scars or in crevices in the bark. Apples are also selected for egg laying, the eggs being frequently placed in the calyx cavity as shown on Plate IX, b. Here they are protected from being rubbed off in handling and are doubtless carried from place to place in the shipment of fruit. Under favorable conditions they may hatch, and regain a host, thus starting a new colony.

Emergence takes place early in the spring though the exact time cannot be stated for this locality. In Sweden the eggs of the same mite hatch about the first of May and young mites were observed in 1920 about this time in Connecticut. From then on they develop rapidly if conditions are suitable, and several generations probably develop before the winter eggs are laid. In 1920, they became much reduced in numbers on the leaves about the

[1] = *mytilaspidis* Riley.

first of August, and very few could be found, although numerous cast skins were present on the leaves. The greatest development therefore took place between May and August (in 1920) and it is probable that most damage was done in June. The different stages consist of a larva, three nymphal, and the adult stage. Eggs, larvae, nymphs and adults may be found on the leaves at the same time so that there appears to be no definite brood limits.

The European red mite spins little or no web. Larvae spin more than adults, but they never produce as much web as the common red spider.

Observations in Various Orchards.

The first extensive leaf injury was seen in Plant Brothers' Orchard, Branford, Connecticut. Here a large block of Baldwin was affected, the leaves having turned brown and the injury being visible as far off as the orchard could be seen. A block of Greening in the same orchard appeared to be untouched, but examination of the leaves showed that there were a good many mites present. Doubtless there is some difference in the vitality of the two varieties, the Greening being better able to withstand injury. In this and other orchards injury from mites was seen on Baldwin, Ben Davis, McIntosh, and Hurlburt, but in nearly every case the Baldwin showed the effects of infestation more than other varieties.

Infested trees lose some of their foliage and the size of the fruit is affected. Examination of Baldwin fruit in the Plant Brothers' orchard, selected from injured and uninjured trees of approximately the same age and size, showed a marked reduction in the size of apples from the injured trees. One Baldwin tree observed in the orchard of Mr. Frank Platt, near Milford, had almost no marketable apples. (See Plate IX, a.)

An effort was made to determine what sprays were used in orchards showing the worst injury. The Plants' orchard proved to be the most instructive, and showed that attention must be given to early sprays, especially the delayed dormant application. This spray apparently should not be diluted more than 1 to 9 in the case of lime-sulphur, and should be applied with great care to cover as much of the tree as possible.

Recommendations of Other Investigators.

Sulphur in some form is usually recommended for control of red spiders. Sulphur dust is said to require an average temperature of 75° F., (7, page 523*,) in the shade, to be effective, but just how it kills is not well understood. It is thought that it vaporizes at this temperature and that the fumes do the work; and it apparently acts only at short range.

*See literature at the end of the article.

Lime-sulphur solution is more frequently recommended, the dilute strength (1-50) being necessary for summer use. It is said to kill by contact, but it is slow in doing its work, and acts over a considerable period of time. The self-boiled mixture is recommended by some (4, page 34), and the addition of flour-paste to dilute lime-sulphur by others (6). Kerosene emulsion (8, page 208) and Scalecide are also encountered in recommendations for red spider control.

In Oregon (2, page 87), one of the most effective controls appears to be afforded by a combination of nicotine sulphate and lime-sulphur or scalecide. It is thought that the eggs are not killed by winter strength lime-sulphur, but observations on the citrus mite indicate that the continued action finally kills a large per cent. of the mites, after hatching.

TABLE I

LABORATORY TESTS OF VARIOUS INSECTICIDES ON THE EUROPEAN RED MITE

Material Used.	Number killed.	Number alive.	Per Cent. killed.	Examination after.	Date.
Sulphur dust.....	1	12	7.6	6 hrs.	July 28
" "	1	18	5.2	24 hrs.	July 28-29
" "	19	45	29.6	48 hrs.	July 28-30
Lime sulphur 34° Bé					
1 gal.-43¼ gals...	7	6	53.8	6 hrs.	July 28
"	17	3	85.0	24 hrs.	July 28-29
"	79	28	73.8	48 hrs.	July 28-30
Borax Soap 2 lbs.,- and 40% Nicotine Sulphate ¾ pint					
50 gals.....	15	3	83.3	6 hrs.	July 28
"	26	1	96.2	24 hrs.	July 28-29
"	114	5	95.7	48 hrs.	July 28-30
Borax Soap 6 lbs.-					
50 gals.....	33	0	100.0	6 hrs.	July 28
"	20	2*	90.9	24 hrs.	July 28-29
"	141	6	95.9	48 hrs.	July 28-30
Borax Soap 4 lbs.-					
50 gals.....	23	2	92.0	12 hrs.	July 28-29
Amalie Auto Soap					
4 lbs.-50 gals.....	15	5	75.0	12 hrs.	July 28-29
6 lbs.-50 gals.....	12	5	64.1	12 hrs.	July 28-29
Check No. 1.....	3	21	12.5	6 hrs.	July 28
"	5	21	19.2	24 hrs.	July 28-29
"	55	321	14.6	48 hrs.	July 28-30
Check No. 2.....	1	29	3.3	12 hrs.	July 28-29

*Young larvae recently hatched.

Material used.	Number killed.	Number alive.	Per Cent. killed.	Examination after.	Date.
Fels Naphtha Soap					
4 lbs.-50 gals.....	18	0	100.0	6 hrs.	July 28
"	15	0	100.0	24 hrs.	July 28-29
Star Soap					
4 lbs.-50 gals.....	21	0	100.0	6 hrs.	July 29
"	23	2	92.0	24 hrs.	July 29-30

TABLE II

RESULTS OF FIELD TESTS IN THE PLANT BROTHERS' ORCHARD
Branford, Conn.

Treatment.	Killed.	Alive.	Per Cent. killed.	No. of trees used.
Soap 4 lbs.-50 gals.....	125	139	47	24
Soap 2 lbs. and 40% Nicotine Sulphate 1 pint-50 gals.....	69	75	48	24
Check.....	66	119	36	24
Dust				
90% Sulphur	No difference could be seen			
10% Arsenate of lead	between check and treated			
3% Nicotine sulphate	blocks.			35

All treatments in Table II were made July 28, 1920.

Welcome borax soap was used, and Black Leaf 40. Dusting was done about noon. The counts were made by selecting twigs at random from trees in the center of the block and examining with a binocular. The examination was made August 5, and also several weeks later. No counts were made at the later date.

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THE APPLE AND THORN SKELETONIZER IN CONNECTICUT.

Hemerophila pariana Clerck.

This is an European species which has recently become established in this country. It first appeared in Westchester County, N. Y., and its presence in the United States was mentioned by Doctor E. P. Felt in a Scientific Note in the Journal of Economic Entomology, Vol. 10, page 502, August 1917. Later a full illustrated account giving habits, descriptions, partial life history and bibliography appeared in the Thirty-third Report of the New York State Entomologist for the year 1917, and it is from this publication that the chief facts were gleaned for use in the present paper.

Doctor Felt had warned us to be on the watch for the insect in Fairfield County, Connecticut, because he had observed it very near the Connecticut border in Westchester County, N. Y., but the first report of its occurrence within the state was made over

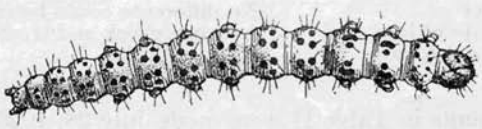

Figure 7. Larva of apple and thorn skeletonizer, six times enlarged. (After Felt, Cornell Extension Bulletin 27, 1918.)

the telephone in the autumn of 1920 by Mr. F. A. Bartlett of Stamford, who stated that the insect was quite abundant in the vicinity of Belle Haven, Greenwich. At my request he gathered some material and sent for examination. This reached the laboratory November 13. From Doctor Felt's published descriptions, we were able to identify it as *Hemerophila pariana* Clerck. On November 18, Messrs. Walden and Zappe of this department visited the locality and gathered more material from which an adult moth emerged on December 7. According to Mr. Bartlett, the insect occurs in the towns of both Greenwich and Stamford. Belle Haven is situated in the southwestern part of Greenwich adjacent to the town of Rye, N. Y.

Nature of Injury.

The caterpillars feed upon the upper surface of the leaves sometimes entirely skeletonizing them, but often leaving a portion untouched at each margin at the base of the blade. Each larva spins a light web over the center of the leaf, curling the leaf upward and drawing together the margins especially toward the tip. The

extent of injury varies from only slight feeding to entire skeletonization and is shown on Plate X, a.

The leaves are not webbed together like the nests of the fall web-worm. In the worst infested sections of Westchester County, N. Y., some of the unsprayed orchards are completely defoliated.

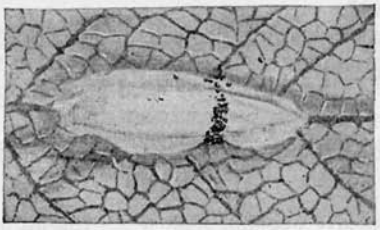

Figure 8. Cocoon of apple and thorn skeletonizer on leaf, twice natural size. (After Felt, Cornell Extension Bulletin 27, 1918.)

Distribution.

According to Doctor Felt, this insect has been recorded from England, France, Germany, the Balkan Peninsula, Bithynia and western Asia including Turkestan.

In America it is known to occur only in Westchester and Rockland Counties in the State of New York, and in Greenwich and Stamford, Fairfield County, in Connecticut It is not known how long the insect has been established in the United States or how it was introduced here, but the probabilities are against rapid dissemination, though its range in Europe and Asia indicates that the insect may be able to maintain itself over a greater portion of the United States and southern Canada.

Figure 9. Pupa of apple and thorn skeletonizer, six times enlarged. (After Felt, Cornell Extension Bulletin 27, 1918.)

Life History.

The life history has not been completely worked out in this country, but the data collected by several entomologists in Europe indicate that there are at least two and probably three generations each year. It is thought that the insect passes the winter in both the adult and pupa stages, the former in any shelter, and the latter in the cocoon on the leaf. Doctor Felt reports much variation in the development of the insect at Irvington, N. Y., as very small and full-grown larvae were both found together in September and early October. Probably the larval or feeding stage lasts from

four to six weeks. As injured leaves seem to be rather uniformly distributed over the tree and throughout the orchard, it is suggested by Doctor Felt that the moths may deposit a few eggs near the base of each leaf. Particularly when abundant, the moths seem to oviposit on nearly every leaf.

In Europe the adults are found on the flowers of the Compositae, especially goldenrod.

Though the insect shows a preference for apple, the list of food plants in Europe includes also pear, hawthorn or thorn, mountain ash, birch and possibly willow. Several Hymenopterous parasites have been reported by European writers and one, *Dioctes obliteratus* Cresson, has been reared in New York State.

Description.

Larva:—Length nearly one-half inch when full-grown, greenish-yellow in color with black, tubercular spots varying greatly in size and bearing hairs. Head amber, with irregular dark-brown line at the lateral dorsal angle adjoining the first thoracic segment. Antennae yellowish brown, legs pale yellow.

Pupa:—Length, about one-fourth of an inch, rather stout, dark bronzy yellow, head dark-brown. The white silken cocoon is about five-eighths of an inch long and one-fourth of an inch broad, fastened to the upper surface of the leaf, frequently along the mid-rib. The pupa can be seen faintly, and before the moth emerges, wriggles partly out from the cocoon, the pupal shell often projecting from it. (See Plate X, b.)

Figure 10. Adult of apple and thorn skeletonizer, four times enlarged. (After Felt, Cornell Extension Bulletin 27, 1918.)

Adult:—Wing-spread of slightly less than half an inch, grayish-brown to dark brown usually with purplish tinge, fore-wing marked with a rather broad broken angulate dark band near basal third, and another less distinct but more regular dark band crossing the wing near the distal fifth. Area between these bands is grayish but variable in color, and usually marked by one or more dark spots near the costal margin. The head, thorax and abdomen are covered with dark brown scales shading into or mottled with yellowish-brown or purplish-brown and quite variable. Rear wings dark fuscous. Both wings margined with purple fringe. Under side lighter with two whitish spots on costal margin of fore-wings.

Illustrations of the larva, cocoon, adult moth and the injured leaves are shown in figures 7-10 and on Plate X, a. and b.

Control Measures.

As the larvae feed upon the upper surface of the leaf, timely and thorough applications of lead arsenate will probably readily con-

trol this pest. It may be necessary to spray rather late in summer in order to check the late brood. It is reasonably certain that such measures will forestall injury in orchards, where the owners make a practice of spraying, but there are so many neglected trees throughout Connecticut that there is great danger that the insect will subsist upon them and gradually become distributed all over the state. If all trees in and around the infested region could be sprayed in this manner, it would be an effective check on the spread of this insect.

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THE SINUATE PEAR BORER.

Agrilus sinuatus Olivier.

This European beetle causes serious injury to pear trees in France and Germany, and was first discovered in this country in New Jersey in 1894. Apparently it was introduced in nursery stock. It seems to have spread rather slowly and in 1915 Doctor Felt* reported that the insect was known to occur in several localities in New York State. The first indication of its occurrence in Connecticut was on May 29, 1917, when we received from Mr. G. S. Brown, Norwalk, a piece of bark from a pear tree which seemed to show the work of this insect, and a note to that effect was printed in the Station Report (1917, page 361). On a visit to Stamford on June 24, 1920, the writer examined a small pear orchard on Strawberry Hill, where many of the trees were attacked, injured, and some of them seriously deformed by this insect. According to Mr. F. A. Bartlett of Stamford, considerable injury has been noticed by him in the pear orchards in Stamford and Greenwich.

Mr. H. B. Weiss† in 1914, reported the insect as being present in Essex, Union, Middlesex and Bergen Counties in New Jersey, and states: "While it is true that it is not abundant every year, it is customary to run across its work in the northern part of the state. In spite of the fact that it is no longer destructive, it is evidently holding its own in a small way and spreading somewhat."

All varieties of pear are infested. The Bartlett seems to be preferred, and the Keiffer, though attacked, is not seriously injured.

CHARACTER OF INJURY.

The larva, which is one of the flat-headed borers, makes a long narrow and winding burrow under the bark chiefly in the sapwood.

*Report of the Entomologist of New York, 31, page 78, 1915.
†Journal of Economic Entomology, Vol. 7, page 251, 1914.

These burrows are rather conspicuous, especially in young trees having a smooth bark. The nearly-grown larvae make burrows which are much larger than those made by the first-season larvae and consequently they are more conspicuous. Trees of all ages are attacked and injured. Small trees are sometimes girdled and killed by intersecting burrows, and large trees are weakened and sickly often losing branch after branch, and finally die. Many instances were noticed where the galleries had killed the bark on one side of a branch while the other side appeared healthy.

Life History and Habits.

The adult beetles appear late in May and during June, and deposit their eggs in the crevices of the bark. These eggs hatch in early July and the grubs begin their sinuous tunnels which are very narrow at first but gradually increase in diameter as the grubs grow. On the approach of winter, the grub stops feeding and rests in its burrow until spring, then continues its work. The second summer the grubs are much larger and of course the burrow corresponds in size. The zigzag or sinuous course which is downward is very pronounced. The bark over the burrows is somewhat depressed, blackened and often cracked, so that an infested tree can usually be recognized at a glance. Smith* states that in no case has he ever seen a complete girdling by a single larva, but where two or more larvae happen to work in the same branch, their galleries often meet and if a small branch or a small tree, it may result in a complete girdling and that part above the injury dies. This is more apt to happen the second season than the first. In September of the second season the larva eats its way into the wood about one-fourth of an inch and makes a cell or enlarged burrow lengthwise the stem. At the opposite end of this cell the grub eats its way to the bark and plugs both ends of its cell with sawdust. In this chamber it passes the winter, gradually contracting in length, and pupating in the cell the following April. The location of this pupal cell is visible in young trees or in the smaller branches of large trees, as the bark is somewhat sunken and blackened, the blackening extending into the wood and probably being due to a fungus. The beetle then emerges through a semicircular hole in the bark.

According to Doctor Felt† the studies of Doctor H. Glasgow of the New York Agricultural Experiment Station at Geneva, N. Y. show that the beetles feed readily upon the foliage. This habit may make it possible to control the pest by the use of arsenical sprays applied late in May or just before the beetles emerge. The adults are found flying about on sunny days or resting upon the bark of the trunk or branches.

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*New Jersey Agricultural Experiment Station Report for 1894, page 558.
†Report New York State Entomologist, 31, page 79, 1915.

Description.

Larva:—Length, about one and one-half inches when full-grown; very flat, white or yellowish, head small and brown, with prominent mandibles. The first thoracic segment is much enlarged about twice as broad as the abdominal segments and having somewhat the appearance of a large head, but flattened like the other segments; first five abdominal segments have parallel sides, but second and third thoracic and last three abdominal segments have rounded or angular sides which are not parallel.

Adult:—Length, about one-third of an inch, breadth about one-fifth of its length, slender like the other Buprestid beetles belonging to the genus *Agrilus*. In color it is bronzy brown, shining, but with the surface granulated and punctured.

Both larva and adult have the appearance shown in figure 11.

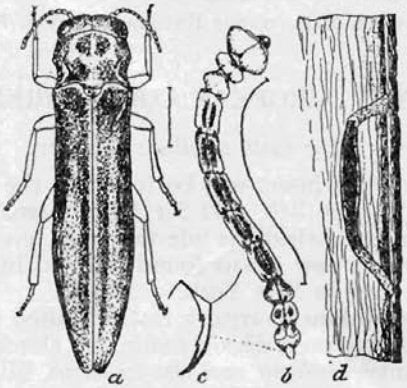

Figure 11. Sinuate pear borer. *a*, adult beetle; *b*, larva; *c*, anal fork of larva; *d*, pupal cell in solid wood—all enlarged. (After Smith, Report New Jersey Agricultural Experiment Station for 1894.)

Control Measures.

All trees infested to such an extent that their value has been destroyed should be cut and burned. The worst infested branches or portions of a tree may also be pruned off and burned. In certain cases the pupal chamber as indicated by the sunken and discolored area may be cut open and the insect destroyed with the knife.

If the foliage be kept covered with arsenate of lead during the latter half of May and June, no doubt many of the adults will be killed in feeding upon the leaves.

Possibly washes of lime-sulphur and arsenate of lead applied to the bark before the beetles emerge may repel them so that they will seek other trees on which to oviposit, but this cannot be ascertained except by a long series of careful experiments.

The trees should be well fertilized and kept in a vigorous and growing condition, as they will not be so soon overcome by the attacks of this insect.

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THE EUROPEAN CORN BORER.

Pyrausta nubilalis Hubner.

An account of this insect will be found in the Reports of this Station for 1918, page 316, and for 1919, page 170. Since the latter Report was published the infested areas have been extended by the discovery of new towns found infested in Massachusetts, New Hampshire and in New York.

Besides this additional territory in the United States, two new infested centers have been discovered in the Dominion of Canada, in Welland County, Ontario, and also in Elgin, Middlesex County, and a part of Oxford County in western Ontario.

SCOUTING IN 1920.

Early in 1920, we received from the Bureau of Entomology at Washington the record of shipments of broom corn imported from Austria a few years ago, and consigned to two broom factories in Connecticut, one at Thompsonville in the town of Enfield, and the other at New Hartford. On April 26, Messrs. Zappe and Walden visited New Hartford and examined the cornstalks and stubble in eight fields around the factory. On April 29 they visited Thompsonville and inspected ten cornfields in the vicinity of the factory. No traces of the European corn borer were found in either case.

Members of the department staff have during the year examined many corn fields in different parts of the state, and have investigated many complaints and reports regarding borers in corn. As a rule these reports apply to the stalk borer *Papaipema nitela* Guen., or to the corn ear worm *Heliothis obsoleta* Fabr. (See Report for 1919, pages 180 and 188 respectively) both of which were quite abundant in 1920 as well as in 1919.

So far the European corn borer has not been found in Connecticut, and none of the appropriation of $10,000.00 made by the

General Assembly for the suppression of this insect should it occur here, has been expended.

State Quarantine.

The Federal Horticultural Board established Quarantine No 43, against the European corn borer, under date of March 15, 1920. In the Report of this Station for 1918, page 323, was published the text of the first quarantine order issued by Connecticut under authority granted by Section 2106 of the General Statutes, the quarantine bearing the date of September 20, 1918. As this order applied only to shipments of corn from the infested section of eastern Massachusetts, and as portions of New Hampshire, New York and Pennsylvania had been found infested after the establishment of the quarantine, a revised order was issued as Quarantine Order No. 3, effective June 1, 1920, prohibiting shipments of plants liable to be infested from all known infested areas in the United States, as follows:—

State of Connecticut
Office of
Agricultural Experiment Station
New Haven, Conn.

Quarantine Order No. 3.

Effective June 1, 1920.

Whereas a very destructive insect, known as the European Corn Borer *Pyrausta nubilalis* Hubner, exists in certain portions of the States of Massachusetts, New Hampshire, New York and Pennsylvania, and threatens the corn growing industry of the country; and whereas there is grave danger that this insect may be brought into this State by the transportation of infested plants or parts of plants from the infested area:—

Therefore, pursuant to the provisions of Section 2106 of the General Statutes, it is hereby ordered that no corn on the ear, stover, or other parts of the corn plant, broom corn, including all the parts of the stalk, celery, green beans in the pod, beets with tops, spinach, rhubarb, oat and rye straw as such or when used in packing, cut flowers or entire plants of chrysanthemum, aster, cosmos, zinnia, hollyhock, and cut flowers or entire plants of gladiolus, and dahlia, except the bulbs thereof, without stems, shall enter Connecticut from the infested areas mentioned below, unless each shipment, car, box, bale, or package bear a valid certificate issued by an authorized Federal inspector, stating that the contents thereof have been examined and found free from infestation by the European Corn Borer. These restrictions do not apply to dry shelled kernels or cooked and preserved products, or products grown in non-infested territory passing through infested areas in transit.

Infested Areas.

Massachusetts: Barnstable, Bourne, Brewster, Dennis, Eastham, Falmouth, Harwich, Orleans, Provincetown, Sandwich, Truro, Wellfleet, Yarmouth, in Barnstable County; Amesbury, Andover, Beverly, Boxford, Danvers, Essex, Georgetown, Gloucester, Groveland, Hamilton, Haverhill, Ipswich, Lawrence, Lynn, Lynnfield, Manchester, Marblehead, Merrimac, Methuen, Middleton, Nahant, Newbury, Newburyport,

North Andover, Peabody, Rockport, Rowley, Salem, Salisbury, Saugus, Swampscott, Topsfield, Wenham and West Newbury in Essex County; Arlington, Bedford, Belmont, Billerica, Burlington, Cambridge, Carlisle, Chelmsford, Concord, Dracut, Everett, Framingham, Lexington, Lincoln, Lowell, Malden, Medford, Melrose, Natick, Newton, North Reading, Reading, Somerville, Stoneham, Sudbury, Tewksbury, Tyngsboro, Wakefield, Waltham, Watertown, Wayland, Weston, Wilmington, Winchester and Woburn in Middlesex County; Avon, Braintree, Brookline, Cohasset, Holbrook, Milton, Quincy, Randolph, Wellesley and Weymouth in Norfolk County; Abington, Brockton, Duxbury, Hanover, Hanson, Hingham, Hull, Kingston, Marshfield, Middleboro, Norwell, Plymouth, Pembroke, Rockland and Scituate in Plymouth County; Boston, Chelsea, Revere and Winthrop in Suffolk County.

New Hampshire: Kingston, Plaistow and Seabrook in Rockingham County.

New York (Eastern): Albany, Cohoes, Colonie and Guilderland, in Albany County; Johnstown and Perth in Fulton County; Amsterdam, Florida and Mohawk, in Montgomery County; Brunswick, North Greenbush and Troy, in Rensellaer County; Ballston, Charlton, Clifton Park, Galway, Malta, Milton, Saratoga Springs and Stillwater in Saratoga County; Glenville, Niskayuna, Princetown, Rotterdam and Schenectady, in Schenectady County; Esperance in Schoharie County. New York (Western): Dayton, Perrysburg and Persia, in Cattaraugus County; Hanover, Pomfret, Dunkirk and Sheridan, in Chautauqua County; Brant, Collins, Cheektowaga, Eden, Evans, Hamburg and North Collins in Erie County.

Pennsylvania: North Girard in Erie County.

The regulations of this quarantine order are subject to modification to include additional territory, if such is found infested and in general will be interpreted as conforming to, rather than as being at variance with the regulations of the Federal Horticultural Board.

Quarantine order No. 1 relating to this insect, and issued September 20, 1918 is hereby revoked.

This order shall take effect June 1, 1920.

Approved.

M. H. HOLCOMB,
Governor.

E. H. JENKINS,
Director Connecticut Agricultural Experiment Station.

Since issuing this Quarantine Order, No. 3, the following new towns have been found infested with the European corn borer:—

Massachusetts: East Bridgewater, Wareham, Whitman, Lakeville and West Bridgewater in Plymouth County; Canton, Dedham, Needham and Medfield in Norfolk County; Maynard, Westford, and Sherborn in Middlesex County; New Bedford in Bristol County.

New Hampshire: Hampton, North Hampton, Portsmouth and Rye in Rockingham County.

New York: Mayfield and Broadalbin in Fulton County; Glen and Charlestown in Montgomery County; Knox in Albany County; East Greenbush, Poestenkill and Schaghticoke in Rensselaer County; Duanesbury in Schenectady County; Middleburg, Schoharie and Wright in Schoharie County; Amherst, East Hamburg, West Seneca and Tonawanda in Erie County; Arkwright, Portland, Villenova, and Westfield in Chautauqua County.

The Federal Horticultural Board has issued four amendments to Quarantine No. 43, to cover these additional infested towns, the fourth bearing the date of October 23, 1920.

THE PEAR AND CHERRY SLUG.

Caliroa cerasi Linn.

The presence of brown slimy slugs or snail-like larvae is often noticed, feeding upon the upper surface of the leaves of pear and cherry. The green tissue may be eaten in patches or over the entire leaf, only the skeleton and lower epidermis remaining. Not infrequently small trees in nurseries and newly-set orchards are completely defoliated.

The author of this mischief is a small sawfly known as the pear or cherry slug, *Caliroa cerasi* Linn., sometimes listed as *Eriocampoides limacina* Retzius. It is an European species which feeds

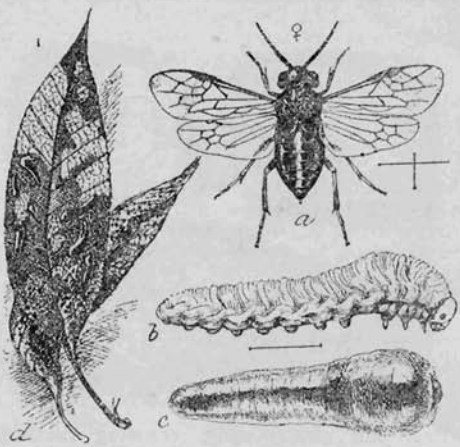

Figure 12. Pear and cherry slug. *a*, adult sawfly, female; *b*, larva with slime removed; *c*, larva in normal state; *d*, leaves and larvae, natural size; *a*, *b*, *c*, much enlarged. (After Marlatt, Circular 26, Division of Entomology, U. S. Department of Agriculture.)

upon a large number of different plants in Europe. It has been known in this country for more than two centuries but here attacks chiefly pear and cherry.

In Connecticut there are two generations each year, the eggs for the first being laid about the middle of May. The eggs are laid in the leaf from the under side, and by means of the ovipositor a cut is made between the lower epidermis and the upper epidermis, and also through the latter around the place where the egg is deposited. These cut places may be seen from the upper side and appear like small blisters. In each blister an egg is laid. The eggs hatch in about two weeks, and the young larva which is at first white, escapes through a crescent-shaped cut to the upper

surface and soon becomes covered with a brownish slime or coating which it carries until the last moulting stage. (See figure 13.)

The larva is much enlarged in the thoracic portion from which the abdomen tapers toward the tail giving it somewhat the appearance of a "bull-head" or tadpole. These brown slimy creatures are much wrinkled transversely, and present a very disgusting appearance. They pass through five stages: at the last moult, the brown slimy covering disappears and in the fifth or final larval stage, the slugs are yellow. They are now through feeding and soon go into the ground two or three inches and make cells in the soil in which they transform within six to eight days. The adults emerge in about ten days and soon lay eggs for the next generation. A part of the first-brood larvae do not transform but remain unchanged in their cocoons in the soil until the following spring. The eggs for

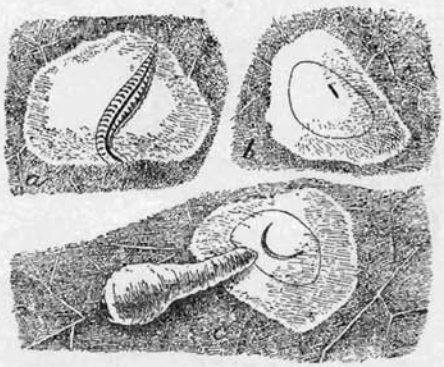

Figure 13. Pear and cherry slug, showing method of ovipositing and emergence of larva: *a*, cutting of cell with ovipositor beneath epidermis; *b*, the same after egg has been deposited; *c*, the same after emergence of larva—all enlarged. (After Marlatt, Circular 26, Division of Entomology, U. S. Department of Agriculture.)

the second brood are laid in July and August, and it is this brood which causes most of the injury in Connecticut.

Though there are usually two generations each year in the northern states, there are said to be three generations in the latitude of Washington, D. C.

This species is parasitzed by a minute four-winged fly, but so far as known this parasite has not been reared in Connecticut.

The adult of the pear and cherry slug is a small sawfly, 6 mm. in length, with black head, body, legs and antennae. The wings are smoky with black veins. (See figure 12.)

The specimens in the Station collection are from New Haven and South Windsor, but it is reasonably certain that the species occurs throughout the state. Larvae or characteristic injury have

been received from Hartford, West Hartford, Southington, Meriden, Wallingford, Norwich, Old Mystic, and South Norwalk. Our nursery inspectors have observed this insect in many other places in the state.

As regards remedies, spraying with lead arsenate will prove the most satisfactory in the nursery and orchard. The larvae may be killed, however, by spraying or dusting the leaves with fresh hellebore. Dusting with air-slaked lime or even with fine road dust will suffocate many of them.

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THE CURRANT STEM GIRDLER.

Janus integer Norton.

A brief account of this insect appeared in the Report of this Station for 1896, page 238, recording its occurrence in Windham in that year. But as this Report has long been out of print, and as the insect has been observed many times and in many places since, it is mentioned here. It was also received from Meriden in 1920. Mr. Zappe examined a currant patch at Norwood, Hamden, on June 6, where nearly every twig had been severed by this insect.

The adult is one of the sawflies (Order Hymenoptera) and a slender species about half an inch in length. Both sexes have black head and thorax. The male has a brownish-yellow abdomen, but basal half of the female abdomen is reddish-orange and distal or posterior half, black.

The female punctures the soft tender shoot of the currant, by means of a saw-toothed ovipositor, and places a yellowish egg in the pith. This egg is elongated oval in shape. Above the egg the shoot is girdled by means of a series of transverse cuts with the ovipositor. The girdling usually occurs about three-fourths of an inch above the egg, but the distance may vary from half to an inch.

The stem is usually not cut entirely, but wilts and soon breaks off, leaving the stubs. Some of the tips break off and fall at once. The injury is shown in figure 14, and on Plate XII, a.

The egg hatches in about eleven days, and the larva feeds on the pith, excavating a tunnel seldom over six inches long, and packing if full of excrement in the rear. About the first of September the

larva becomes full grown, hollows out the lower end of its burrow, and gnaws its way outward to the bark. In this enlarged chamber, the larva encloses itself in a silk cocoon in which it passes the winter. In the spring the larva changes to a pupa and the adult emerges during the latter half of May. The adult, larva and pupa are shown in figures 15 and 16.

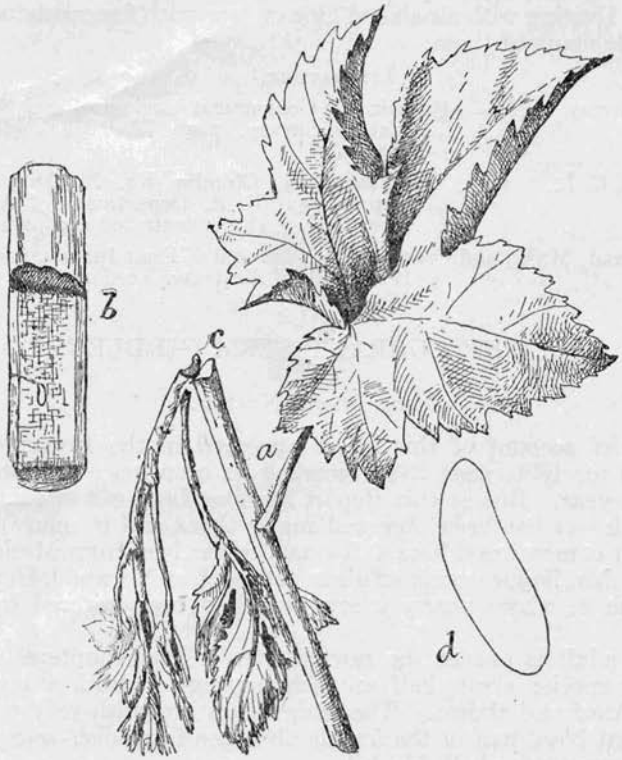

Figure 14. Currant stem girdler: *a*, egg puncture; *b*, section of stem showing egg in pith; *c*, severing of terminal shoot by female; *d*, egg — greatly enlarged. (After Marlatt, Insect Life, vols. vi and vii, Division of Entomology, U. S. Department of Agriculture.)

This insect was first described in print by Norton* under the name of *Cephus integer* in 1861, but the following year Fitch† published a description of the same species under the name of *Janus flaviventris*. Writers have used the name of *Phylloecus integer* and *P. flaviventris*, but according to the rules of priority

*Proc. Boston Soc. Nat. History, Vol. VIII, p. 224.

†Seventh Rept. on Insects of New York, p. 852.

Norton's name stands, and from the latest accepted scheme of classification, the insect belongs in the genus *Janus*.

In Connecticut this insect has been collected or observed in Windham, Canaan, New Haven, Hamden, Cheshire, Meriden, New London, Greenwich and Hartford. Undoubtedly it occurs throughout the state.

The currant stem girdler is probably a native of North America where it formerly bred in wild currants. Now it attacks the cultivated species, especially *Ribes rubrum*, often causing considerable injury. In nurseries and where the wood is used for

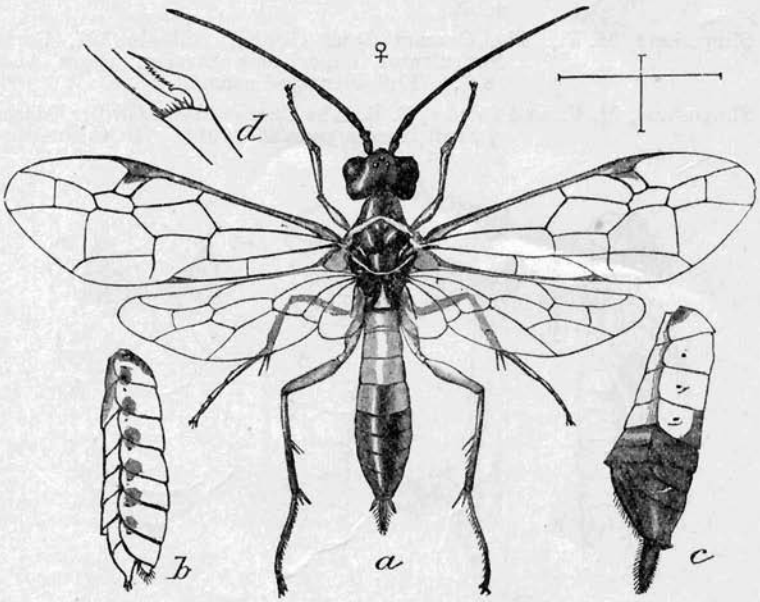

Figure 15. Currant stem girdler: *a*, adult female; *b*, lateral view of male abdomen; *c*, lateral view of female abdomen; *d*, apex of anterior tibia of female—all greatly enlarged. (After Marlatt, Insect Life, vols. VI and VII, Division of Entomology, U. S. Department of Agriculture.)

cuttings the insect is considered more of a pest than in fruiting plantations.

About the only remedial measures to be recommended are those of gathering and burning the tips containing the insect. If the girdled canes are cut back one or two inches in June, the tips will drop to the ground, soon become dry and the newly hatched larvae will be destroyed. Failing to do this, the tips of the infested canes can be gathered and burned in the fall or early spring. If these measures are practiced thoroughly for a few seasons, the injury will be much lessened.

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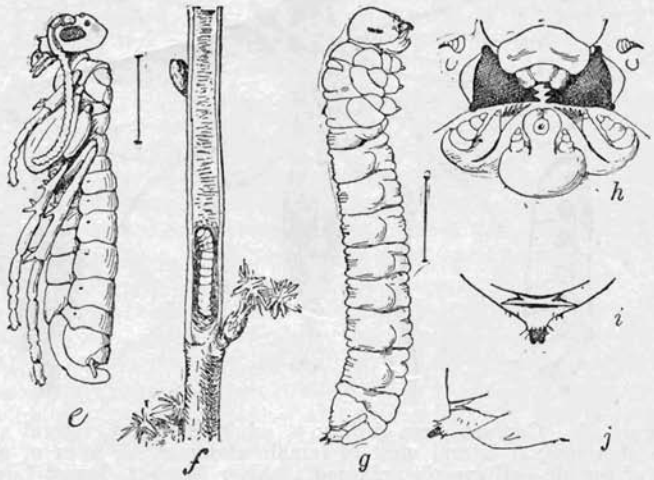

Figure 16. Currant stem girdler: *e*, pupa; *f*, larva in twig; *g*, larva; *h*, mouthparts of larva; *i*, dorsal view of tip of abdomen; *j*, lateral view of same—all enlarged. (After Marlatt, Insect Life, vols. VI and VII, Division of Entomology, U. S. Department of Agriculture.)

THE CELERY CATERPILLAR OR FENNEL WORM.

Papilio polyxenes Fabr. (*asterias*).

A yellowish-green caterpillar, more or less prominently marked cross-wise with black is often seen feeding upon the leaves of celery, carrots, parsnip, parsley, fennel, or in fact almost any plant of the family Umbelliferae. Though never very abundant, one often

finds several of these caterpillars on a short row in the garden. Sometimes they are quite destructive to young plants, especially celery.

Few observers recognize this caterpillar as the larva of the common black swallow-tail butterfly which may be seen here and there, everywhere, at certain periods of the season.

The eggs are one millimeter in diameter, globular, smooth, and yellow changing to reddish-brown. They are laid on the upper side of the leaves of the host plants, and hatch in about ten days. At first the young caterpillar is black with the rear end white, and a white band across the middle, but it moults five times and after each moult has a somewhat different appearance. When fully grown it is about two inches in length, green with the front margin of each segment black enclosing six yellow spots. When disturbed, this caterpillar pushes out from the prothorax just back of the head, two hornlike scent organs and a disagreeable odor may be noticed. These organs are probably for defense. The appearance of the caterpillar is shown on Plate XI, a.

A period of between three and four weeks is required for the larva to reach maturity and during this time it devours its food plant. Then it suspends itself to a leaf, stem, fence or other object of support which happens to be in the vicinity. The pupa is brown marked with black and dark green and is attached by a button of silk at the tail and by a girdle around the thorax. The insect remains in this state from nine to sixteen days, except when formed late in the season when it passes the winter.

The butterfly has a wing-expanse of between three and four inches, the female being usually larger than the male. Both pairs of wings are black crossed near the outer margin by two rows of yellow spots and a row of yellow lunules on the margin. A broad bluish band occurs between the rows of yellow spots on the rear wings and this color even extends faintly upon the rear margins of the fore wings. As a rule the blue band is more prominent in the female, and the yellow is more pronounced in the male, often appearing as solid bands on the rear wings, but great variations occur. At the inner angle of the rear wings there is an orange spot with a black center. Each of the rear wings bears a black tail-like appendage. Thorax and abdomen are black, marked with yellow spots. Plate XI, b, shows the appearance of this butterfly.

There are two generations in the northern states and at least three in the South. In the North the butterflies emerge in May and June from over-wintered pupae.

The species occurs throughout North America from southern Canada into South America as far as Venezuela and also in the West Indies.

Regarding control measures, hand picking is the usual and best method for the home garden. In large fields of carrots or parsnips where the tops are not to be eaten or fed to domestic animals,

spraying or dusting with lead arsenate may be practised in case the insect appears in great numbers.

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THE GRAPE BERRY MOTH.

Polychrosis viteana Clemens.

The chief cause of wormy grapes in Connecticut is this insect which occurs in the eastern portion of the United States and Canada, and westward as far as Illinois. The berries in a cluster are often webbed together, caused by the second-brood larvae leaving one set of berries and going into another. In some New York vineyards injuries are recorded which amount to a loss of from 25 to 50 per cent. of the total crop. In one case even 90 per cent. of the crop was ruined.

The grape berry moth undoubtedly occurs throughout the state; it has been sent to the Station from Sharon, Norwich, Mystic, Clinton and New Haven. It is a native American species and probably infested the wild grapes in this country before any vineyards were planted.

The adult is a small moth, having a wing-spread of slightly less than half an inch, of purplish-brown color, the fore wings marked or mottled with patches of darker brown. Rear wings are smoky-brown shading to whitish at the base.

In New York State the grape berry moth has two complete generations and a partial third one, the winter being passed in the pupa state on the old leaves on the ground. In making this cocoon portions of the leaves are cut and the edges rolled over and a silken case is formed inside the roll.

The moths emerge the first half of June and are thought to lay their eggs on the stems of the blossom clusters. Be this as it may, the first brood of caterpillars are at work at the time the grapes blossom, and make a scanty web among the blossom buds, and feed somewhat upon the buds often destroying a dozen or more in a cluster. They continue to feed during the month of June and also destroy many of the newly-set berries. The caterpillars of the first brood become mature soon after July 1, and make their cocoons by rolling up flaps of the leaves as has been described above. In a period varying from twelve to fourteen days the moths emerge

leaving their empty pupa shells projecting from the cocoons. They soon lay eggs on the berries or perhaps some of them on the stems, and the larvae of the second brood gnaw their way into the berries, usually entering near the stem or where two berries touch each other. The infested berries show a dark reddish spot around each entrance hole, and as the larvae feed inside the berries these spots enlarge until perhaps half the berry is discolored. (See Plate XII, b).

The young larva is whitish, with a blackish head, but as it grows the body changes to a dark olive green or brownish color, and often a purplish tinge is apparent. Thoracic shield and legs also become blackish. The larva is active and when disturbed wriggles out of the berries and spins down on a silken thread. The feeding period in the berries lasts about three weeks.

According to Goodwin* two thorough sprayings at the right time and with the proper materials will control this pest and ensure fruit nearly free from infestation. He recommends a Bordeaux mixture made after the 2-3-50 formula, to which four pounds of paste arsenate of lead and two pounds of dissolved soft soap have been added. The first treatment should be made just after the vines blossom, when the young berries are about one-eighth of an inch in diameter. The second application should be made about seven weeks after the first, or just before the eggs have been laid for the second-brood larvae. In Ohio this comes between August 2 and 12, but the exact time may be determined for each locality by placing in a jar about July 20, some wormy grapes with grape leaves on top of the berries: a piece of cheese cloth should be tied over the top of the jar and the jar placed out of doors in the shade. The spray should be applied ten days after the larvae first begin to make their cocoons on the leaves, and for this application six instead of four pounds of paste arsenate of lead should be used.

The vineyard should be intelligently pruned, cultivated, fertilized and sprayed properly for the other insect and fungous pests in order to produce a perfect crop.

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*Bulletin 293, Ohio Agricultural Experiment Station, 1916.

MOSQUITO WORK, SEASON OF 1920.

By S. T. Sealy.

During the season of 1920, a constant patrol has been maintained on all of the drained salt marsh areas in the towns of Fairfield, Orange, New Haven, East Haven, Branford, Guilford and Madison, an approximate total of 5,000 acres. This means that at no time have the drainage ditches been allowed to become clogged or choked for any appreciable length of time. This patrol has kept the water in circulation and the surface drained, thereby reducing mosquito breeding to a minimum. It has also shown the need of supplementary ditches, which we have installed, to take off water which the original ditching did not fully care for.

Except for a few high tides in the fall, the season as a whole has been comparatively dry, making conditions somewhat better for mosquito elimination work than in previous wet seasons.

The mosquitoes which have been most troublesome this season have come, not from the drained marshes, but from adjoining ones where no drainage ditches have been installed, and from the "rain barrel" mosquito which breeds in any standing water about dwellings or in inland pools.

The writer states this as a fact, since he has made it a point to spend one day each week with the men doing the maintenance work in the different towns. At no time has any intensive breeding been found on drained areas. As soon as surface breeding was located it was immediately drained to the nearest ditch.

Fairfield.

The work at Fairfield has been carried on by Mr. Nicholas Matinck with an average crew of two men to assist him. As Mr. Matinck has been engaged in this kind of work for the past few years, his efficient methods have made the Fairfield marshes almost mosquito proof. In addition to the salt marsh work the town officers of Fairfield have authorized and paid for, from town funds, considerable work in the upland sections; such as oiling, draining, and cleaning fresh water streams, brooks, ponds, etc.

New Haven, East Haven, Orange.

In the towns of New Haven, East Haven and Orange, a crew of four men, part of the time and two men the remainder of the time, have been at work keeping the ditches clean, the outlets free and the water in circulation. This crew started at West Haven and worked around the harbor to East Haven, going over the same route when the circuit was completed.

The tide gates constructed by the City of New Haven at Congress Avenue Bridge have been completed and are doing excellent

work. The marsh north of the gates has been dry all the season, thereby eliminating the breeding of salt marsh mosquitoes on this area.

BRANFORD.

The work at Branford has been under the direct supervision of Mr. L. E. Rice. The defective tide gates at Indian Neck have kept the marsh in a very wet condition causing a small amount of breeding in the upper end of the swamp. These gates will be put in repair as soon as it is determined what the state is going to do in regard to road and bridge; as gates are now hung on the bridge it would not be practicable to repair them at present.

A sand bar has formed at the mouth of the creek below the gates, stopping the flow of water. It is planned to remove this obstruction next season.

GUILFORD.

Mr. Frank Blatchley has patrolled and maintained the marshes of Guilford in perfect condition. He also repaired the tide gate at Shell Beach, which was damaged by last winter's storms.

MADISON.

The State Park Commission has maintained the ditches on the state property in good shape and hundreds of feet of new ditches have been installed for mosquito drainage by Mr. Joseph P. Synnott, who was in charge of the work for the Commission. Only a few days this season have visitors at the State Park been annoyed by mosquitoes, and then only when the prevailing winds have been from the east, blowing hordes of mosquitoes over from Clinton.

Mr. Russell Bartlett has had charge of the work in Madison that was not controlled by the Park Commission, and has maintained the marshes in excellent condition. The most trouble was along the beach caused by sand filling the main outlet ditch; this sand had to be dug out very frequently.

NEW WORK.

On June 4, 1920, a contract was let to Eaton, Brown & Simpson, Inc., 90 West Street, New York City, to drain for mosquito elimination sixty acres at Groton Long Point, Connecticut. They installed 28,000 feet of 8 x 20 ditch and built a bridge over the main outlet to the bay, for the sum of $1,000.00, three-quarters of which was subscribed by the members of the Groton Long Point Association.

As there are no other marsh lands in the near vicinity of Groton, the inhabitants are not likely to be troubled with mosquitoes from now on.

On September 14, 1920, at the request of Mr. J. Frederick Jackson, Director Bureau of Engineering, State Health Depart-

ment, an inspection was made at Lydall's Brook, Manchester, Conn. Light breeding was found in Union Pond and along the brook as far as Fould's Paper Mills. The settling tanks used to catch the waste water from the mills were found to be prolific breeders of mosquitoes (*Culex pipiens*). When these tanks overflow into the brook, the larvae are scattered along all the way to Union Pond, causing the people in the near vicinity to be pestered by mosquitoes. The State Department of Health is working on this matter, and will very likely plan some way to abate this nuisance.

COST OF MAINTENANCE AND NEW WORK, SEASON 1920.

Maintenance:	Madison	$265.63
	Guilford	578.14
	Branford	376.90
	East Haven	68.42
	New Haven	386.95
	Orange	474.66
	Fairfield	1,397.76
		$3,548.46
New Work:	Groton	250.00
Supervision*		2,401.43
Total		$6,199.89

MISCELLANEOUS INSECT NOTES.

Stalk Borer:—The stalk borer *Papaipema nitela* Guen., was present and ruined an occasional stalk of corn and potatoes, but was not nearly so prevalent as in 1919. Specimens were received from Danbury, Ridgefield, Derby, Milford, West Haven, New Haven, Hamden, New Hartford, Middletown and Hartford.

The Bud-Moth Injuring Apples:—One species found injuring the mature fruit in the orchard of Mr. William F. Platt, Milford, was the bud moth *Tmetocera ocellana* Schiff. The dark brown larva occurred with other leaf-rollers, several species of which were feeding upon the surface of the fruit.

Green Clover Worm:—The green clover worm *Plathypena scabra* Fabr., which was so prevalent in 1919 causing injury nearly everywhere throughout the eastern United States, did not injure beans at all in Connecticut in 1920. By making a thorough search in my own garden, I managed to find a few larvae, but the feeding which they did was unnoticeable.

Pine Tube Moth:—The pine tube moth *Eulia pinatubana* Kearfott, mentioned on page 201, and shown on Plate XXXII, of the Report of this Station for 1919, was reported as being rather

*Supervision includes salary and traveling expenses of Deputy in Charge, first cost, insurance and upkeep of automobile.

abundant around Stamford in 1920. Late in the fall three samples were received from Norwalk, Sound Beach and Stamford. If ornamental pines are infested sufficiently to endanger their foliage, or even their appearance the trees should be sprayed with lead arsenate.

Periodical Cicada or Seventeen-Year Locust:—Brood II of this interesting insect was scheduled to appear in 1920 in Suffield and in Tolland, Conn. Several correspondents and entomologists were warned to watch for it, and though they did so, the reports were all negative. I have yet to learn of anyone who collected or observed this insect in Connecticut in 1920.

Corn Ear Worm:—The corn ear worm *Heliothis obsoleta* Fabr., was received from Mystic, Milford, Middlebury and New Canaan. In one field in Mystic about half the crop was damaged. This insect usually attacks late maturing corn, especially sweet corn, and feeds on the soft kernels chiefly at the tips of the ears. Sometimes it works down the side of the ear and eats some of the kernels near the base. It is a much more serious pest farther south than it is in Connecticut. In New Jersey it is controlled by dusting the corn silk with powdered sulphur and dry lead arsenate, equal parts.

Sesiid Borers:—On July 1, 1920, Mr. Zappe visited a garden at 260 Howard Avenue, New Haven, and found apple trees infested with Lepidopterous larvae boring in the branches and doing considerable damage. Some material was brought to the laboratory, and on July 16, an adult clear-wing moth emerged. This proved to be *Sesia pyri* Harris, a species having a wing expanse of less than three-fourths of an inch, and transparent wings with black margins. It rarely causes serious injury, as the larva burrows in the bark but does not penetrate the sapwood.

A similar borer was received, June 11, from the Elm City Nursery Company in a stem of Rhododendron. On June 23, the adult emerged. It is a similar though different species from the preceding, but has not yet been identified.

Oriental Peach Moth:—No larvae of this insect could be found in 1919 by Mr. Zappe, at the place where it infested peach fruits in 1918 near Stamford (see Report of this Station for 1918, page 299) and on June 20, 1920, Messrs. Zappe and Britton in company with Mr. W. O. Filley, Forester of this Station, and Mr. F. A. Bartlett of Stamford, visited the same premises. It is true that some of the trees had died and had been removed and others had been severely pruned. Though there was little fruit to become infested, we examined the twigs of several trees and found no signs of injury. Doctor T. J. Headlee informs the writer that the Oriental peach moth has been unusually destructive in New Jersey the past season.

Red Banded Leaf-Roller:—In harvesting and scoring the fruit in the experiments in dusting and spraying in the orchard of Mr. William F. Platt, Milford, described in the preceding pages of this Report, many of the apples were gnawed on the surface, especially where covered by a leaf or another apple, and in some cases in the stem or calyx cavities. At least three insects were responsible for this injury: (1) the bud moth mentioned on page 176, (2) the lesser apple worm, *Enarmonia prunivora* Walsh, and (3) the red banded leaf-roller *Eulia velutinana* Walker. The last seemed to be the most abundant and the injury was apparently done late in the season. The injury shown on Plate VI, a, was sufficiently serious to warrant another and later treatment to prevent it.

Juniper Scale:—On August 4, 1917, a twig of common red cedar *Juniperus virginiana*, infested with the juniper scale *Diaspis carueli* Targ.-Tozz., was received from Danbury. On March 11, 1920, Mr. A. S. Peterson, New Rochelle, N. Y., sent to the Elm City Nursery Company a branch of a cultivated juniper *Juniperus pfitzeriana*, well infested with this scale. It is a scale with shell nearly circular, and occurs on the leaves sometimes in great numbers, as is shown on Plate XIII, b. The female shell is very convex, gray or dirty white, often covered with a sooty deposit. The male is small, elongated, narrow with parallel sides, with a median ridge or carina, and white in color.

Apparently little is known regarding the life history of this insect, or how best to hold it in check. Probably it will do little harm to trees in their native habitat, but should it infest choice ornamental specimens, it can doubtless be controlled by several applications between June 1 and September 1, of either kerosene emulsion, or nicotine solution and soap, given in the form of a spray.

The Elm Leaf-Miner:—On June 14, elm leaves were received from Miss Charlotte B. Norton, Lakeville, Conn., which showed the characteristic mines and feeding injury of a sawfly known as the elm leaf-miner *Kaliofenusa ulmi* Sundewall. More material was requested and received a few days later. This was placed in the breeding cages and possibly next summer some adults may be obtained. The larvae are miners between the upper and lower epidermal layers of the leaves, and frequently there are several larvae in a leaf and the mines run into each other making a large blister, sometimes involving the entire leaf. These blisters are very conspicuous, showing almost as plainly from beneath as from above, and have the appearanee indicated by Plate XIII, a. The badly injured leaves drop, but those slightly injured remain upon the tree, the mined areas falling out leaving holes. In aggravated cases trees are nearly defoliated by July 1, but later new leaves appear and the trees regain their normal appearance. Of course such attacks weaken the trees and render them very

unsightly. As is the case with the elm leaf beetle, the European species of elm are preferred to the American elm.

This is the first evidence that the elm leaf-miner is present in Connecticut, though it has been known to injure elms in and around Albany*, N. Y., for more than twenty years. The adult is a small sawfly only three millimeters long, and the eggs are laid in the leaves during the latter half of May and June. There is only one brood each year.

A number of experiments in controlling this insect have been conducted by Professor G. W. Herrick† of Cornell University. He found that when a tree was sprayed thoroughly with 40 per cent. nicotine solution and laundry soap, just as the mines begin to show, all larvae were killed.

Ox Warbles:—On May 15, three larvae were received from Mr. B. K. Allen of Saybrook, with the statement that they had been squeezed from a cow's back. It is not unusual for cattle to have "grubs" under the skin on their backs. The infestation is most noticeable in late winter or early spring, and a series of lumps may be felt or often seen. These lumps increase in size and finally discharge their inmates which go into the ground to pupate and later emerge as two-winged flies, more or less covered with yellow hairs somewhat resembling bees. (See Plate XV, a.) These flies are known as "bot-flies" or "warble flies" and annoy cattle and horses in the pasture in summer, laying their eggs upon the hairs of the legs or body. The eggs are licked off by the animals and taken into the stomach where they obtain nourishment. The larvae of the horse-bot, *Gastrophilus equi* Clark, are attached to the wall of the stomach and when finally mature pass out of the animal with the excrement. But those in cattle make their way through the stomach wall and other tissues, finally reaching the skin upon the back. Two species, *Hypoderma bovis* DeGeer, and *H. lineata* DeVillers, are known to attack cattle and both occur in Connecticut. They cause considerable injury by annoying the animals, and "warbled" hides are much less valuable than perfect ones.

There is no good remedy. Grubs beneath the skin may be squeezed out or treated with mercurial ointment. Where possible it is advisable to keep the animals well cleaned and brushed and to prevent them from licking themselves.

A closely allied species, *Oestrus ovis* Linn., is the well-known sheep-bot, the larva of which infests the nasal cavities in sheep.

Other closely related species belonging to the genus *Cuterebra*, infest rabbits and are occasionally found in cats. On October 2, a

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*M. V. Slingerland, Cornell Agr. Expt. Station, Bulletin 233, page 50, 1905.

†*Ibid*, Bulletin 333, page 510, 1913.

large larva was received from Vernon, which had been squeezed from a hole through the skin on the side of a kitten six months old.

A Curious Form of Injury to Dahlias by the European Giant Hornet:—On September 21, two adults of the European giant hornet, *Vespa crabro* Linn., were received from Miss Emily Slocombe of 555 Townsend Avenue, New Haven, with a statement that these hornets had killed two dahlia plants and injured several more by eating off the bark. On September 25, Messrs. Walden and Garman visited the premises. They saw five or six large plants which had been badly chewed by the hornets as shown on Plate XIV, b. Seven of these large hornets were around one plant and seemed to return to it even after having been driven away. The sap oozed out of the injured plants, fermented, and many adults of the bumble flower beetle *Euphoria inda* Linn., were feeding upon the sour sap. It was suggested to the owner that the stems of the injured plants be sprayed with lead arsenate.

This insect has long been known to gnaw the bark from hard wood twigs often girdling them, but this is the first instance coming under our observation in which it has attacked herbaceous stems. A note regarding the giant hornet and its habit of girdling twigs may be found in the Report of this Station for 1916, page 144.

On October 9, specimens of the European giant hornet were received from Mr. E. Vanderwerken, of Stamford, who writes that Italians and Japanese both regard the species as a great menace to bee keeping, as the adults kill honey bees in great numbers. We have made no observations to confirm this statement.

This hornet is a native of Europe, and was first noticed around New York City some twenty-five years ago, from where it has spread gradually into Connecticut and throughout New Jersey.

It was first collected in Connecticut at New Haven, June 13, 1900, and specimens have been received at the office many times in recent years from Greenwich, Stamford, Darien, Plantsville, Hamden and New Haven. It is shown on Plate XIV, a.

Leaf-Roller on Tartarian Honeysuckle:—In the Report of this Station for 1918, page 342, mention is made of a larva feeding on Tartarian honeysuckle, from which was reared on July 18, a moth belonging to the genus *Harpipteryx* and apparently undescribed. The larvae were rather abundant in the writer's garden in 1920 webbing together and feeding upon the tender terminal leaves. Several adult moths were reared, emerging on July 1. A brief description follows:—

Larva.—15-18 mm. in length; 1.5 mm. thick at fifth abdominal segment, from which it tapers towards both extremities, the taper being greater though less abrupt toward the head: lateral and ventral surfaces leaf-green with a lighter blue-green stripe adjoining dark median stripe, and short diagonal lighter stripes above the spiracles: two longitudinal dorsal stripes, purplish to chocolate brown, separated only by a faint narrow line of lighter color. Head grayish-green, faintly marked and

mottled with light-brown, bearing brown hairs. Legs and prolegs green like dorsal surface; anal prolegs prominent. Each segment bears a number of short brown hairs or bristles. Wriggles like a Pyralid, and spins down on a silk thread.

Cocoon.—About 18 mm. in length; 3 mm. thick for two-thirds its length; tapering equally at both ends to a sharp point. Whitish or straw-color. Fastened to a leaf.

Adult.—Wing-spread 20-22 mm. Fore wings chestnut-brown with a conspicuous cream-colored rear margin: near the outer end of this marginal band there extends forward and outward a pointed streak of the same color ending just beyond the disk. Fore wings extended at tips and curved backward forming recurved hooks. A cream-colored dorsal patch on thorax extends over head and palpi: antennae filiform, whitish but annulated with brown or black. Rear wings blackish or smoky-brown with lighter fringe. Abdomen, legs and under surface colored about like rear wings.

Since rearing this moth in 1918, Doctor William Barnes has published* an illustration of an European species *Harpipteryx xylostella* Linn., which appears to be the same as our specimens. Some of our material was therefore sent to Doctor Barnes, who reports it to be the European species *H. xylostella.*

Illustrations of the larva, cocoon and adult may be found on Plate XV.

ILLUSTRATIONS.

All plates are from photographs from the following sources:—Plates IV, V, and X by W. E. Britton; Plate IX, b, and d, by M. P. Zappe; Plate IX, c, by K. F. Chamberlain; Plate XIII, b, by Philip Garman; all others by B. H. Walden. The text figures are from drawings as follows:—Figure 4, map drawn by A. E. Moss; Figure 5, plan of orchard experiments, drawn by E. M. Stoddard; Figure 6, by Philip Garman; Figures 8, 9, 10 and 11, after Dr. E. P. Felt, Cornell Extension Bulletin 27; Figure 11, after J. B. Smith, New Jersey Agricultural Experiment Station; Figures 12, 13, 14, 15 and 16, after C. L. Marlatt, Bureau of Entomology, U. S. Department of Agriculture.

*Contributions to the Natural History of the Lepidoptera of North America, Vol. IV, page 246, Plate XXVIII, figure 12, 1920.

INDEX

a. Front view of outfit.

b. Rear view.

DUSTING IN APPLE ORCHARD.

PLATE V.

a. Side view of dusting outfit.

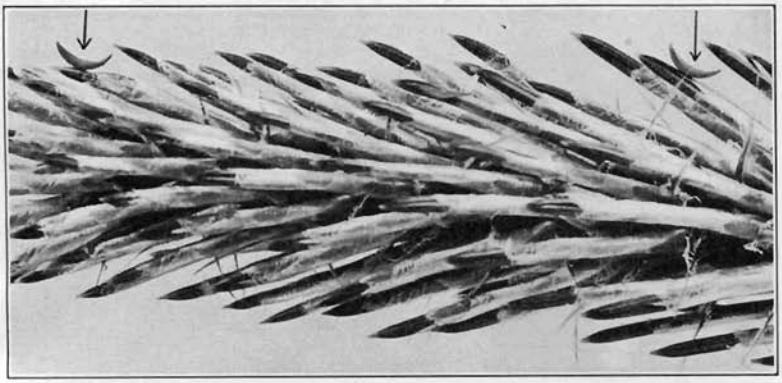
b. Spraying outfit used in Platt's orchard.

DUSTING AND SPRAYING IN APPLE ORCHARD.

a. Work of red banded leaf-roller on fruit, natural size.

b. Spraying potatoes to kill aphids, at Woodmont.

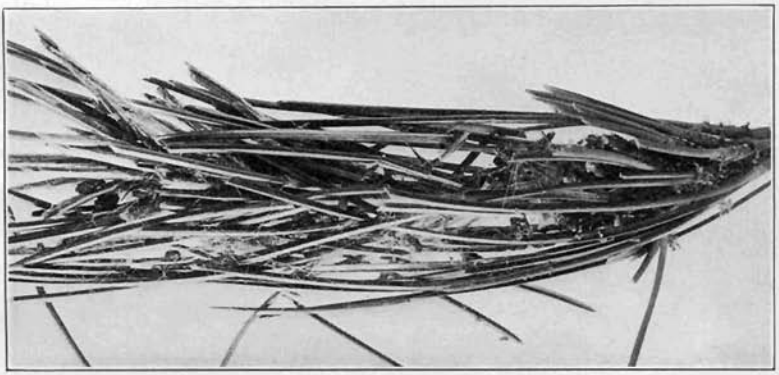
INJURY TO APPLES: SPRAYING POTATOES.



a. Crescent-shaped eggs on developing needles, twice natural size.

b. Larva, twice natural size.

c. Larva feeding in cluster of needles, natural size.



d. Cluster of needles webbed together in characteristic fashion by the larva, natural size.

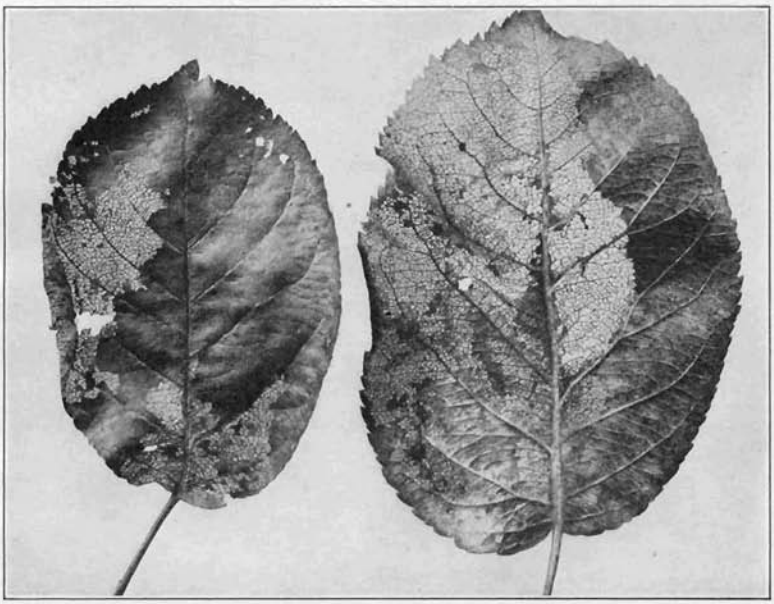
SAWFLY ON AUSTRIAN PINE.

PLATE IX.

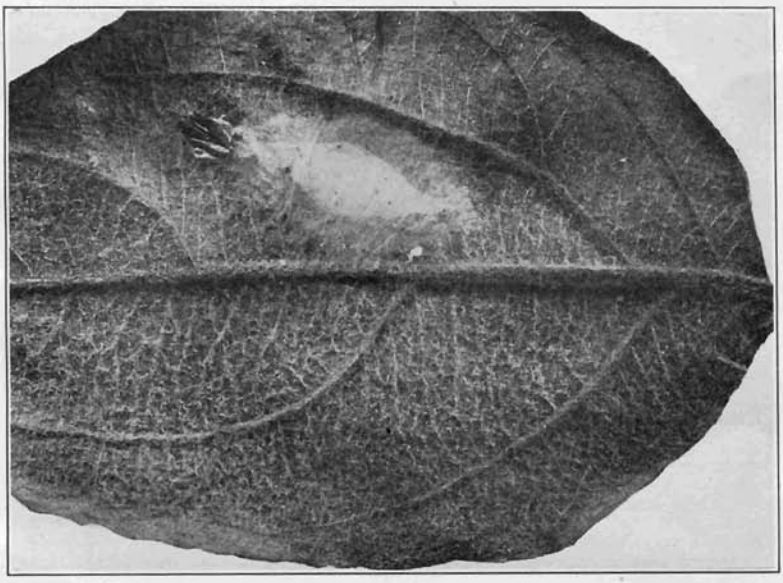
a. Infested apple tree which has lost much foliage from the attacks of the mite.

b. Eggs on calyx end of apple, and on twig, three times enlarged; insert, same from twig, enlarged about ten times.

EUROPEAN RED MITE.



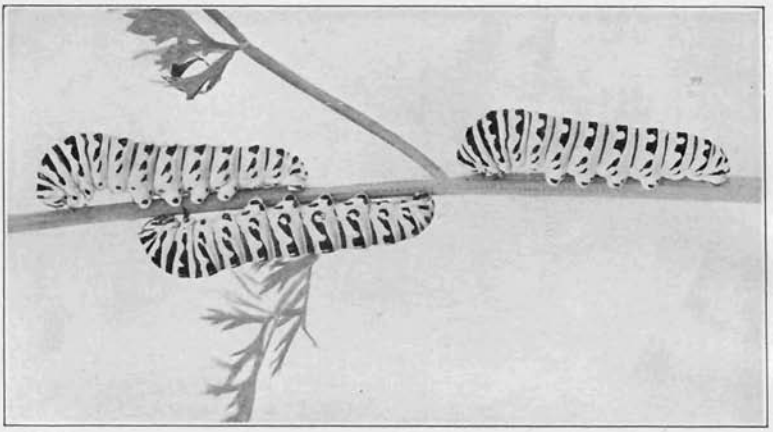
a. Characteristic injury of larvae on apple leaves, somewhat reduced.



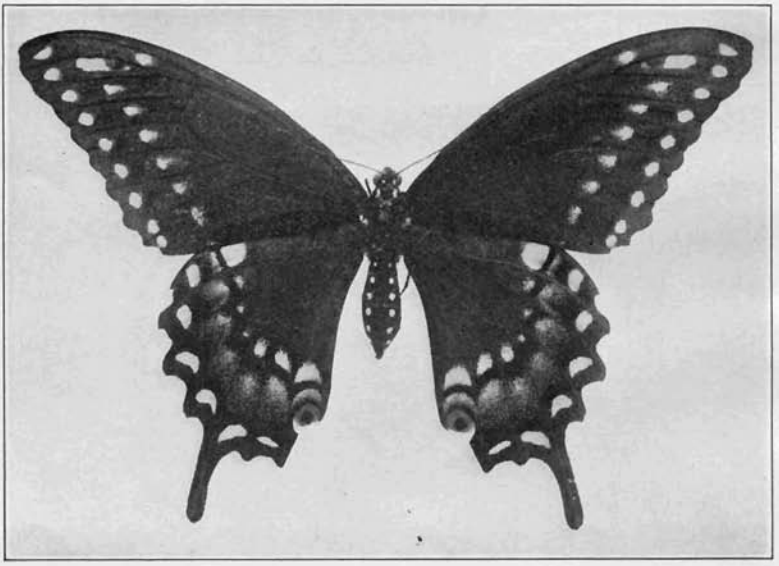
b. Cocoon on under surface of apple leaf, twice natural size.

APPLE AND THORN SKELETONIZER.

PLATE XI.

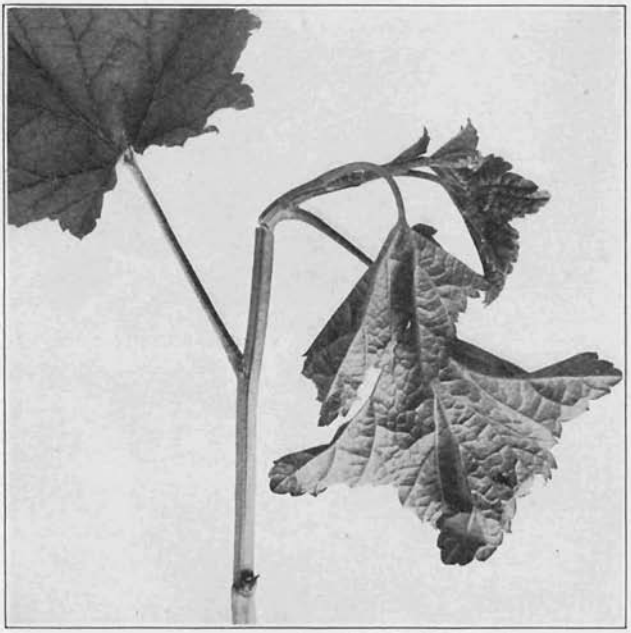


a. Larvae feeding upon carrot, natural size.

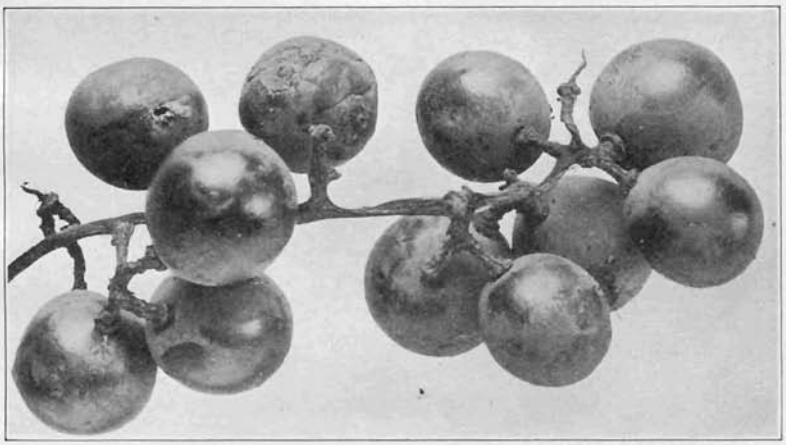


b. Adult, known as the black swallow-tail butterfly; female, natural size.

CELERY CATERPILLAR.



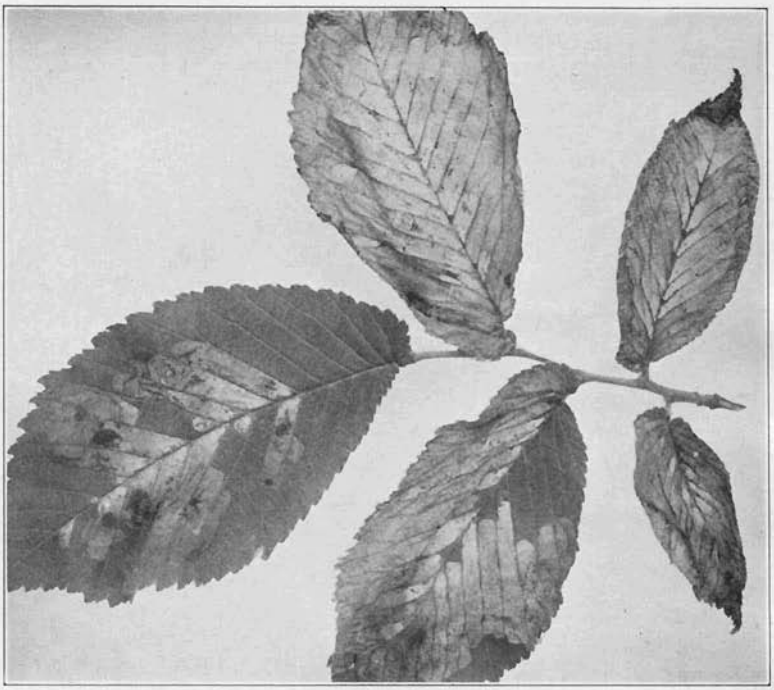
a. Work of currant stem girdler, in severing tip of new shoot. Egg is laid just below the cut. Natural size.



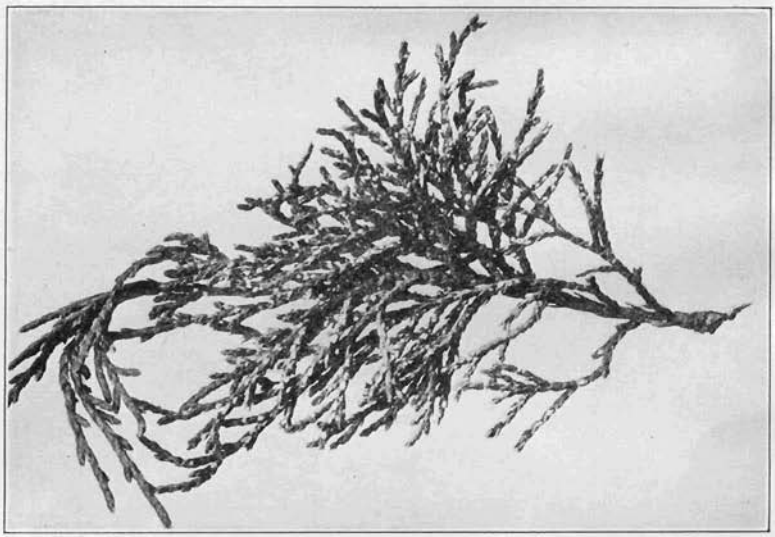
b. Cluster of grapes infested by larvae of the grape berry moth. Natural size.

CURRANT STEM GIRDLER AND GRAPE BERRY MOTH.

PLATE XIII.

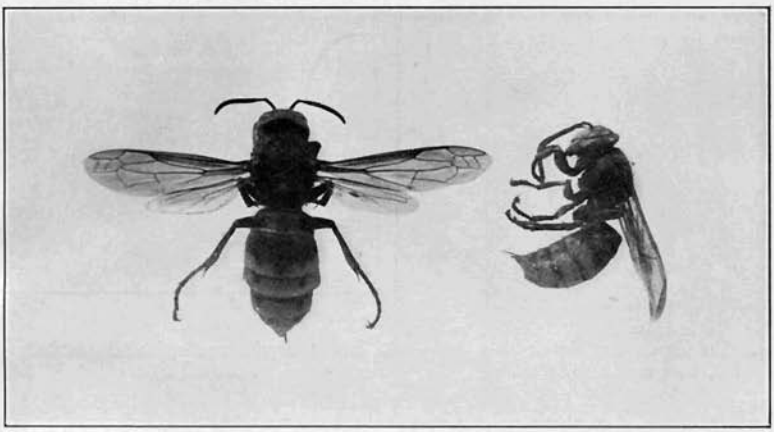


a. Characteristic injury of elm leaf-miner, somewhat reduced.

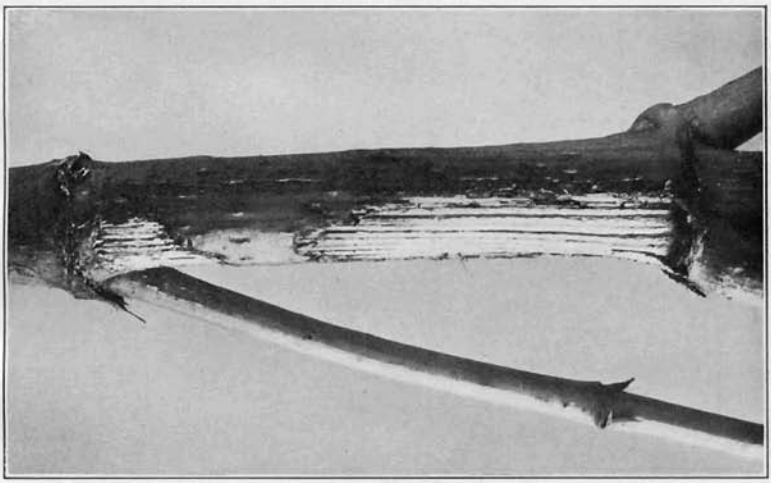


b. Juniper twig, showing scales on leaves, natural size.

ELM LEAF-MINER AND JUNIPER SCALE.



a. Adult hornets, dorsal and lateral views, natural size.

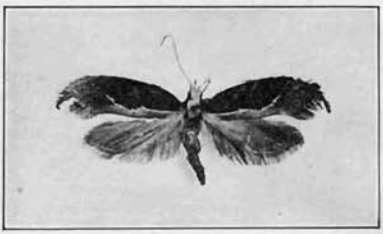


b. Dahlia stem gnawed by hornets, somewhat reduced.

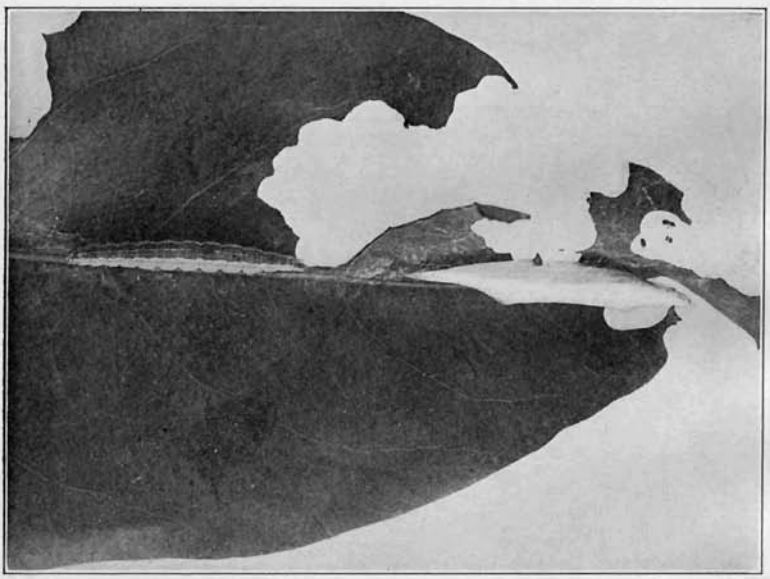
EUROPEAN GIANT HORNET.

PLATE XV.

a. Adult ox warble or bot fly, twice natural size.



b. *Harpipteryx xylostella*, twice natural size.



c. Larva and cocoon of *Harpipteryx xylostella*, twice natural size.

OX WARBLE OR BOT FLY, AND HARPIPTERYX ON TARTARIAN HONEYSUCKLE.