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Connecticut State Entomologist

FORTY-FIRST REPORT

1941

R. B. Friend, Ph.D.
State Entomologist

Connecticut
Agricultural Experiment Station
New Haven

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

I have the honor to transmit, herewith, the forty-first report of the State Entomologist for the year ending October 31, 1941.

Respectfully submitted,

ROGER B. FRIEND,
State and Station Entomologist.

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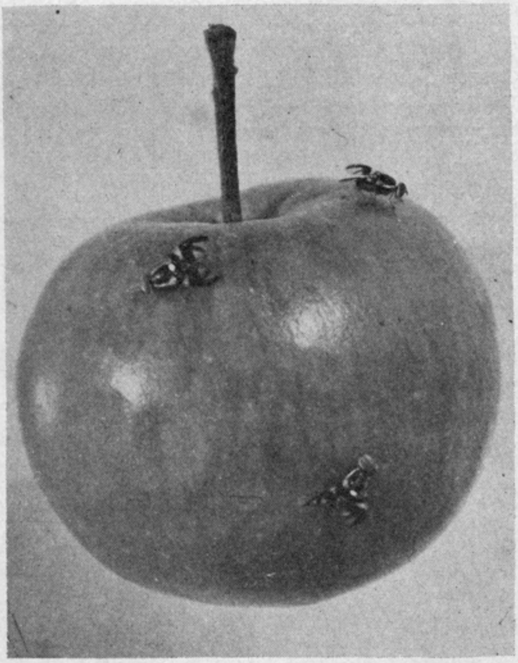

Adult flies of the apple maggot, Connecticut's most important fruit insect.

CONNECTICUT STATE ENTOMOLOGIST

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During the year the regulatory phases of the work of the Department were carried out as usual. The reports on nursery inspection, Japanese beetle quarantine enforcement, inspection of apiaries, gypsy moth control, Dutch elm disease suppression, rodent control and mosquito control are given in detail on pages 468 to 486. Many of these operations are conducted in cooperation with federal agencies. There are at present five federal quarantines which affect the transportation of plant products out of Connecticut: gypsy moth, Dutch elm disease, Japanese beetle, white pine blister rust and barberry-grain black stem rust. Inasmuch as the gypsy moth and Dutch elm disease quarantine lines pass through the State, state quarantines corresponding to the federal are in force.

The control of fruit orchard insects presents many problems, and in this field we have paid particular attention to the Japanese beetle, the oriental fruit moth, the apple maggot, the European red mite and the efficiency of non-sulfur sprays in the apple orchard. The Japanese beetle is increasing in abundance in the State and has caused some injury to fruit and ornamental trees, shrubs and herbaceous garden plants. The larvae have injured the turf on lawns and golf courses. At present most of our efforts are directed toward the establishment of certain parasites and the distribution of the organism causing milky disease of the larvae (page 488). A mimeographed special bulletin on the control of the adult beetle was issued in June and another, on the control of the larvae, in September.

The oriental fruit moth was less abundant than usual in 1941 and the peach crop was unusually free of larvae. Parasites were reared and distributed to peach growers throughout the State, as in previous years (page 487). A rather extensive investigation of possible alternate hosts of fruit moth parasites, which has been in progress since 1938, has yielded some important information (page 490).

The apple maggot continues to be our most important apple pest and was, as usual, abundant in 1941. Field experiments conducted during the past few seasons have demonstrated that rotenone dusts may have a significant place in the control program (page 503). The rate of rotenone breakdown, under the influence of ultraviolet light in dusts having certain red clays as carriers, has been further investigated (page 503). Certain new materials have bee nshown to be toxic to these flies (page 504). Circular **145**, "Control of the Apple Maggot", was issued in May.

The European red mite infestation did not become serious until late in the season. Field experiments were conducted in several apple orchards, particular emphasis being placed on so-called "dinitro" dusts and rotenone dusts, with significant results (page 507). Insecticidal control operations often significantly affect the predators of this mite in treated plots.

Comstock's mealybug has recently become a significant orchard pest in Connecticut, particularly in Fairfield County. Certain parasites have been obtained from the federal government and released in infested areas (page 489).

Certain other fruit pests were more or less conspicuous. The codling moth (*Carpocapsa pomonella* L.), which flared up in 1940, was less injurious over the State as a whole in 1941. The pear psylla (*Psylla pyricola* Főrst.) was somewhat more injurious than usual in several orchards. The curculio (*Conotrachelus nenuphar* Hbst.) infestation in apple orchards was unusually light. The meadow spittle bug (*Philaenus leucophthalmus* L.) was very injurious to strawberries on a farm in Hamden. Circular **143**, "Control of the Pear Psylla in Connecticut", was issued in January.

During the last two years the effectiveness of non-sulfur sprays with special stickers has been compared with standard mixtures in use in this vicinity for the control of apple pests. Such materials as aluminum sulfate, manganese sulfate and an aluminum aceto-borate-oil mixture have given promising results (page 512).

Among the pests of vegetable crops in Connecticut the European corn borer continues to be the most important, although less abundant in the fall of 1941 than in the fall of 1940. According to a survey by Vance (U. S. Bureau of Entomology and Plant Quarantine) in the fall of 1941, there was an average of 81.9 borers per 100 plants in the State as compared to 348.4 in 1940. In the counties of Fairfield, New Haven and Hartford the 1941 averages were 121.8, 143.4 and 235.8 borers per 100 plants, respectively. In early market sweet corn in New Haven County the average infestation was 493 borers per 100 plants in 1940, and 109 in 1941. Connecticut is the most heavily infested state in New England. In 1940 a field test demonstrated the practicability of controlling the borer on early sweet corn by using insecticides. A repetition of this test in 1941 gave the same results (page 520). The application of insecticides to control the borer and the bionomics of the borer have been extensively investigated during the last few years. The results will be published in the near future. Circular **144**, "Control of the European Corn Borer by Sprays and Dusts", was issued in May and revised and reprinted in October.

The squash bug and the squash vine borer are quite common in the State and are frequently quite injurious, particularly the vine borer. The results of a study of the bionomics of the bug, with particular reference to the interrelations between it and its principal parasite, were published in Bulletin **440**, "The Biology of *Anasa tristis* DeGeer with Particular Reference to the Tachinid Parasite, *Trichopoda pennipes* Fabr.", issued in January. As a result of investigations in 1940, it appeared probable that the date of planting might have an effect on the injuriousness of the vine borer to winter squash. This was investigated more carefully in 1941 (page 521). The effect of date of planting appeared to be due to the size of the plants when infested, rather than to the infestation rate. Insecticide experiments showed no significant difference between lead arsenate spray and 1 percent rotenone dust. The infestation was light.

The abundance and injuriousness of certain other vegetable insect pests was called to our attention during the season. A very severe local outbreak of the potato flea beetle (*Epitrix cucumeris* Harr.) occurred in a small field in North Haven where the vines on about one-fourth of an acre were killed. Aphids (*Illinoia solanifolii* Ashm.) were very abundant on and injurious to tomatoes in New Haven County. The cucumber beetle (*Diabrotica vittata* F.) was abundant and injurious to young cucurbit plants in parts of the State. The imported cabbage worm (*Pieris rapae* L.) and cabbage looper (*Autographa brassicae* Riley) were less abundant than usual.

Grassland insects and those which injure the roots of other plants include several species of economic importance. In 1941 an extensive outbreak of white grubs (the larvae of scarabaeid beetles) occurred, and injury to turf was extensive. Several species were involved, and certain observations on their habits were made (page 523). A general study of these insects, which include three imported Asiatic species, is in progress. Results of a study of *Cyclocephala borealis* Arrow were published in the Journal of Agricultural Research in January.

The chinch bug (*Blissus hirtus* Mont.) injured many lawns during the summer. Experiments with various insecticides on the control of this insect were continued (page 544). Good control depends on the method of application as well as the nature of the insecticide.

A severe outbreak of the bronze cutworm (*Nephelodes emmedonia* var. *violans* Guénée) occurred during the spring on the grass areas along the Merritt Parkway (page 542).

The imported weevil, *Calomyctcrus setarius* Roel., caused some injury to plants in Sharon. This insect is a potential pest and its habits are being studied.

The studies of insects affecting coniferous plantations, particularly the pine weevil, the European pine shoot moth and the spruce gall aphid, have been in progress for some time. These are essentially studies of population fluctuations and hence take a number of years to complete. Since 1935 the injuriousness of the pales weevil (*Hylobius pales* Herbst) has been under observation in white pine plantations in Connecticut and southern New Hampshire (page 530). The amount of injury sustained by a pine plantation set out on cut-over pine land is not serious when the trees are planted the second spring after cutting.

Elm bark beetles have been of particular interest to us in relation to the spread of Dutch elm disease. During the past year particular attention was devoted to the effect of trap logs on the abundance of the two common species and to the prevalence of parasites (page 537). A third species, *Scolytus sulcatus* LeC., has been found to be more prevalent than was formerly supposed (page 540).

A number of other forest and shade tree pests came to our attention. The red-humped oak caterpillar (*Symmerista albifrons* S. & A.) was again abundant in an oak stand of five to ten acres in Bloomfield (page 546). The eastern tent caterpillar (*Malacosoma americana* F.) was abundant on wild cherry in parts of Fairfield and New Haven counties. The elm leaf beetle (*Galerucella luteola* Müll.) seriously defoliated elms throughout the State. The smaller European elm bark beetle (*Scolytus multistriatus* Marsh.) occurred in its usual numbers. The locust leaf miner (*Chalepus dorsalis* Thunb.) caused extensive browning of black locust in northern Middlesex County. The larch case bearer (*Coleophora laricella* Hübn.) was unusually abundant on larch trees in the northwestern part of the State. The pine sawfly (*Gilpinia frutetorum* F.) was reported by J. V. Schaffner of the Federal Bureau of Entomology and Plant Quarantine to be rather abundant in early fall in a red pine stand in Southington and to occur in Middletown, North Haven, Branford and Litchfield. The outbreaks of *Ellopia athasaria*, a geometrid caterpillar, which occurred in hemlock stands in Woodbridge and Branford in 1940, were not in evidence in 1941. A hemlock stand in Sandy Hook was also defoliated in 1940.

During the year, 504 samples of insects about which information was desired were received at this office. These are classified in economic groups as follows:

Fruit pests	24
Field and vegetable crop pests	23
Forest and shade tree pests	131
Timber and wood products pests	53
Pests of shrubs and vines	26
Flower garden and greenhouse pests	38
Pests of the household and stored grain	70
Soil and grassland inhabiting pests	69
Insects annoying to man and domesticated animals	14
Parasitic and predaceous insects	16
Miscellaneous	40
	504

In addition to these, 118 specimens were identified for collectors. This list does not indicate the relative economic significance of the groups in this State. The following fourteen insects were received five or more times. They are listed in order of frequency, those most frequently sent in being first.

1. Elm leaf beetle (*Galerucella luteola* Müller)
2. Termite (*Reticulitermes flavipes* Kollar)
3. Carpet beetle (mainly *Attagenus piceus* Oliv.)
4. Carpenter ant (*Camponotus herculeanus pennsylvanicus* DeG.)
5. Japanese beetle (*Popillia japonica* Newm.)
6. Pine leaf scale (*Chionaspis pinifoliae* Fitch)
7. Maple bladder gall (*Phyllocoptes quadripedes* Shim.)
8. Oriental beetle (*Anomala orientalis* Waterh.)
9. Pavement ant (*Tetramorium caespitum* L.)
10. Sitka spruce gall aphid (*Adelges cooleyi* Gill.)
11. Eastern spruce gall aphid (*Adelges abietis* L.)
12. Euonymus scale (*Chionaspis euonymi* Comst.)
13. Birch leaf-mining sawfly (*Fenusa pumila* Klug)
14. Common red spider (*Tetranychus telarius* L.)

The members of the staff also visited 211 orchards, farms, gardens and houses at the request of owners in regard to insect problems.

The Station insect collection, which is indispensible to the work of the department, contains about 7,500 Connecticut species. It is being augmented continuously.

Our Department works with the Federal Bureau of Entomology and Plant Quarantine in carrying out parts of its program. This applies not only to regulatory functions but to certain aspects of research. The cöoperation is deeply appreciated.

CONFERENCE OF CONNECTICUT ENTOMOLOGISTS

The eighteenth annual conference of Connecticut Entomologists was held in the Community House of the University of Connecticut at Storrs on Friday, October 31, 1941. All arrangements were made by Professor J. A. Manter of the Department of Entomology of the University. Seventy-seven persons registered. The program was as follows:

GREETINGS. Dean C. B. Gentry, University of Connecticut

ARTHROPOD PARASITISM IN A ZOOLOGICAL GARDEN.
Lawrence Penner, University of Connecticut

THE USE OF THERMIONIC CONTROL DEVICES IN PHYSIOLOGICAL WORK.
R. H. Wallace, University of Connecticut

CAN THE CODLING MOTH AND THE APPLE MAGGOT BE CONTROLLED BY TREATMENTS APPLIED BEFORE THE END OF JULY? O. H. Hammer, N. Y. Agr. Expt. Station

STUDY OF "DYNAMITE" TYPE STICKERS FOR ORCHARD SPRAYS.
Philip Garman, Conn. Agr. Expt. Station

DINITRO COMPOUNDS AS INSECTICIDES.
J. L. Horsfall, Amer. Cyanamid and Chem. Corp.

METHODS OF SAMPLING EUROPEAN RED MITE INFESTATIONS.
H. A. Jaynes, Bureau of Ent. and Pl. Quar.

EXPERIMENTS WHICH CONFUSE OUR KNOWLEDGE OF THE DEVELOPMENT OF THE COMMON RED SPIDER AND ITS CONTROL ON GREENHOUSE FLOWERING PLANTS.
W. D. Whitcomb, Mass. Agr. Expt. Station

THE PRESENT STATUS OF THE EUROPEAN SPRUCE SAWFLY IN THE UNITED STATES.
P. B. Dowden, Bureau of Ent. and Pl. Quar.

OBSERVATIONS ON THE EUROPEAN CORN BORER.
R. L. Beard, Conn. Agr. Expt. Station

INSPECTION OF NURSERIES, 1941

M. P. Zappe

The annual inspection of nurseries, as required by Section 2136 of the General Statutes, began on July 1, 1941. The writer, assisted by the regular inspectors, Messrs. A. F. Clark, W. T. Rowe and R. J. Walker, inspected all the larger nurseries during the months of July and August. The smaller ones were inspected in September, and Mr. L. A. Devaux assisted for a few days during the month. He inspected those nurseries which ship stock outside of the area quarantined on account of the Japanese beetle and a few others that were nearby. The regular inspection was completed by the end of September. Several of the nurseries were reinspected to see that pests were properly eradicated. Most of the nurseries were in good condition, as better business during the spring allowed the nurserymen to spend a little more money on cultivation. Some of the smaller nurseries, which consider the nursery business as a side line, were rather neglected.

Altogether, 81 different insect pests and 48 plant diseases were found during the inspection period of 1941. Most of them, however, were of minor importance. San José scale is rather scarce at the present time but the usual amount of oyster-shell scale was found, mostly on lilac, ash, birch and fruit stock. Usually only a few plants in a nursery are infested with oyster-shell scale, and the nurserymen prefer to have the inspectors break the plants or mark them for removal rather than attempt to spray. Spruce gall aphids were about as abundant as usual. Although the inspection records show a very small decrease in the number of nurseries infested with pine leaf scale, there appeared to be more plants infested per nursery. A large number of ornamental plantings around the State show a rather heavy infestation of this insect, giving them a grayish color which is visible at some distance. One of the regulations necessary to grow peach stock in Connecticut is that there shall be no chokecherries

Table 1. Ten-Year Record of Certain Nursery Pests

Pest	1932	1933	1934	1935	1936	1937	1938	1939	1940	1941
Oyster-shell scale	68	78	104	93	87	84	53	49	57	77
San José scale	10	13	19	17	11	8	2	1	2	7
Spruce gall aphids[1]	141	231	244	285	337	306	312	216	231	227
White pine weevil	70	61	67	98	82	101	97	93	70	61
Pine leaf scale	26	46	66	42	72	60	25	50	48	46
European pine shoot moth	77	137	120	121	108	128	130	110	108	106
Poplar canker	40	34	39	28	28	26	20	14	15	15
Pine blister rust	12	11	7	2	0	4	5	3	3	4
Nurseries uninfested	24	22	21	16	26	25	32	19	33	32
Number of nurseries registered	351	362	381	372	380	377	402	399	376	356

[1] Includes both *Adelges abietis* and *A. cooleyi.*

within 500 feet of any block of such stock. This means a careful selection by the nurseryman of a suitable field to grow the stock before peach pits for seedlings are planted. This site must be kept free from chokecherries until the peach trees are dug. In one case a small block of peach trees was refused certification because the owner failed to properly eradicate chokecherries. No peach "X" disease was found in any Connecticut nursery in 1941.

The list of nurserymen for 1941 contains 356 names, a decrease of 20 since 1940. A classification of nurseries by size is given in the following table:

TABLE 2. CLASSIFICATION OF NURSERIES BY AREA

Area	Number	Percentage
50 acres or more	17	5
10 acres to 49 acres	47	13
5 acres to 9 acres	32	9
2 acres to 4 acres	89	25
1 acre or less	171	48
	356	100

The list of Connecticut nurseries varies from year to year. Some of the smaller nurseries, carried as a side line, have been discontinued. Some of the owners have discontinued the nursery business temporarily in order to devote more time to their other business, and a few of them have obtained employment in factories manufacturing war materials. The acreage also changes from year to year, some nurseries increasing their acreage and others decreasing it. The average nursery in 1941 contained a little over 13 acres of growing stock.

Twenty-two nurserymen failed to register before July 1, 1941, and, as provided by Section 2137 of the General Statutes, were charged for the cost of inspection, a minimum of $5.00 in each case. All but five have paid the inspection fee, and $85.00 has been turned over to the treasurer of the Station to be sent to the State Treasury. The nurserymen who failed to pay the cost of inspection were not issued certificates and therefore cannot legally sell their nursery stock.

The cost of inspecting the nurseries, including a few additional visits to see that pests were properly eradicated, was approximately $1,932.35, exclusive of traveling expenses.

Other Kinds of Certificates Issued

During 1941, 159 duplicate certificates were issued to Connecticut nurseries to be filed in other states. Ninety-one dealers' certificates were issued to dealers who do not grow the nursery stock they sell. All this stock is purchased from certified nurseries for resale. Shippers' permits to the number of 205 were issued to out-of-state nurserymen who wished to ship nursery stock into Connecticut. Also, 231 parcels of nursery stock and other plant material were inspected and certified for shipment to accommodate individuals. Two hundred and thirty-nine blister rust control area permits were issued and 6,604 permits for shipment of shelled corn and other seeds, most of which were consigned to foreign countries, mainly South and Central America.

Inspection of Imported Nursery Stock

Foreign nursery stock enters the United States at designated ports of entry under permits issued by the Federal Bureau of Entomology and Plant Quarantine, and some of it is released for transit to destination points, where it is inspected by state inspectors. Other foreign plant material goes directly to Washington, D. C., where it is inspected, freed from pests by fumigation or other methods, and is then released for transit to the consignee. Rose stocks from Europe are inspected by state inspectors, but during the past season no such stock was received, probably because of the European war. The following material entered Connecticut under special permits and most of it was inspected at Washington before arriving in this State.

5,999	orchid plants
925	pounds of seeds
133	shrubs
54	tubes and flasks of orchid seedlings
53	bulbs and tubers
50	perennial plants
27	cactus plants

JAPANESE BEETLE QUARANTINE ENFORCEMENT, 1941

M. P. Zappe and L. A. Devaux

Since the establishment of the Japanese beetle quarantine in Connecticut, the Department of Entomology of the Connectciut Agricultural Experiment Station has cooperated with the Bureau of Entomology and Plant Quarantine of the United States Department of Agriculture in administering the quarantine. The work consists of seasonal scouting of certain nursery and greenhouse properties and their sources of sand, soil and manure for classification purposes; the inspection and certification of all articles included in the quarantine regulations, and other tasks necessary to the operation of the quarantine.

The State is divided into two sections, using the gypsy moth quarantine line as a boundary. The section of the State within the gypsy moth quarantined area, which includes Hartford, Middlesex, New London, Tolland and some towns in eastern Litchfield and New Haven counties, is under the supervision of Mr. H. N. Bartley, in charge of the federal Japanese beetle office at Waltham, Mass. His inspectors make the necessary inspections to comply with the Japanese beetle and gypsy moth quarantines, and European corn borer inspections as required by certain states. In the rest of the State the inspections are made from the New Haven office at the Experiment Station.

During the past year, because of the rush during the shipping seasons, Mr. L. A. Devaux, of the New Haven office, performed the necessary inspection service for the gypsy moth quarantine in the towns of Branford and North Haven. Mr. A. S. Beecher, also of the New Haven office, assisted in this work when available.

Scouting

Scouting for the Japanese beetle has been conducted yearly, and the procedure followed during the summer of 1941 to determine whether or not adult beetles were present on classified properties was similar to that of preceding years. Three crews were used to carry on this work, two of which were under the supervision of the Waltham office, each consisting of one foreman and two scouts. This work was begun on July 14 and finished September 4. The third crew, working out of the New Haven office, was composed of the two regular district inspectors, no extra men having been hired. Each crew followed a prepared itinerary as in previous seasons. They scouted 20 nursery, greenhouse or other similar establishments and their subdivisions, a total of 30 units, three to five times. The minimum distance examined around each establishment was 500 feet. A total of 166 adult beetles was found on or within 500 feet on 16 of the units scouted. The crews also scouted the premises of 18 dealers in sand, soil and manure and found 36 beetles on four of these establishments. In addition, four woodland properties were scouted and one beetle was found on one of these units. The discovery of infestations on scouted premises resulted in four changes in classification and 13 establishments dropping their classified status under the quarantine regulations.

Beetles were found in Avon, East Hampton, Middlebury and Redding for the first time. There are 87 towns now known to be infested and probably many more that have not come to our attention.

Inspection and Certification

The total number of plants inspected and certified for shipment to other states and foreign countries was 6,179,405.

The number and kinds of certificates issued are shown in the following table:

Table 3. Number of Certificates Issued, 1941

Kind	Farm products	Cut flowers	Nursery and ornamental stock	Sand soil	Manure	Total
"A"	0	70	5,380	8	0	5,458
"B"	0	0	5,852	0	1	5,853
Total	0	70	11,232	8	1	11,311

As in past seasons, the district inspectors were able to make the necessary farm products quarantine inspections in addition to their regular duties. These were few in number and consisted of 70 boxes of cut flowers. No inspections were made of farm products material because no towns in Connecticut required such inspection and certification.

Treating

During the period of June 28 to July 1, inclusive, Messrs. Beecher and Devaux supervised the treating of nursery stock with arsenate of lead, in compliance with the Japanese beetle quarantine regulations. Four nurseries treated 13,773 trees, using a total of 6,638 pounds of lead arsenate, which was applied at the rate of 1,100 pounds to the acre. The nurseries began moving such treated stock on and after October 1.

INSPECTION OF APIARIES, 1941

M. P. Zappe

On July 1, 1941, an additional apiary inspector, Mr. Elbra L. Baker of Brooklyn, Conn., was appointed and started to work. The State was divided into three sections, and one inspector assigned to each. Mr. W. H. Kelsey worked in Litchfield and Hartford counties and the western part of Tolland County. Mr. Roy Stadel had Fairfield, New Haven and Middlesex counties and Mr. Baker worked in the eastern third of the State.

A total of 2,222 apiaries consisting of 10,720 colonies of bees were inspected, this year being the first time all the known apiaries were inspected in every town in the State. The apiaries averaged 4.8 colonies each, as against 5 colonies in 1940 (Table 4). There were 429 colonies in 187 apiaries in 71 towns infected with American foul brood (Table 5), which was a slight increase over 1940; but the percentage of diseased colonies was 4.0 in 1941 (Table 6) and 4.3 in 1940, which shows a slight decrease. The reason for this is the fact that over 2,000 more colonies of bees were inspected in 1941 than in 1940 so that the percentage of foul brood was less in 1941, even though the actual number of diseased colonies was greater than in the previous year. Most of the diseased colonies were found in Fairfield and New Haven counties, only one being found in the County of Tolland and 11 in Windham (Table 5). Some of the apiaries were

TABLE 4. THIRTY-TWO YEAR RECORD OF APIARY INSPECTION

Year	Number apiaries	Number colonies	Average No. colonies per apiary	Average cost of inspection per apiary	per colony
1910	208	1,595	7.6	$2.40	$.28
1911	162	1,571	9.7	1.99	.21
1912	153	1,431	9.3	1.96	.21
1913	189	1,500	7.9	1.63	.21
1914	463	3,882	8.38	1.62	.19
1915	494	4,241	8.58	1.51	.175
1916	467	3,898	8.34	1.61	.19
1917	473	4,506	9.52	1.58	.166
1918	395	3,047	7.8	1.97	.25
1919	723	6,070	11.2	2.45	.29
1920	762	4,797	6.5	2.565	.41
1921	751	6,972	9.2	2.638	.24
1922	797	8,007	10.04	2.60	.257
1923	725	6,802	9.38	2.55	.27
1924	953	8,929	9.4	2.42	.25
1925	766	8,257	10.7	2.45	.22
1926	814	7,923	9.7	2.35	.24
1927	803	8,133	10.1	2.37	.234
1928	852	8,023	9.41	2.12	.225
1929	990	9,559	9.55	2.19	.227
1930	1,059	10,335	9.76	2.01	.206
1931	1,232	10,678	8.66	1.83	.212
1932	1,397	11,459	8.2	1.60	.195
1933	1,342	10,927	8.1	1.69	.208
1934	1,429	7,128	4.98	1.40	.28
1935	1,333	8,855	6.64	1.556	.234
1936	1,438	9,278	6.45	1.429	.221
1937	1,437	10,253	7.1	1.28	.18
1938	1,609	10,705	6.7	1.18	.177
1939	1,627	8,936	5.5	1.12	.204
1940	1,719	8,552	5.0	1.33	.268
1941	2,222	10,720	4.8	1.16	.239

TABLE 5. INSPECTION OF APIARIES, 1941

County	Number of towns	Apiaries Inspected	Apiaries Diseased (Am. f. b.)	Colonies Inspected	Colonies Diseased (Am. f. b.)
Fairfield	23	346	68	1,748	176
New Haven	27	278	45	1,466	107
Middlesex	15	144	7	919	15
New London	21	235	16	1,271	35
Litchfield	26	348	18	1,578	40
Hartford	29	540	30	2,483	44
Tolland	13	167	1	548	1
Windham	15	164	2	707	11
	169	2,222	187	10,720	429

TABLE 6. SUMMARY OF INSPECTION

	Apiaries	Colonies
Inspected, 1941	2,222	10,720
Infected with American foul brood	187	429
Percentage infected	8.4	4.0
Colonies treated		8
Colonies destroyed		421
Average number of colonies per apiary		4.8
Average cost of inspection	$1.16	$ .239
Total cost of inspection, 1941	$2,567.56	

visited twice so that all diseased colonies could be destroyed. All of the diseased colonies were infected with American foul brood. No sacbrood was found in 1941.

TABLE 7. FINANCIAL STATEMENT
January 1, 1941—December 31, 1941

Disbursements		
January 1 to June 30, 1941:		
Salaries	$ 516.00	
Travel	333.26	
		$ 849.26
July 1 to December 31, 1941:		
Salaries	$1,014.00	
Travel	704.30	
		1,718.30
Total disbursements for 1941		$2,567.56

Registration of Bees

Section 2129 of the General Statutes provides that: Each bee-keeper shall register his bees on or before October 1 of each year with the town clerk of the town in which the bees are kept, and that each town clerk, on or before December 1, shall report to the State Entomologist whether or not any bees have been registered and, if so, shall send a list of names and number of colonies belonging to each. In 1941, 2,222 apiaries containing 10,720 colonies were inspected. However, only 1,479 apiaries and 7,947 colonies were registered. This shows that 743 more apiaries and 2,773 more colonies were inspected than were registered by the town clerks. No doubt there are still some apiaries that have not been inspected in this State because the bee inspectors have been unable to locate them due to their not being registered in the towns where they are kept.

REPORT ON CONTROL OF THE GYPSY MOTH[1]

J. T. Ashworth, Deputy in Charge

During the past year, gypsy moth cnotrol work has been carried on as previously. Trees in the open and woodland were examined during the fall, winter and early spring for egg masses, which were destroyed when found. In the spring infestations were sprayed with lead arsenate to reduce the abundance of, or possibly eradicate, the gypsy moth locally. During the summer infested areas were patrolled to detect gypsy moth caterpillars. Such work, in one form or another, was carried on in 61 towns in all sections of the State (Table 8) with the cooperation of the United States Bureau of Entomology and Plant Quarantine, and the C. C. C. This cooperation is greatly appreciated and the writer here expresses his gratitude to Mr. A. F. Burgess, who has general supervision of gypsy and brown-tail moth control operations for the Bureau of Entomology and Plant Quarantine; Mr. H. L. Blaisdell, in charge of field work under Mr. Burgess; Mr. S. S. Crossman, under whose direction gypsy moth control work was carried on in the various C. C. C. camps in Connecticut, and to Mr. A. F. Hawes, State Forester, who has general supervision of the C. C. C. camps.

Control Operations

Work Performed by State Men

In addition to the usual control work performed by state men, several related projects were carried on this year. Nursery scouting for infestations were carried on in six counties. Type mapping, which was started in September, 1939, and a description of which will be found in the previous report, was continued this year and 10 additional towns were completed in New London and Windham counties. Red pine plantations in six counties were examined to determine the severity of the European pine shoot moth infestation. The detailed account of work performed by state men in the various counties is given below.

Hartford County: Scouting work was performed in the towns of Hartford, Manchester, Rocky Hill, South Windsor and Windsor, infestations of gypsy moth being found in all these towns except Hartford. During the larval season, the towns of Berlin, Bloomfield, East Hartford, Glastonbury, Southington and West Hartford were patrolled, larvae or pupae being found at points visited. Spraying operations were carried out at one infestation in Simsbury, 528 pounds of arsenate of lead being used, and one infestation at Rocky Hill, which required 688 pounds of arsenate of lead.

Litchfield County: State crews operated in the towns of Colebrook, Roxbury and Kent, and infestations were found in all towns

[1] July 1, 1940, to June 30, 1941, inclusive.

TABLE 8. SUMMARY OF GYPSY MOTH CONTROL[1], 1940-41

County	Number of towns worked	Infestations found	Egg masses creosoted	Number of colonies sprayed	Lbs. of lead arsenate used	Larvae, pupae crushed	Bands applied	Miles scouted	Acres scouted	Acres cleaned
Hartford	16	50	8,740	2	1,216	49,769	46,738	117	6,330	857
Litchfield	21	188	4,580	12	36,712	10,851	234,619	355	92,904	161
Middlesex	4	24	623	1	1,968	1,497	6,271	16	3,192	281
New Haven	5	8	158	1	7,893	8,188	15,768	70	11,678	78
New London	3	39	969	0	0	274	0	56	1,220	0
Tolland	4	23	1,085	0	0	260	0	89	101	0
Windham	8	189	7,841	0	0	1,554	0	302	1,664	0
	61	521	23,996	16	47,789	72,393	303,396	1,005	117,089	1,377

[1] Total for all agencies.

but Roxbury. The towns of Colebrook, Kent, Roxbury and Salisbury were visited in the larval season, caterpillars being found at points visited.

Middlesex County: The only control work carried on in this county by state men was the spraying of one infestation in Cromwell, this operation requiring 1,968 pounds of arsenate of lead.

New Haven County: During the larval season, state men patrolled infested areas in Southbury, finding caterpillars at points visited.

New London County: A larval scout was carried on in Stonington, caterpillars being found at points visited.

Tolland County: The following towns were scouted in this county: Ellington, Stafford and Union. No colonies were found but scattered gypsy moth egg masses were found in Stafford and Union. A larval scout was also carried on in Stafford and Union, caterpillars being found in both towns.

Windham County: Scouting work was performed in Hampton, several egg masses being found. The towns of Canterbury, Sterling and Thompson were patrolled during the larval season and caterpillars were found in all these towns.

During the year state men performed work in one form or another in 26 towns in Litchfield, Hartford, Middlesex, New Haven, New London, Tolland and Windham counties. One hundred seventeen miles of roadside and 1,764 acres of open country and woodland were scouted, and 7,780 egg masses and 8,199 larvae and pupae were destroyed. Spraying operations were carried on in three infestations, using 3,184 pounds of arsenate of lead.

Work Performed by C. C. C. Men

During the past season, C. C. C. crews worked in 27 towns in all counties of the State but Fairfield. They scouted 22,390 acres of open and wooded country and 482 miles of roadside, cleaned and removed underbrush from 1,300 acres, and destroyed 12,456 egg masses. Ninety-five thousand five hundred twenty-one trees were banded in infested areas and, when patrolling these bands in the larval season, 50,856 larvae and pupae were destroyed. State men continued patrolling these bands when C. C. C. gypsy moth work was discontinued in the camps. C. C. C. men sprayed one infestation in Meriden, using 7,893 pounds of arsenate of lead, and three infestations in Barkhamsted, using 12,956 pounds of arsenate of lead. State men were supplied to run the spraying equipment and to direct the application of spray material.

Work Performed by the W. P. A.

During the past season, W. P. A. crews supervised by the U. S. D. A., Bureau of Entomology and Plant Quarantine, carried on control operations in 21 towns in Hartford, Litchfield and New Haven counties. They cleared the underbrush from 77 acres and scouted 406 miles of roadside and 92,935 acres of open and wooded country, destroying 3,760 egg masses and 13,338 larvae and pupae. Previous to the larval season, they applied 207,875 bands to trees in and around infested areas. W. P. A. men sprayed nine infestations in six towns in Litchfield County, using 23,756 pounds of arsenate of lead.

The above record includes work done in Kent, Roxbury, Salisbury and Southbury by state crews. This was not a duplication, but work in which state men were used when federal men were not available.

Brown-Tail Moth Control

There was no brown-tail moth scouting project carried on in Connecticut during the 1940-41 season.

DUTCH ELM DISEASE

M. P. Zappe

During the past year this Station has continued its cooperation with the United States Bureau of Entomology and Plant Quarantine in the suppression work on the Dutch elm disease. The Bureau of Entomology does the scouting and control work and this Station carries on research and assists in obtaining permission from landowners when control measures are necessary on their property. This Station also cultures samples from trees in towns not previously known to be infected to confirm the findings of the federal laboratory. If cultures from these trees prove to be positive the trees are cut and burned. Dr. F. A. McCormick of the Department of Plant Pathology has made these cultures as in previous years.

Owing to a scarcity of W. P. A. labor and a shortage of regular funds, the work in the known infected area was radically curtailed this year. In this area highways, village and city streets, and areas containing valuable elms were scouted and control measures carried on as usual, but no swamp or woodland areas were scouted. Two meetings of tree workers and town tree wardens were held, one in New Haven and the other in Fairfield. At these meetings those present were asked to cooperate in the Dutch elm disease program by reporting suspected trees either to this Station or to the federal Dutch elm disease headquarters at Bethel.

The scarcity of relief labor and skilled climbers made it necessary for owners of diseased elms to have these trees felled at their own expense if they needed topping, but the federal department would then remove and burn the elm logs and larger branches.

The area outside of the known infected zone was thoroughly scouted for a distance of 15 miles from the old boundary. This scouting resulted in the discovery of diseased trees in 11 towns not previously known to be infected, as follows: Clinton, Cornwall, Goshen, Haddam, Kent, Meriden, New Hartford, Plymouth, Southington, Thomaston and Washington. Diseased trees in these towns were immediately felled and burned to reduce the chance of any further spread from these centers. A total of 19 trees were found in the above-mentioned towns. There has been no change in the Preston area during the year. Beetle breeding material was disposed of and no new diseased trees have been discovered in this area.

During the year we succeeded in getting some of the light, power and telephone companies to issue orders to their employees and subcontractors to dispose of all elm wood by burning. When these companies have cut new right-of-ways for the erection of their lines, they have been in the habit of giving the wood to landowners, but with the new plan elm wood is burned, thus reducing the amount of bark beetle breeding material. The State Highway Department has been doing this for some time.

The Federal Department of Agriculture revised the Dutch elm disease quarantine, effective October 1, 1941. This revision added several new towns to the area already under quarantine. As far as Connecticut is concerned the new quarantine now includes all of Fairfield County; the towns of Bethlehem, Bridgewater, Harwinton, Litchfield, Morris, New Milford, Roxbury, Thomaston, Torrington, Washington, Watertown and Woodbury in Litchfield County; all of New Haven County except the towns of Cheshire, Madison, Prospect and Wolcott. It also includes the Town of Preston in New London County. The state quarantine was revised to coincide with the federal one and the revision became effective November 1, 1941.

During the year 138 diseased trees were found and destroyed.

RODENT CONTROL

Howard A. Merrill, Assistant District Agent

Fish and Wildlife Service, U. S. Department of the Interior
cooperating with the Connecticut Agricultural Experiment Station

During the year research on various phases of the control of injurious rodents has been continued. Studies on the ecology, life history and control of pine mice (*Pitymys pinetorum*), the cyclic tendency of meadow mice (*Microtus pennsylvanicus*), and the effectiveness of repellents to protect trees and shrubs against cotton-tail rabbits (*Sylvilagus transitionalis* and *S. floridanus mallurus*) have been of primary importance.

Pine Mice

Part of the necessary information in the development of a control method is definite knowledge of the food habits of the animal.

During all of the ecological and life-history studies made to date the stomachs of trapped animals have been preserved. During April a method of determining the presence of apple tree roots in these stomachs was developed at the Patuxent Research Refuge at Bowie, Maryland, in conjunction with Messrs. A. C. Martin, D. A. Spencer and H. J. Spencer. The study of stomach contents will be completed with the aid of equipment from the University of Connecticut.

Study plots were established during January and February on which traps were set to determine the activity of pine mice. Of the traps set, half were surface sets (just below the grass and leaf litter) and half were underground sets (below the frost line, which was 6 to 8 inches). Activity was by far the greatest below the frost line, but difficulty was encountered in trapping the animals there because of the frequency with which the traps were covered with dirt incidental to the repair of their runways by the mice.

The movement of soil has always caused a difficult problem in the control of pine mice. Any movement of soil is likely to cover the poisoned bait which is placed directly in the underground burrows or in the surface runways. For this reason it is important to know if and when there are any periods of the year that mice are less likely to be moving soil. There are many reasons for the movement of this soil, and as soon as they can be determined more progress in the method of bait placement can be made. It is already definitely known that during the fall months, when the mice are preparing to store a winter's supply of food, they must remove considerable soil to provide for storage space. It is also definitely known that in light, sandy soils shallow burrows may be disturbed during spraying or apple picking operations, thus causing the mice to do much repair work which requires the movement of soil. Objects, such as accumulated mulch, fertilizer bags, etc., cause mice to build up much soil under them, especially in light, sandy soils with light vegetative cover (Figure 1). More information is necessary along these lines before definite control recommendations can be made.

In order to obtain further information regarding the placement of poisoned baits, a number of mouse burrow systems were excavated. It was found that the nest and food caches are generally located within one or two feet of the trunk of the tree and are usually six to ten inches below ground. The exact depth to which the underground burrows extend is not definitely known; however, many burrows were excavated to a foot below the surface. The majority of the deeper underground burrows are close to the trunk of the tree, coming nearer the surface as they reach the drip line. Most of the underground burrows come to the surface near the outer margin of the tree. The average colony size in Connecticut rarely exceeds four to six mice per tree. Even with this population the trails (both surface and underground) may be restricted to the area under one-half or even one-quarter of the tree. This fact makes it necessary to

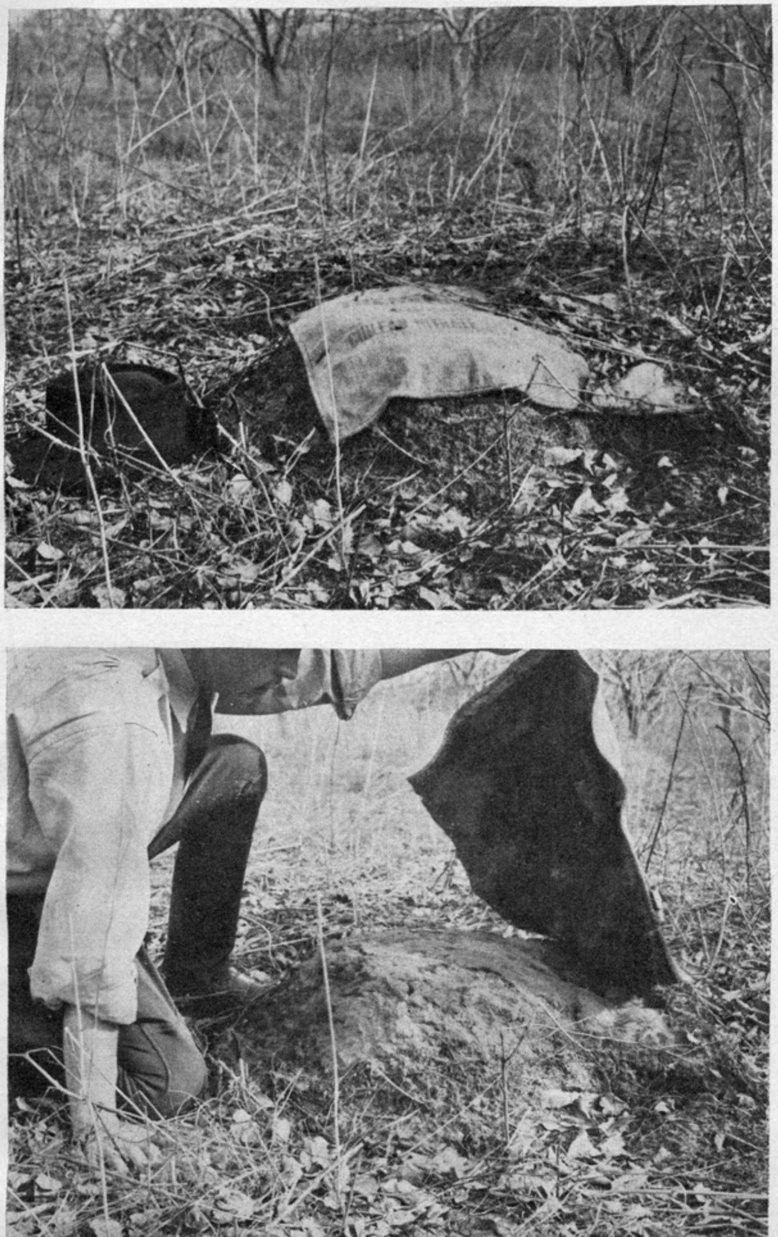

Figure 1. Mound built by pine mice under old fertilizer bag and, below, same mound exposed.

examine the entire area under each tree before it can be definitely determined that there are no mice present.

Meadow Mouse Population Cycle

During May a survey was made to determine any changes in the meadow mouse population. At the same time that this study was made in Connecticut similar studies were made in all of the Northeastern States, and this data is correlated in this report. Indications pointed toward increased Microtus pressure in orchards this fall. The infestation was more general in the northern part of the Northeast, graduating to variable and spotted in the southern sector. Populations in the best habitats more than doubled over figures obtained in 1940.

A very logical explanation of the present variable distribution in numbers is afforded by the history of the present cycle. The spring die-off in 1939 (the low of the present cycle), followed by a summer and winter both unfavorable to Microtus, was more severe than first supposed. In large areas, especially in the southern regions, it amounted to almost complete eradication except for scattered "islands". The effect was less severe in the northeastern sector of the Northeastern States. These "islands" of breeding stock made recoveries depending on food, cover and predator pressure. Naturally, many good habitats show little or no infestation because the spread of Microtus from surviving "islands" has not been great enough to populate the entire area.

A survey was made in September and it was found that Microtus populations were definitely at a higher level in the Northeast than during a similar period in 1940. The upswing in the fluctuation of numbers, which has been constant since the spring of 1939, was rather radically checked this fall by the late summer drought. This resulted in the distribution again being very spotted. However, dangerous concentrations of Microtus were found in orchards having the best cover.

Rabbit Repellents

Various repellents, most of them prepared by the Research Laboratory, were tested under pen conditions. Twelve wild rabbits (*Sylvilagus transitionalis* and *S. floridanus mallurus*) trapped during February and March were used in the tests, one per pen (approximately 30 by 30 feet). The natural vegetative cover was upland brush type, consisting of the following sprouts: red and white oaks, hickory, red maple, gray birch, aspen, sumac, spirea, raspberry, etc. Some trouble was encountered in maintaining a supply of rabbits; four died and three escaped. Although a three-foot (one-inch mesh) chicken wire was used with three feet of two-inch mesh poultry wire above it, the rabbits were still able to climb the fine wire and crawl through the two-inch mesh. Four rabbits died of so-called "shock disease", probably due to being caught in traps and being held in partial confinement, which resulted in a depletion of the glycogen reserve in the liver.

Freshly cut apple tree prunings (McIntosh variety) were used in the tests. These were cut into two-foot lengths, and all in a given pen were of uniform diameter. The prunings varied in size and were grouped into three classes: 1-5 mm., 5-10 mm., 10-20 mm. For each pruning treated with a repellent an untreated was used as a control. The various treated prunings and the controls were alternated, i. e., A—Control—B—Control—C—Control—D—Control. A, B, C and D were all different repellents and the arrangement was repeated until five prunings of each repellent were used.

The repellents were applied to the prunings at room temperature (70 degrees F.) and placed in the pens the following day. Observations were made each day to record the amount of damage. Decided variations were observed in the effectiveness of the various repellents on individual rabbits (Table 9).

TABLE 9. SUMMARY OF TESTS

Repellents used in test	Pen No.	Repellents listed in order of effectiveness
Nos. 78, 109, 112, 120	1	120, 78, 109, 112
	2	109, 120, 112, 78
	3	112, 78, 109, 120
Nos. 111, 116, 117a, 122	5	122, 111, 116, 117a
Nos. 59, 96a, 114, 129	7	None damaged except 129
	8	One nick on 59 and 96a
Nos. I, II, III, IV	3	IV, II, I, III
	4	IV, III, II, I
	8	III, II, IV, I
	10	III, II, IV, I
	11	II, III, IV, I
Nos. 111, 114, 129, IV	7	111, IV, 129, 114
	12	111 and 129 no damage, 114, IV
Nos. 78a, 112, 116, I, II, III	1	None damaged except 116
	4	None damaged except I
	11	III, II, 116, I, 78a, 112
Nos. 59, 96a, 109, 133, III, IV	1	None damaged except 96a, 59
	4	None damaged except 59
	7	96a, IV no damage, 109, III, 133, 59
	11	None damaged except 133
	12	None damaged except 59

The following repellents were used:

No. 59 Ethylene chloride, rezyl, asafoetida.
No. 78a Asphalt emulsion, methyl alcohol, copper carbonate.
No. 96a Rezyl, asphalt emulsion, ethylene chloride, copper sulfate, copper carbonate, lime sulfur.

No. 109	Rezyl, asphalt emulsion, ethylene chloride, copper carbonate, lime sulfur.
No. 111	Asphalt emulsion, ethylene chloride, copper carbonate, lime sulfur, dicalite.
No. 112	Rezyl, ethylene chloride, copper carbonate, lime sulfur, dicalite.
No. 114	Asphalt emulsion, ethylene chloride, free nicotine, dicalite.
No. 116	Rosin, methyl alcohol.
No. 117a	Rezyl, ethylene chloride, Monsanto arochlor #2565, dicalite.
No. 120	Asphalt emulsion, rezyl, copper carbonate, calcium carbonate.
No. 122	RSL resin, rezyl, ethylene chloride, copper carbonate, lime sulfur.
No. 129	Rezyl, ethylene chloride, lime sulfur.
No. 133	Composition unknown.
No. I[1]	Bordeaux mixture, water.
No. II[1]	Bordeaux mixture, asphalt, water.
No. III[1]	Bordeaux mixture, asphalt, ethylene chloride.
No. IV	Bordeaux mixture, rezyl, ethylene chloride.

The repellents showing the greatest promise are: Nos. 96a, 109 and 111. At this time no definite evaluation can be given the various repellents; however, No. 59 (asafoetida), No. 114 (free nicotine) and No. 117a give little promise. All of the repellents showed a decided repelling effect, but under pen conditions, where there is a possibility of forced feeding, all of the treated material was damaged to a certain extent.

During the repellent tests the rabbits were feeding on sumac, gray birch, red and white oak, hickory, red maple, aspen and raspberry. Many of these plants are seldom eaten to any extent in the wild, showing that there was not an overabundance of food. During the last part of the tests small amounts of supplemental feed were added to the pens to insure the health of the rabbits. Lettuce and a prepared commercial rabbit ration were added.

Asphalt and rezyl both act as repellents, as was shown very clearly in the bordeaux tests. The plain bordeaux was much more severely damaged than the bordeaux-rezyl or the bordeaux-asphalt combinations. Asphalt appears to be more of a repellent than does rezyl. No definite data is available to show whether the coppers or the sulfates have the greatest repelling effect. However, those repellents which have both the copper and the sulfates gave the best results.

That several of the materials may be sufficiently effective to repel rabbits under natural conditions is shown by tests conducted in the University experimental orchard. On March 20 a number of trees were treated in the experimental orchard where a great deal of damage had taken place during the past three months. There are 56 trees in the test plot: 14 were treated with 96a; 14 were treated with "Rodent Repellent" (Castle Chemical Company); 14 are protected with 18-inch wire guards; and 14 are unprotected. During the past three months the following damage has been done to the trunks of the trees:

[1] Not prepared at the Research Laboratory.

Repellent	No. trees damaged	Amount damaged, in inches
96 a	2	3, 6
"Rodent Repellent"	7	2, 4, 1, 3, 3, 3, 8
Wire guard	0	....
Unprotected	9	2, 6, 5, 1, 3, 2, 12, 12, 8

In addition to the damage done on repellent-treated areas there was considerable damage done above the repellents and above the wire guards as follows:

96a	7 trees
"Rodent Repellent"	9 trees
Wire guard	6 trees
Untreated	4 trees

On untreated trees the damage was 18 inches or more above ground level.

MOSQUITO CONTROL[1]

R. C. Botsford, Agent,
State Board of Mosquito Control

This report covers the calendar year 1941 and gives a brief summary of the season's work. The State has accepted for maintenance 11,000 acres of salt marsh and is legally obliged to keep the ditches, dikes, tide gates, etc. in good condition in that area. At the last meeting of the Legislature the appropriation for the fiscal year of July 1, 1941, to June 30, 1942, was increased to $20,000, which should be adequate to properly care for the 11,000 acres mentioned above if labor is available.

Up to July 1, while operations were carried out under the old appropriation, not all of the marshes could be kept in good condition. The regular field work began in April with a total of eight men in the crews. Tide gates were put into operation and clogged outlets cleaned. No systematic work could be done renewing ditches, as it became necessary to attend to actual mosquito breeding spots. Some mosquitoes escaped in scattered areas, particularly in Clinton, Guilford and Fairfield. After July 1 the crews were increased to a total of 19 men who worked steadily until December 19. The ditches on 8,000 acres were cleaned and put in excellent condition. In some marshes these ditches had become nearly filled with mud, entailing considerable labor to bail them out. It is estimated that one crew removed 125 tons of such mud in one week. Vulnerable areas were inspected throughout the season and the crews were assigned to areas where work was most urgent. Suitable labor could not be found in Groton and Stonington so no work was done in those two towns. The ditches remained in fair condition, however, and no mosquito nuisance was reported.

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[1] The control of mosquitoes is carried out under a State Board of Mosquito Control and is not a function of the Agricultural Experiment Station. This report is published here as a matter of convenience.

The construction of new tide gates, dikes and special outlets by the W. P. A., sponsored locally or by the Board, which has been previously reported, has greatly improved the operation of drainage systems and facilitated the maintenance of areas accepted by the State. When the unemployment situation was relieved several proposed improvements planned by the W. P. A. were abandoned, and the dike and jetties at Great Harbor, Guilford, and a dike at Stony Creek, Branford, were left unfinished.

REPORT ON PARASITE WORK

PHILIP GARMAN, W. T. BRIGHAM, J. C. SCHREAD and G. R. SMITH

Oriental Fruit Moth

This year we supplied 226 colonies of larval oriental fruit moth parasites to 89 growers on order. Eighty-six additional colonies were placed in their orchards wherever the infestation appeared to be threatening. The actual number of larval parasites used for colonization was 69,645, as compared with 66,185 in 1940.

The average larval parasitism during July was 44.7 percent, compared with 31.6 percent for 1940, a gain of 13.1 percent; and the egg parasitism for the same month was 62.7 percent, as compared with 41.8 percent last year.

This gain in parasitism, together with a very general reduction in moth population, brought about by various climatic factors, resulted in a decreased infestation at harvest. An examination of fruit from about 20 orchards scattered over the State indicated that the average infestation in 1941 was only 4.6 percent, whereas a similar average in 1940 was 14.8 percent higher, or 19.4 percent. This year only an occasional orchard appeared to have enough fruit moth larvae in the fruit to be noticed by the consumer.

Examination of our records since 1936 indicates a steady rise of both larval and egg parasitism of the oriental fruit moth, accompanied by a steady decline of the average Elberta infestation throughout the State since 1938 (Figure 2). Macrocentrus has now become fairly abundant in sections of the State where it was scarce or absent 10 years ago. If the present level of parasitism remains the same

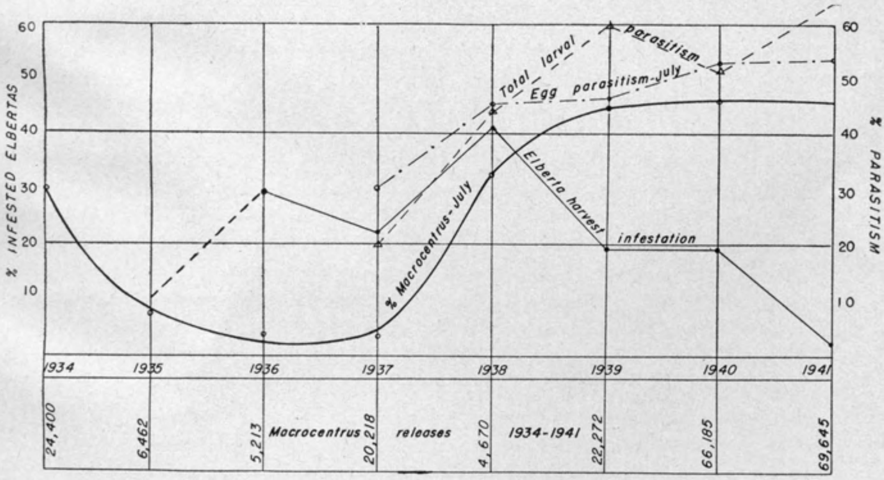

Figure 2. Chart showing trend of oriental fruit moth parasitism since 1934, in connection with fruit infestation at harvest and yearly Macrocentrus liberations.

during the next two or three years we may expect a very low amount of fruit moth damage. Should the cycle of fruit moth abundance behave as it has since 1928 and 1929, we may further expect the infestation to remain low and begin rising about 1946 or 1947.

During the last three years intensive studies have been made of the parasite supply in sumac seed clusters and also ragweed stems in or near peach orchards. It has been found that *Glypta rufiscutellaris* Cresson has an important secondary host in ragweed stems and this has a bearing on its abundance in Connecticut. Intensive cultivation would destroy this source of supply and probably effect an increase of fruit moth infestations. The detailed results are given in another paper.

Japanese Beetle

Our efforts this year were confined largely to distribution of the new "milky" disease (*Bacillus popilliae* Dutky). Spore dust was supplied by the U. S. Bureau of Entomology and Plant Quarantine, which manufactured it from 100,000 grubs dug in Connecticut by our men. Approximately 1,000 pounds of spore dust were used this year and a total of 467 properties received treatments. This represents a total of about 751 treated acres. The method of application is shown in Figure 3. A majority of the treatments were made in Fairfield County, although some were made in and around Hartford and New Haven.

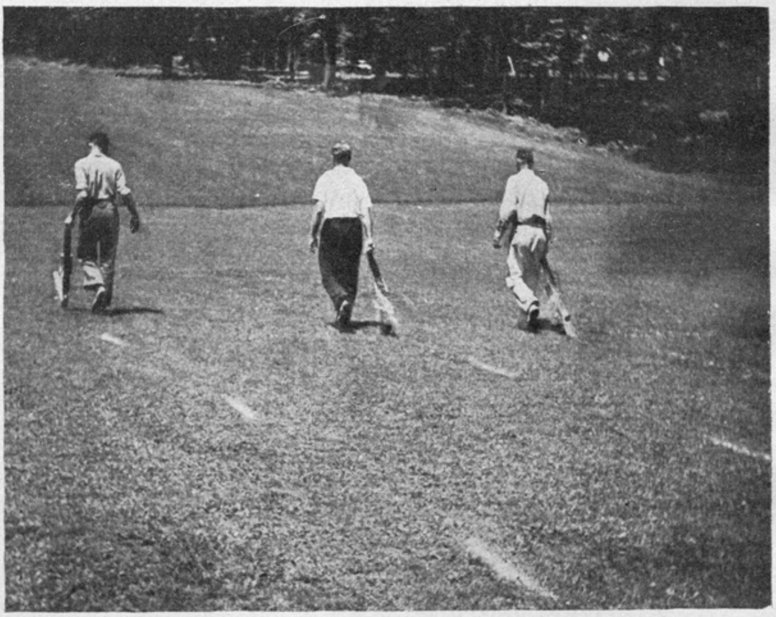

Figure 3. Distributing spore dust of the bacteria causing milky disease of the Japanese beetle.

Continued checks of our experimental plots indicate a fairly high percentage (18-28 percent) of disease in two of the 25. Diseased grubs were found in six different plots as well as a number of untreated check areas.

Sixteen additional colonies of *Tiphia vernalis* were placed in various sections of Connecticut and observations continue to indicate survival of both *T. vernalis* and *T. popilliavora.*

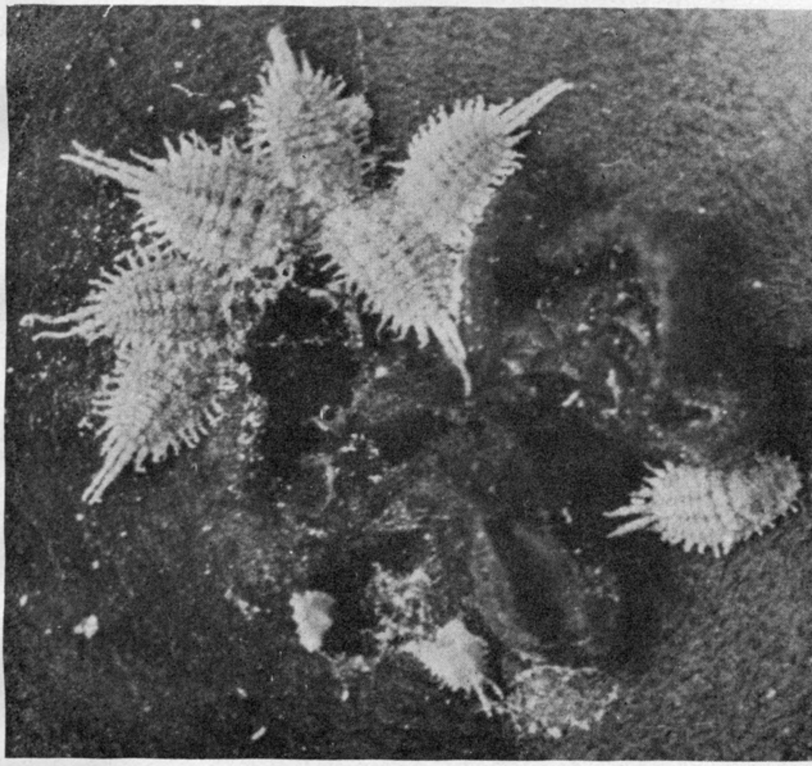

Figure 4. Comstock's mealybug, a new fruit pest for Connecticut. Adult bugs in the calyx end of a pear.

Comstock's Mealybug

The alarming increase of Comstock's mealybug (Figures 4 and 5) on pears at Conyers Farm in Greenwich caused us to seek parasites for this insect. Through the courtesy of the U. S. Bureau of Entomology and Plant Quarantine, Department of Foreign Parasite Introduction, we secured a shipment including *Allotropa* (No. 1), approximately 1,800 individuals; *Leptomastix* sp., 500 individuals; and *Clausenia purpurea*, 425 individuals. These were released on July 24 and August 1, 1941. One recovery collection in October showed the presence of *Allotropa* sp. in considerable abundance. A single specimen of *Clausenia purpurea* was also reared, but no *Leptomastix* were found.

Personnel. This year we employed four temporary assistants. Miss Root carried on laboratory work with the oriental fruit moth, and Messrs. McVey, Chapman and Evans assisted in distribution of the milky disease. Valuable assistance was given by Mr. A. DeCaprio, who spent several weeks in New Jersey collecting Macrocentrus parasites.

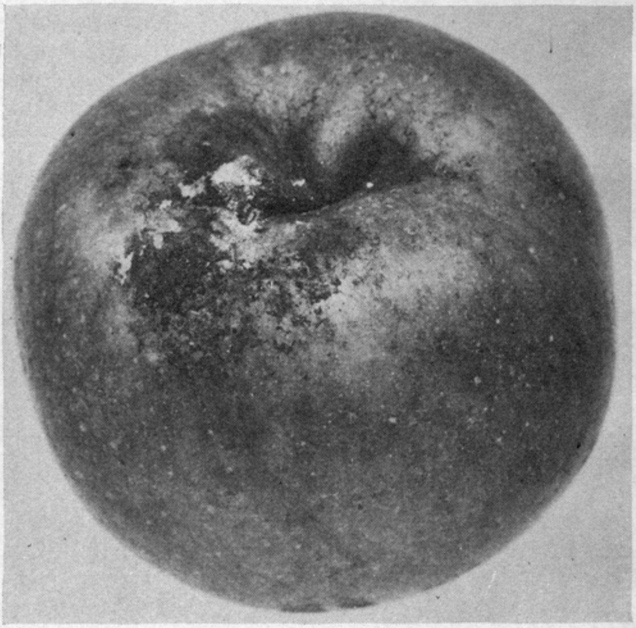

Figure 5. Effect of Comstock's mealybug on apples.

ALTERNATE HOST STUDY OF THE PARASITES OF THE ORIENTAL FRUIT MOTH[1]

John C. Schread, W. T. Brigham and G. R. Smith

The important larval parasites of the oriental fruit moth (*Grapholitha molesta* Busck) are not abundant during early summer in Connecticut. First brood fruit moth larvae appear in late May and early June and are seldom heavily parasitized, probably due to low populations of both host and parasites. This condition has been overcome to a certain extent in the case of *Macrocentrus ancylivora* Rohr. (Braconidae), which is annually released in sufficient numbers

[1] For aid in the identification of some of the parasites we are grateful to C. F. W. Muesebeck, R. A. Cushman and A. B. Gahan of the U. S. National Museum.

in the peach orchards of the State to relieve the situation. There are a number of other fruit moth enemies, however, such as egg, larval and pupal parasites, which play an important part in the host-parasite complex. Very little is known about these parasites and their relation to the fruit moth. Some appear during the first brood of fruit moth larvae and others not until the later broods are present in the orchards. Where they come from in the spring, and where they go to in the fall, has become largely a matter of speculation; but it is certain that at least some of them must pass the winter in alternate hosts because the fruit moth winters in the larval stage in a cocoon.

From 1938 through 1941 two types of vegetation conspicuous for their abundance of insect enemies were selected as probable reservoirs of parasitic forms of insect life with the possibility that some of them would be recognized as known parasites of the oriental fruit moth. During the first year, 1938-39, sumac was investigated exclusively because it is abundant in all parts of the State, easily accessible and obtainable, can be handled with ease, and requires no special outlay of funds and equipment. Sumac grows along roadsides, in pastures, abandoned meadows and on waste lands. It has considerable value from the apiarist standpoint, as the honey produced from the nectar gathered from its flowers is unexcelled.

The species collected were the staghorn sumac (*Rhus typhina* Linn.), a tall shrub or small tree which in Connecticut usually reaches a height of about 10-20 feet; the dwarf sumac (*Rhus copallina* Linn.) which, in contrast to *R. typhina*, is a small shrub rarely more than 5-8 feet tall in this latitude, and the smooth sumac (*R. glabra* Linn.), growing somewhat taller than *R. copallina.* The large erect conical fruit clusters of *R. typhina* are a densely matted mass of hairy seeds, crimson in color and velvety in texture. They are generally heavily infested with larvae, some of which are Lepidoptera and others Hymenoptera, thus creating an ideal condition for overwintering parasites. *Anacampsis rhoifructella* Clemens is the species of Lepidoptera commonly found in the fruit clusters of *Rhus typhina*, and *Homoeosoma stypticellum* Grote in the fruit-spikes of *Rhus glabra.* Several other larvae, *Moodna ostrinella* Clem., *Polychrosis rhoifructana* Kearfott, *Schreckensteinia erythriella* Clem., and *Holcocera fumerella* Dietz., occur in sumac heads. The fruit clusters of *R. copallina* and *R. glabra* are much less closely knit, not so compact, and the red hairs covering individual fruits are shorter and fewer in number than those of *R. typhina.* As a rule larval infestation of the dwarf and smooth sumac fruit clusters is approximately 10 percent that of the staghorn sumac, a possible reason for this being the more open and less compact nature of the former.

The winters of 1939-40 and 1940-41 saw a change in the procedure of the investigation. During these two seasons, dwarf ragweed (*Ambrosia artemisiaefolia* Linn.) was gathered exclusively from peach orchards throughout the State. Ragweed attains a height of from

1-3 feet and grows in waste places, along roadsides and in peach orchards after cultivation ceases. The ragweed borer (*Epiblema strenuana*) has been reported by Crawford (3) as an alternate host of *Glypta rufiscutellaris* Cresson, and by Allen and Lott (1) as host of several important parasites: *Macrocentrus ancylivora* Roh., *M. delicatus* Cress., *Glypta rufiscutellaris* Cress., *Pristomerus ocellatus* Cush. and *Cremastus minor* Cush. Of these five, *M. ancylivora* is the most important oriental fruit moth parasite in Connecticut, with *G. rufiscutellaris* of next importance. *M. delicatus*, *C. minor* and *P. ocellatus* are about equally abundant, but they are always less important than the two first mentioned species. (See Table 10.)

A study of the parasite species reared from sumac (*R. typhina*, *R. glabra* and *R. copallina*) revealed nothing of great importance from the fruit moth standpoint. *Epiurus indagator* Cresson, a larval or prepupal parasite of the fruit moth, was the only one of the genus bred from sumac and there was but one town record and one specimen record for the species. It seems quite probable that it issued from a lepidopterous larva boring in the stem supporting a sumac fruit cluster, rather than from the fruit cluster itself. Although there are three species of *Apanteles* listed in Table 11, only *A. clavatus* has been reared at this office from both *Grapholitha molesta* Busck and larvae infesting sumac fruit clusters. This species of *Apanteles* has been reported from three towns: Danbury, Wethersfield and Manchester. We have but three specimens in our collection which were reared from the oriental fruit moth. *A. glomeratus* L. is an important parasite of *Pieris rapae* L., and *A. aristoteliae* Vier. is reported reared from *Aristotelia fungivorella* Clem.

Bassus agilis Cresson, an important parasite of the European corn borer, *Pyrausta nubilalis* Hübn., is, perhaps by reason of its known host and the type of plants it infests, parasitic on a borer in the stalks or small stems comprising the fruit cluster heads.

Eurytoma rhois Crosby (4) in its relationship to sumac fruit clusters is phytophagous in habits. Although there are many other species of the genus *Eurytoma*, some of which are parasites of hymenopterous larvae, others attack the larvae of Coleoptera, Lepidoptera and Diptera in galls and tunnels. The 11,650 specimens reared from sumac were all of the phytophagous species living on and developing within the individual seeds comprising the fruit clusters. The species *E. rhois* was reared from sumac in 18 of the 20 towns from which the material was collected.

Gelis sp. and certain members of the genus *Horismenus* show a strong tendency toward hyperparasitism, especially species of the first mentioned genius. It is quite probable *H. microgaster* Ashm. is in this class. However, some members of the genus are primary parasites. *Gelis* sp. has been reared as a secondary parasite of the fruit moth at this office and elsewhere. It is an unimportant factor in minimizing the effectiveness of the primary fruit moth parasites in Connecticut.

TABLE 10. LIST OF PARASITES REARED FROM LARVAE INHABITING THE STALKS AND STEMS OF *Ambrosia artemisiaefolia* Linn.

Species	Order	Family	Stage of host attacked	No. specimens reared	Primary or secondary parasite	Towns recorded from
Angitia sp.	Hymenoptera	Ichneumonidae	larva	2	primary	W. Simsbury, New Britain
Apanteles aristoteliae Vier.	"	Braconidae	"	1	"	Glastonbury
Apanteles monticola Ashm.	"	"	"	3	"	Middlefield
Bassus erythrogaster Vier.	"	"	"	7	"	widespread
Bassus rugareolatus Vier.	"	"	"	6	"	widespread
Campoplex sp.	"	Ichneumonidae	"	7	"	Mt. Carmel, Guilford
Chrysocharis sp.	"	Eulophidae	"	3	hyperparasite	Manchester, So. Glastonbury, Middlefield
Chrysocharis ainsliei Cwfd.	"	"	"	3	"	So. Glastonbury, Middlefield, Farmington
Cremastus epagoges Cush.	"	Ichneumonidae	"	1	primary	Guilford
Cremastus forbesi Weed.	"	"	"	1	"	Wallingford
Diglochis sp.	"	Pteromalidae	"	1	"	Poquonock
Elasmus marylandicus Gir.	"	Elasmidae	"	9	primary or hyperparasite; prob. latter	widespread
Epiurus pterophori Ashm.	"	Ichneumonidae	larva or prepupa	43	primary	widespread
Epiurus indagator Cress.	"	"	larva	11	"	widespread
Euderus elongatus Ashm.	"	Eulophidae	"	3	"	Guilford, Wallingford, Greenwich
Eupelminus saltator Ratz.	"	Eupelmidae	"	2	"	Wallingford, Stepney
Eupelmus spongiportus Foers.	"	"	"	1	prob. primary on *Ambrosia* gall-maker	Manchester
Eupelmus sp.	"	"	"	2	prob. primary on *Ambrosia* gall-maker	Wallingford, Glastonbury
Eurytoma sp.	"	Eurytomidae	"	292	primary or hyperparasite	widespread

TABLE 10 (Continued)

Species	Order	Family	Stage of host attacked	No. specimens reared	Primary or secondary parasite	Towns recorded from
Glypta rufiscutellaris Cresson	Hymenoptera	Ichneumonidae	larva	86	primary	widespread
Glypta varipes Cresson	"	"	"	1	"	Guilford
Habrocytus languriae Ashm.	"	Pteromalidae	"	27	"	widespread
Habrocytus sp.	"	"	"	54	"	widespread
Heterospilus languriae Ashm.	"	Braconidae	coleopterous larva	53	"	widespread
Heterospilus sp.	"	Braconidae	coleopterous larva	2	"	Guilford
Leucodesmia typica How.	"	Eulophidae	coleopterous larva	16	prob. primary	Glastonbury, Middlefield
Macrocentrus sp.	"	Braconidae	coleopterous larva	1	primary	Middlefield
Macrocentrus delicatus Cress.	"	"	coleopterous larva	2	"	Manchester, Wallingford
Microbracon auripes Prov.	"	"	larva prot. as in a burrow, cocoon, or web	12	"	widespread
Microbracon caulicola Gah.	"	"	larva prot. as in a burrow, cocoon, or web	1	"	Middlefield
Microbracon dorsator Say	"	"	larva prot. as in a burrow, cocoon, or web	11	"	widespread
Microbracon lutus Prov.	"	"	larva prot. as in a burrow, cocoon, or web	27	"	widespread
Microbracon metacomet Vier.	"	"	larva prot. as in a burrow, cocoon, or web	1	"	Guilford
Microbracon nigropectus Prov.	"	"	larva prot. as in a burrow, cocoon, or web	4	"	Deep River, Kensington, Wallingford

Microbracon oenotherae Mues.	"	"	larva prot. as in a burrow, cocoon, or web	1	primary	Shelton
Microbracon sp.	"	"	larva prot. as in a burrow, cocoon, or web	9	"	widespread
Neocatolaccus tylodermae Ashm.	Hymenoptera	Pteromalidae	larva	3	primary	Mt. Carmel, Middlefield
Ooencyrtus clisiocampae Ashm.	"	Encyrtidae	egg	1	"	So. Glastonbury
Pristomerus ocellatus Cush.	"	Ichneumonidae	larva	7	"	widespread
Scambus notandus Cress.	"	"	"	2	"	Guilford
Sympiesis nigrifemora Ashm.	"	Elophidae	dipterous and lepidopterous leaf-mining larva	1	primary or prob. secondary	New Britain
Sympiesis sp.	"	"	dipterous and lepidopterous leaf-mining larva	1	primary or prob. secondary	Windsor
Syntomopus americanus Ashm.	"	Pteromalidae	dipterous larva	14	primary	widespread
Tetrastichus spp.	"	Eulcphidae	egg, larva or pupa	22	primary or hyperparasite	widespread
Triaspis curculionis Riley	"	Braconidae	larva	33	primary	widespread
Trichasis rubicola Ashm.	"	"	egg—sometimes larva	1	"	Somers

TABLE 11. LIST OF PARASITES RECORDED FROM INSECT ENEMIES OF FRUIT CLUSTERS OF *Rhus typhina* Linn., *R. glabra* Linn. and *R. copallina* Linn.

Species	Order	Family	Stage of host attacked	No. of specimens	Primary or secondary parasite	Town reported from
Apanteles clavatus Prov.	Hymenoptera	Braconidae	larva	1	primary	Danbury, Wethersfield, Manchester
Apanteles aristoteliae Vier.	"	"	"	34	"	widespread
Apanteles glomeratus L.	"	"	"	2	"	Stepney
Bassus agilis Cresson	"	"	"	4	"	Bantam
Elachertus proteoteratis How.	"	Eulophidae	"	321	"	widespread
Epiurus indagator Cresson	"	Ichneumonidae	larva or prepupa[1]	1	"	Northford
Eurytoma rhois Crosby	"	Eurytomidae	phyto-phagous	11,650	neither; in this case developed in the seed clusters	widespread
Gelis sp.	"	Ichneumonidae	larva in cocoon[1]	5	secondary	Seymour
Habrocytus piercei Cwfd.	"	Pteromalidae	larva	7	primary	Hamden, Glastonbury, Northford
Horismenus microgaster Ashm.	"	Eulophidae	larva[1]	2	primary or secondary	Greenwich
Idiomacromerus n. sp.	"	"	larva[1]	3	secondary[1]	Fairfield, Middlefield
Leucodesmia typica How.	"	"	larva	187	primary	widespread
Microbracon caulicola Gahan	"	Braconidae	"	9	"	Hamden, Bantam
Pleurotropis tarsalis Ashm.	"	Eulophidae	"	4	tertiary	Seymour, Danbury
Syntomopus americanus Ashm.	"	Pteromalidae	larva of dipterous gall maker[1]	1	primary	Hamden
Trichogramma minutum Riley	"	Trichogrammidae	egg	3	"	Fairfield

[1] Probable.

Pleurotropis tarsalis Ashm., a tertiary parasite, is discussed by Muesebeck and Dohanian (10). In a study of the hyperparasites of *Apanteles melanoscelus* they found that, in 98 percent of the cocoons of *A. melanoscelus* dissected, *P. tarsalis* had developed as a parasite of a number of different secondary parasites, such as *Eupelmus*, *Dibrachys*, *Eurytoma* and *Habrocytus*. In the light of this information, it is quite possible that the individuals of *P. tarsalis* reared from material collected in Seymour and Danbury could have been associated with *Apanteles clavatus* and other species of this genus as a secondary or as a tertiary parasite. This would be more probable still if the four named genera (*Eupelmus*, etc.) were actually known to be secondary parasites of *Apanteles*, reared from sumac. Should this be the case, *Pleurotropis* might by shifting from a tertiary to a secondary parasite prove quite disastrous for *Apanteles harti* and *A. clavatus*, both of which are incidental primary parasites of the oriental fruit moth. Because of the fact that *P. tarsalis* plays the role of both secondary and tertiary parasite with equal facility, it may at times prove an important factor in eliminating certain secondary parasites of the fruit moth. However, by the same token, its presence could constitute a distinct disadvantage. This would occur should local conditions account for a decided reduction in secondary species, leaving the primary parasite (*Apanteles*) open to attack.

Microbracon caulicola Gahan has not been reared from the oriental fruit moth in Connecticut. However, several other species of the genus are reported as primary parasites of this host in other states and in Canada. We would not expect *Microbracon* to play an important part as a primary parasite of the pest in question, as no single species has been found to be of any considerable importance. There is but one record of the rearing of *Trichogramma minutum* Riley from sumac collected in Connecticut (Fairfield County) which merely demonstrates that the type of protection afforded by sumac fruit clusters is perhaps desirable for the overwintering of *Trichogramma* hosts.

Elachertus proteoteratis How. and *Leucodesmia typica* How. are parasites of larvae infesting sumac fruit clusters. They were considerably more abundant than all other parasites reared from sumac, but neither of the two species has been reported as a parasite of the fruit moth. There was, however, a representative of the genus *Leucodesmia* (*L. nigriventris* Gir.) bred from the oriental fruit moth [Stearns (11), Haeussler (7)], suggesting, perhaps, that *L. typica* may at some time in the future be reared from this host.

Several of the parasites reared from borers in dwarf ragweed (*Ambrosia artemisiaefolia* Linn.) are important as primary parasites of the oriental fruit moth. The ragweed borer (*Epiblema strenuana* Walk.) is found infesting ragweed in all parts of the State. It constitutes a host reservoir for many parasites, some of which play an important part in fruit moth control, while others are regarded as incidental to the host. Allen and Lott (1) collected a large number of *E. strenuana* near Morristown, N. J., from which were reared *Macrocentrus ancylivora* (10 percent of all parasites), *M. delicatus* (23 percent), *Glypta rufiscutellaris* (10 percent) and *Pristomerus ocellatus* (5 percent). This was, however, the only locality in which *M. ancylivora* was recovered from *E. strenuana*-infested ragweed collections. Field collections from points in Pennsylvania, Ohio and Indiana produced numerous *G. rufiscutellaris*, *M. delicatus* and *P. ocellatus*, but no *M. ancylivora*. In Connecticut all of the parasites mentioned above were reared from the ragweed borer with the exception of *M. ancylivora*.

Ragweed material examined in 1939-40 and again in 1940-41, representing 74 separate collections and thousands of *E. strenuana*, revealed the presence of but two individuals of *M. delicatus*, one from Manchester and the other from Wallingford, and but one male specimen of *Macrocentrus* sp. from Middlefield. From the information available it seems improbable that *E. strenuana* is an alternate host of *M. ancylivora* or a host of any importance of *M. delicatus* in Connecticut. *M. delicatus* has never played any important part in this State as a primary parasite of the oriental fruit moth. From 35,000 peach tree tips collected during three seasons, only 39 individuals of *M. delicatus* were reared. On the other hand, 6,687 *M. ancylivora* were bred from the same material.

Glypta rufiscutellaris Cresson has been listed by Garman (6) as the second most important larval parasite of the oriental fruit moth in Connecticut. It was reared from *E. strenuana* in ragweed collected from 34 localities in 26 towns in the State. In view of the importance of this parasite in fruit moth control it is quite fortunate for the fruit growers that it has an alternate host of such widespread distribution. The species is also reported as a primary parasite of the strawberry leaf roller (*Ancylis comptana* Fröel.). The leaf roller, however, is of minor importance here and consequently would play an unimportant role as a source of *G. rufiscutellaris* for oriental fruit moth control purposes.

Crawford (3) made a life history study of *Glypta* and its relationship to three important hosts: the oriental fruit moth, the strawberry leaf roller and the ragweed borer. His field studies show that the number of larvae overwintering in the oriental fruit moth is relatively negligible in comparison to the percentage of individuals overwintering in the ragweed borer. Furthermore, his observations revealed no hyperparasitism of *Glypta* in New York State, whereas Driggers (5) attributed the decline of the parasite in 1928-29 in New Jersey to hyperparasitism of overwintering hibernacula of the fruit moth on peach trees. There is no definite proof that hyperparasites obtained from ragweed at the Connecticut Station were from *G. rufiscutellaris*.

The economic importance of *Glypta* throughout the range of its distribution seems to be definitely established and it is second only to *M. ancylivora* as a factor in the biological control of *Grapholitha molesta* Busck. Driggers (5) found *G. rufiscutellaris* more effective as a control agent of the fruit moth (in northern New Jersey) than any other parasite. Garman (6), in making a study of the species in 1928, reported 70 percent of the fruit moth parasitism at New Haven, Conn., to be that of *G. rufiscutellaris*; however, it is not now relatively so high. Haeussler (7) lists *G. rufiscutellaris* and *M. ancylivorus* as the most important larval parasites of the oriental fruit moth.

There is a noticeable fluctuation in the abundance of *Glypta* from year to year. In Connecticut in 1939 the parasite was relatively six times as plentiful as in 1940, and five times as numerous as in 1941. Because of a comparatively light fruit moth infestation in 1941, the number of fruit moth larvae collected was considerably less than in the two previous years. This factor would necessarily regulate to some extent the frequency of fruit moth larval parasitism, as reflected in the number of *Glypta* reared.

A single specimen of *Glypta varipes* Cress. was reared from a collection of ragweed made in Guilford. Haeussler (7) lists this species as a primary parasite of the oriental fruit moth. He also includes *G. phoxopteridis* Weed, *G. rufiscutellaris* Cress. and G. *vulgaris* Cress. with *G. varipes* as fruit moth parasites. *G. varipes* and *G. vulgaris* occur so infrequently in this State they are considered as rather unimportant in fruit moth control.

Cremastus forbesi Weed, bred from *E. strenuana* collected in Wallingford, has been listed by a number of fruit moth investigators as a primary parasite of its hosts. Since the occurrence in Connecticut has been found to be slight, the possibility of its becoming an important enemy of the fruit moth is precluded. Allen and Lott (1) reported *C. minor* as a parasite of *E. strenuana* in New Jersey. Numerically it was less important than other parasites; however, in view of the fact that it is likewise a primary parasite of the oriental fruit moth, the rearing records for Moorestown, N. J., are of interest. *C. epagoges*, bred from Guilford ragweed collections, provides locally a new alternate host for the species; Garman (6) reported it as a primary parasite of the fruit moth in Connecticut.

Pristomerus ocellatus Cush., an ichneumonid larval parasite of the fruit moth, was reared from *E. strenuana* collected from seven Connecticut towns. It is listed as a primary parasite of the fruit moth in a number of states and occurs annually in this host in Connecticut from the latter part of June to the close of the season. Field observations have proved it to be consistently abundant in certain parts of the State each year, whereas in other sections it is rarely found. This may be due to a scarcity of ragweed or a light infestation of *E. strenuana.* Although the parasite is rather slow in getting started in early summer, it does become effective before *G. molesta* enters the fruit.

Epiurus indagator Cress. and *E. pterophori* Ashm. are both primary larval or prepupal parasites of ragweed borer in Connecticut. *E. pterophori* was reared from 23 towns, and *E. indagator* from 5 towns. The latter species is listed by Haeussler (7) as a primary parasite of the fruit moth. However, it has not been reared from that host in this State. There are other hosts of the various species of *Epiurus* which it will not be necessary to mention here. The occurrence of *E. indagator* with *E. pterophori* as ragweed borer parasites, and the affinity of the genus for *Grapholitha molesta* Busck., suggest the possibility of encouraging the increase of the parasites in peach orchards by fostering the growth of ragweed. The obvious objection to this would be the irritating effect of ragweed pollen on human beings.

Among the parasites reared from ragweed material the genus *Microbracon* is represented; no species of this genus, however, is known to attack the fruit moth in Connecticut. In view of the fact that Muesebeck (9) lists *Microbracon lutus* Prov. as a parasite of both coleopterous and lepidopterous larvae, perhaps some of the eight species reared at the Connecticut Station were parasitic on coleopterous larvae concealed in the ragweed material. There are two species of the genus listed by Stearns (11)—*M. hebetor* Riley and *M. gelechiae* Ashm. These were also listed by Haeussler (7) together with an additional species, *M. mellitor* Say, as larval parasites of *G. molesta.*

Tetrastichus was represented by five species, the specific identity of which could not be correctly ascertained. Most of the members of the genus are internal parasites in the egg, larva or pupa of other insects. Occasionally one develops as an external parasite. Hyperparasitism occurs frequently and some species play the part of both primary and secondary parasites. Because *Tetrastichus* is a secondary parasite on both the larvae and pupae of various *Apanteles* it may be assumed that certain of the species obtained from ragweed emanated from members of this genus. Others, perhaps, were parasitic in Coccinellidae which were present in the ragweed material. Both larvae and pupae of Diptera are attacked by *Tetrastichus*, suggesting the probability of *Agromyza virens* Lw. as a host for one or more of the reared species.

Two species of the genus *Bassus* were reared from *Ambrosia* collected in 11 towns. They are not important from the fruit moth standpoint and do not seem to have been reported as parasitic on that host. There is, however, a representative of the genus, *Bassus diversus,* an Oriental species which was introduced into the State some years ago but failed to establish itself to any extent.

A short discussion of *Apanteles* and its relationship to parasites reared from sumac was undertaken in the first part of this paper. Muesebeck (8) in his revision of the genus lists as hosts of *Apanteles aristoteliae* Vier. four species of microlepidoptera, all of which web together the leaves of host plants and feed therein. It seems safe to say that *A. aristoteliae* obtained from ragweed material had its origin in some such a host.

Elasmus is a small genus with few representatives. What is known about them is rather fragmentary, but it is certain they are primary parasites of the larvae of Lepidoptera or hyperparasites upon them, through certain Ichneumonidae and Braconidae. The species *Elasmus marylandicus* Gir. has not been reported from Connecticut until now; just what part it plays in the ragweed parasite complex is a matter for further investigation. As it is known that certain of its closely related species parasitize lepidopterous larvae protected by a web, it is possible *E. marylandicus* came from leaf rollers or leaf tiers present in *Ambrosia* stock material. The number of specimens reared and the frequency with which they occurred, as revealed by the list of towns from whence they came, suggests a more widespread presence of the species than was expected.

Triaspis curculionis Riley is a well known larval parasite of the plum curculio (*Conotrachelus nenuphar* Hbst.). It was reared from ragweed collections made in 16 towns and is, perhaps, parasitic on some curculionid closely related to *C. nenuphar* Hbst.

The remaining species listed in Table 10 are primary or secondary larval parasites of various hosts. *Sympiesis nigrifemora* Ashm. and *Sympiesis* sp. attack dipterous and lepidopterous leaf-mining larvae, a number of which were present in the large quantity of *Ambrosia artemisiaefolia* material accumulated during the investigation. Still others, such as *Ooencyrtus* and *Trichasis rubicola*, were egg parasites of insect species incidental to the ragweed collections. *Chrysocharis*, like *Pleurotropis*, is most frequently encountered as a hyperparasite attacking the major parasites of lepidopterous and dipterous leaf miners. *Habrocytus* is sometimes parasitic on *Apanteles* but its effectiveness as a secondary may be materially reduced in the presence of the tertiary *Pleurotropis*.

Idiomacromerus sp., occurring in two localities in the State, is presumably a secondary of *Eurytoma rhois*. A related species was reared by Bugbee (2) from *Eurytoma* infesting *Rhus trilobata*. The author states that the species ". . . . according to Gahan, of the U. S. National Museum, seems to be identical with the genotype species *Idiomacromerus bimaculipennis* Crawford." Perhaps when more material is reared *I. bimaculipennis* may be found occurring in Connecticut.

Summary

Of the 16 distinct parasites reared from sumac fruit clusters, only one, *Epiurus indagator*, is important as a primary larval para-

site of the oriental fruit moth in Connecticut. Two secondary parasites, *Eurytoma* and *Gelis*, have been listed by fruit moth parasite investigators as sometimes occurring as hyperparasites of *G. molesta*. *Ambrosia artemisiaefolia* Linn., host of *Epiblema strenuana* Walk., and other larval boring insects produced 47 parasite species. Of these *Glypta rufiscutellaris*, *Macrocentrus delicatus*, *Cremastus forbesi*, *Pristomerus ocellatus* and *Epiurus indagator* are recognized as primary larval parasites of the oriental fruit moth, *Glypta* being the most important of all. Hyperparasites *Eurytoma*, *Habrocytus*, *Tetrastichus* and *Eupelmus* may at times attack one or more of the important parasites in fruit moth control. *Triaspis curculionis*, although not a parasite of *G. molesta*, occupies a place of importance in the war waged against the plum curculio. It is interesting to note that the last has an alternate host of some consequence infesting ragweed.

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APPLE MAGGOT CONTROL

Philip Garman

Continued research in control of the apple maggot (Frontispiece) indicates that it may be possible to obtain fair control by dusting with rotenone dust alone. After allowing the fly population to build up to a high point in one orchard in 1939, a dusting program was started in 1940. This program was confined to a single block in the orchard that year, but was extended to the entire orchard in 1941. The first year infested fruit dropped from 97 percent (1939 infestation) to 72 percent, while the second year the infestation in the same trees had dropped to 30 percent (Table 14). At the same time the infestation in surrounding orchards remained at the high level attained in 1939, namely 98 to 100 percent.

In the Burton orchard, dust treatments were omitted this year after treatment with rotenone dust for the three preceding years. The infestation in picked fruit increased from 7 percent in 1940 to 44 percent in 1941, and the percent of infested dropped fruits increased from 26 to 44 (Table 15).

In programs of this kind it appears to be necessary to dust at frequent (7-10 day) intervals at the height of fly emergence and to dust from both sides of the tree. Rapid removal of the flies from the trees by rotenone dusts was noted again this year, indicating satisfactory kills at the time of applications.

Following laboratory tests with red or pink clay carriers, attempts were made to secure dusts made up with them. We were unable to obtain enough for field test, and work this year was carried on with a pyrophyllite-oil carrier, the same as in 1940.

Rotenone dusts, such as have been used for the last three years, enable one to extend the season of maggot control much nearer harvest and kill much more rapidly than lead arsenate, but they are more expensive than the standard lead arsenate sprays. However, they are not as expensive as generally believed because of the relatively small dosage per tree. One and one-half to two pounds of the oil-impregnated dust are sufficient for a fairly large tree capable of bearing about 15 bushels. Rotenone dusts may have a place in late season control in order to avoid arsenical residues and should be useful in seasons when maggot control is difficult with the standard mixtures. European red mite control is not successful with the rotenone-oil dusts used so far, which brings in another complication. It may be possible, however, to mix rotenone with DN dusts in order to prevent mite outbreaks. This would appear to be a logical conclusion from our seasons' work on mite control. (See pp. 505-511).

Laboratory Experiments

Continuing our experiments with red clays for preventing the action of ultraviolet rays on rotenone, two additional products have been tested. These were compared with talc as a carrier and both showed improvement over the latter. The red clays used so far varied from 6 to 8 percent in iron oxide (Fe_2O_3) content, according to Dr. Fisher. One of the materials tested this year was a finely ground slate dust obtained through the courtesy of the New York

Agricultural Experiment Station. This contained 7.9 percent Fe_2O_3. Some of our results are given in Table 12 below.

TABLE 12. COMPARISON OF TALC AND RED CLAY AND SLATE FOR PREVENTING BREAKDOWN OF ROTENONE BY ULTRAVIOLET LIGHT
All Mixtures .5 Percent Rotenone[1]

Material	Wt. on slide grams	% mortality 48 hours	Sun lamp exposure hours
Red clay[2]	.0054	100	24
" "	.0108	100	24
" "	.0120	100	24
Red slate	.0073	100	24
" "	.0118	100	24
" "	.0147	100	24
Talc (white)	.0095	16	24
" "	.0156	0	24
" "	.0198	22	24
Red clay[2]	.0060	100	0
Red slate	.0070	100	0
Talc	.0080	100	0
Talc	.0098	100	0
Check—no dust	----	16	—

[1] Material dusted on 3¼ x 4¼ slide, placed under the ultraviolet lamp and then used as a window in a small cage. Procedure same as reported last year.
[2] Obtained from the Southeastern Clay Company.

In addition to the tests outlined above, a series of 20-day laboratory tests were run during 1940 and 1941 to determine the value of several new materials. Results are given in Tables 13, 14 and 15.

The method of treatment consists of dusting apples and hanging them in a small cage near the top, where they remain for 20 days. A water bottle is provided and honey-yeast mixture placed in the top of the cage—not mixed with the insecticide.

It is interesting to note in these experiments that antimony compounds are quite efficient in killing flies and also in preventing oviposition. It appears to be possible to poison the flies even more effectively by mixing antimonates with the honey or other food placed in the cages.

TABLE 13. SUMMARY OF 20-DAY TESTS FOR MAGGOT CONTROL, 1940-1941

Materials	No. replicates	Mortality 20 days	Egg punctures per female
.5 percent rotenone dust	5	100.	0.
Phthalonitrile, pure dust	4	91.5	1.5
Tartar emetic, pure dust	13	87.9	.01
Antimonelle, pure dust	5	83.5	0.
Pyrocide 10, dust[3]	5	74.5	.19
Check—no treatment	5	33.6	15.3

[3] Commercial pyrethrum dust.

TABLE 14. SUMMARY OF APPLE MAGGOT CONTROL WITH ROTENONE DUST, 1939-41
Townsend Orchard, Westwoods

Tree	Variety	% injured by maggot		
		1939	1940[1]	1941
B2	Cortland	94.0	86.6	40.0
B5	"	97.0	61.0	31.0
B9	"	97.0	70.0	26.5
B13	"	99.0	70.0	28.8
B17	"	99.0	74.0	26.6
L	Staymen Winesap	—	99.5[2]	8.8
Nearby farm (untreated)	McIntosh	—	—	97.8

[1] Dusting begun in this year.
[2] Untreated for maggot in 1940.
Note: 5 dusts in 1940 approximately 1 week apart.
4 dusts in 1941 approximately 2 weeks apart.

TABLE 15. APPLE MAGGOT CONTROL
Burton Orchard, Mount Carmel. Variety — Gravenstein

Treatment	Year	Kind of fruit	Percent injured by maggot
.5% rotenone-oil dust	1938	Drops	37
4 applications	1938	Picked	16
.5% rotenone-oil-pyrophyllite dust	1939	Drops	21
4 applications	1939	Picked	3
.5% rotenone-oil-pyrophyllite dust	1940	Drops	26
5 applications	1940	Picked	7
No treatment for maggot control	1941	Drops	46
	1941	Picked	44

CONTROL OF THE EUROPEAN RED MITE

PHILIP GARMAN and J. F. TOWNSEND

During 1941, tests were run in six orchards in four different localities. The main object of this work was to obtain more satisfactory controls for the growing season. Owing to abundance of natural enemies, as well as other factors, mites failed to develop in some of the test plots, even in check trees, so that adequate data could not be secured. Towards the latter part of the season, however, a few heavy infestations were found which enabled us to secure data of some value. These experiments are described in detail later and the data assembled in tables. During 1941, we concentrated on "dinitro" dusts and rotenone sprays. Thiocyanates were tried earlier in the season and some limited experiments were made with dormant oils.

During the spring, summer and fall the U. S. Bureau of Entomology and Plant Quarantine, Department of Foreign Parasite Introduction, stationed men in Connecticut for the purpose of studying European red mite predators and white apple leafhopper parasites. Much progress has already been made by these men. Among other things they have tested a brushing machine developed in California for sampling mite populations on citrus. It appears to be satisfactory here also for the apple and they have made use of it throughout the season.

A sudden warm spell in April seriously interfered with dormant field control work. We were able, however, to secure from manufacturers 12 different oil sprays (emulsions or self-emulsifying oils) and tested these in the laboratory for compatibility with available "dinitro" powders. Only five of the 12 appeared to be stable in the presence of the dinitro powder so that the remainder would not be suitable for mixing with it. The entire lot of oil sprays were then submitted to the Department of Analytical Chemistry of this Station for analysis. According to Dr. Fisher's report, they varied from 72 to 83 percent oil and from 10 to 62 percent unsulfonatable residue. Viscosity in all cases was between 100 and 150 Saybolt at 100° F. The nature of the emulsifiers was also examined and such materials as ammonium caseinate, sodium alkyl sulfate and bentonite were identified. One oil was reported to contain a sulfonated oil emulsifier, but this was not certain. Of the 12 products, four were of the ready-mix type, emulsifiable in the tank with spraying equipment.

The Burton orchard, divided into three spray plots, became of interest during the summer because of foliage browning in one section. It received wettable sulfur and lead arsenate. This portion became heavily infested with mites in August. Samples of leaves from four Baldwin trees in each plot were submitted to Dr. Morgan of the Soils Department, who determined the pH of the leaves as well as the proportions of various chemicals present. Nitrate nitrogen, ammonia nitrogen, phosphorus, potassium, calcium, magnesium, manganese and pH were considered. The figures in Table 16 represent parts per million on a green weight basis and are the average of two different series of analyses.

TABLE 16. ANALYSIS OF GREEN AND BROWN FOLIAGE FROM BURTON'S ORCHARD

	pH	Am N	P	K	Ca	Mg	Mn
Trees brown Flotation sulfur and lead arsenate	5.73	330	90	6125	4000	768	130
Trees green Talc and lead arsenate	5.72	355	52	3780	4187	831	107
Trees green Lime sulfur and lead arsenate	5.72	378	34	4962	3587	856	135

The tests are entirely preliminary in nature and final conclusions should not be drawn from them. They do indicate, however, that the pH in all cases was so close that it seems doubtful whether this alone could have influenced the condition. It should be pointed out, too, that the ammonia nitrogen and magnesium levels were both low in the browned section, indicating that mites may possibly remove these elements from the foliage in the course of feeding. Phosphorus and potassium both averaged high in the brown plot.

The 1941 Field Experiments

Graham Orchard—Lebanon. An infestation threatened to become serious early in the season and the owner sprayed portions with "Lethane" thiocyanate, at the manufacturer's recommendation. Examination of the trees on June 20 indicated so little reduction in mites that the application was considered of no practical use. In fact, the count on June 7, about a week after the treatment, revealed that the trees receiving "Lethane" had approximately twice as many mites as the untreated trees. Further random examination in the orchard showed no definite benefits from the spray. On laboratory examination, there appeared to be a slight reduction of egg hatch, which is to be expected, since thiocyanates are definitely ovicidal in their action.

Curtis Orchard—Bantam. Examination on July 13 showed an infestation developing in Spy and McIntosh blocks about one-half mile apart. The owner applied summer oil to the Spy block shortly after this date and the control seemed to be good. There was some leaf burn on trees at the lower end of the orchard, possibly due to moisture and heat.

In the second portion of the orchard Mr. Cole, the manager, was kind enough to apply for us a number of materials including (a) white summer oil, (b) dinitro-cyclo-hexyl-phenol (DNCHP) dust, (c) dinitro-o-cresol (DNOC) dusts, and (d) a rotenone spray known as "Syntone". The plots were laid out in alternating series and counts were made on several dates. Predator abundance was determined by Messrs. Jaynes and Marucci of the U. S. Bureau of Entomology and Plant Quarantine.

In general, the results indicated good kills for DNCHP dust, one percent DNOC dust, Syntone rotenone spray, and summer oil (Table 17). Predators were noted at one side of the plot and they progressed across the sprayed portions, so that counts cannot be considered entirely reliable in all cases. However, the immediate reduction in mite population may be taken as an indication of what the materials will do, an observation verified by subsequent tests in the same and other orchards. It was puzzling, however, to observe in the second series of tests (not shown in the tables) in this orchard that the rotenone spray at one-half strength gave better control (95 percent) than full strength (74 percent). This may have

TABLE 17. EUROPEAN RED MITE CONTROL, 1941
Curtis Orchard, Bantam. Variety—McIntosh

Treatment	Number adult females per 20 leaves July 13	July 16	% reduction
1% summer oil, tank mix	61	5	
July 14	523	30	
	49	5	
	206	4	
	839	44	94.7
DNCHP dust	182	7	
July 15	334	8	
	229	7	
	267	6	
	1012	28	97.2
Syntone, 1 pint	228	3	
Qth oil, 1 quart	576	11	
Spreader, ¼ pound	218	1	
July 14	391	10	
	208	18	
	1621	43	97.4
1% DNOC dust	299	34	
July 15	291	40	
	229	52	
	179	44	
	998	170	82.7
½% DNOC dust	215	48	
July 15	556	160	
	263	91	
	123	45	
	1157	344	70.2
Check—no treatment	45	25	
	49	19	
	43	29	
	20	12	
	158	123	
	75	76	
	390	284	27.4

been due to predators which were somewhat more abundant in the one-half strength plots. The best of the DN dusts gave 90 percent reduction. Predators were developing so rapidly by the time of the second tests that untreated mite populations declined almost as fast as the sprayed or dusted. Summer oil was not used in the second test.

A careful study of the figures presented by Jaynes and Marucci indicates that the rotenone sprays were slightly more toxic to predators than the DN dusts, and that natural enemies increased in the dusted plots at about the same rate as in the checks. Full data before and after the oil spray are not available, although there seems to have been a steady decline in predator population there paralleling the decline of red mites.

In general, then, we were able to get good reductions in the Curtis orchard with summer oil, DNCHP dust and Syntone rotenone spray; and fair to good with one percent DNOC dust. In the second test, one-half strength Syntone outranked the others for some unknown reason. None of the materials were more effective in reducing mite populations than summer oil.

Townsend Orchard—Hamden. On July 28, alternate trees in a heavily infested row of Cortlands were dusted with DNCHP dust. Here, reduction in mite population was immediate and substantial (Table 18), although subsequent counts indicated that the population was declining, as in the Curtis orchard.

TABLE 18. CONTROL OF EUROPEAN RED MITE, 1941
Townsend Orchard, Westwoods. Variety—Cortland

Tree	Adult females per 20 leaves			Treatment
	July 28	July 31	August 6	
B5	100	95	39	
B9	106	128	13	None
B13	144	89	25	
B17	74	80	9	
B7	114	0	2	
B11	186	2	3	1.7% DNCHP dust
B15	66	0	0	
B19	142	1	0	

Hoffmeister Orchard—Hamden. The owner of this orchard became alarmed in late July about the number of mites developing and allowed us to apply dusts in a block of Delicious. Counts of adult female mites were made before and after treatment although no check trees were left. The area was divided between DNCHP and one percent DNOC dusts. There were eight trees in two rows in each treatment. Reduction in the number of adult females per 20-leaf sample from each tree showed 80.8 and 89.0 percent reduction for the DNCHP and 63.5 and 64.9 percent for the one percent DNOC. These results, therefore, confirm what we got at the Curtis farm, namely that good kills may be had with DN dusts and that the DNCHP appears to be slightly more effective than the one percent DNOC. Subsequently, Mr. Hoffmeister dusted some quite heavily infested McIntosh trees and noted almost complete elimination of the mites by the treatment. No injury or only very slight injury was noted in these and previous tests.

Clark Orchard—Woodbridge. A heavily infested Delicious block was called to our attention during August and we arranged with Mr. Clark for a series of tests in order to check our results in the orchards previously mentioned. Syntone was used at several concentrations and DN dust was applied to about 100 large trees. In this experiment the dusted trees received only about 75 pounds for the entire lot and the control was poor. Subsequently a smaller area was more heavily dusted with one percent DNOC, 1 to 2 pounds per tree, and a reduction of 60 percent was observed. This is not too far out of line with the results obtained at Hoffmeister's and Curtis'. We were unable to test the DNCHP dust further because of lack of material. The sprays of Syntone applied by Mr. Clark appeared to give better results than were obtained at the Curtis orchard, and the reduction in actual numbers of mites was remarkable (Table 19). According to counts by Mr. Jaynes, the total population dropped from 10,924 to 352 (96.8 percent reduction) per 100-leaf sample in one plot, and from 10,976 to 548 (95 percent) in another. These figures were further checked by leaf counts of adult females before and after treatment and it was apparent that the spray was effective because of the large numbers of dead mites observed. Results again seem to confirm what was obtained at the Curtis farm for the rotenone spray, but dusts were inferior in performance, probably because of the low dosage or other factors.

Table 19. Control of European Red Mite, 1941
Clark Orchard, Woodbridge. Variety—Delicious

Tree	Treatment	Number mites per 100 leaves by brushing (Jaynes) Aug. 21	Sept. 6	Sept. 20	Sept. 20 % of number present on Aug. 21
B1	"Syntone" ½ pint Q oil 1 quart Spreader ¼ pound Water 100 gallons	10,924	352	172	1.7
B2	"Syntone" ½ pint Q oil 1 pint Spreader ¼ pound Water 100 gallons	10,976	548	236	2.1

Notes: Natural enemies observed in considerable numbers in portions of this orchard. At the time of application foliage had begun to turn brown.

Sprayed August 21, with power outfit and four-nozzle gun, by Mr. Clark, the owner. Sprayed from ground.

Shepard Orchard—Hamden. A row of seven Delicious trees was sprayed with Syntone, using our Experiment Station outfit. Two different concentrations were used and the counts before and after are given in Table 20. Here, as at the Clark orchard, reduction in mite population was outstanding and the material seemed to be more

TABLE 20. CONTROL OF EUROPEAN RED MITE, 1941
Shepard Orchard, Hamden. Variety—Delicious

Treatment	Tree	No. of adult females per 20 lvs. Aug. 7	Aug. 9	Aug. 22	Sept. 3	Sept. 3 % of number present Aug. 7
"Syntone" ½ pint	1	227	10	70	94	
Q oil 1 pint	3	58	10	53	72	
Spreader ¼ pound	6	93	11	50	60	
Water 100 gallons						
		378	31	173	226	59.8
"Syntone" 1 pint	2	142	4	37	28	
Q oil 1 quart	5	57	5	14	13	
Spreader ¼ pound	7	278	7	45	28	
Water 100 gallons						
		477	16	96	69	14.4
No treatment	4	71	61	81	115	161.9

Notes: Few or no natural enemies observed in these trees.

Applications made August 7, with power outfit and six-nozzle gun, from the ground. Temperature about 85° F.

effective at one percent concentration, in contradiction to the figures obtained from the Curtis orchard.

Costs and Compatibility. Both the dusts and the spray utilized in 1941 appear to be more expensive than summer oil. However, the DN dusts are apparently compatible with sulfur and the rotenone products do not spoil the finish of such varieties as Delicious when used about September 1. It would seem, therefore, that both materials may become useful for controlling mites without too many complications or incompatibility with other sprays. Rotenone products need to be freshly made or else carefully standardized and stabilized in order to prevent breakdown and assure the consumer of a uniform product.

Description of the Materials Used in 1941. (a) DNCHP dust. A yellow dust about like sulfur in dusting properties; reported to contain 1.7 percent of the sodium salt of dinitro-cyclo-hexyl-phenol. Carrier unknown. (b) DNOC 1, and ½ percent dusts containing dinitro-o-cresol as the active ingredient. (c) Syntone, a rotenone spray containing 2.8 percent rotenone—a whitish emulsion. Qth self-emulsifying oil, a synthetic oil reported to contain a "mixture of high boiling point liquid organic chlorine compounds, probably aromatic",[1] together with some mineral oil. The spreader used with the above rotenone-oil combination (Naccanol NR) is a synthetic product similar to the alkyl sulfates—not a soap.

[1] Analysis by Dr. Fisher.

FURTHER STUDIES OF NON-SULFUR SPRAYS WITH SPECIAL STICKERS COMPARED WITH STANDARD MATERIALS FOR CONTROL OF APPLE INSECTS

PHILIP GARMAN

During 1940 and 1941 several combinations were used and compared with flotation sulfur-lead arsenate mixtures at strengths commonly employed in this vicinity. The following conclusions were deduced from field notes and the tables presented below (numbers 21-29). The Experiment Station orchard at Mount Carmel was used for this work.

TABLE 21. COMPARISON OF FOUR FORMULAE FOR SPRAYING APPLES, 1940

Treatment		% clean	% curculio	% scab	Variety and Location
Lime sulfur	(1)	68.6	25.7	.2	Baldwin—inside; not in marginal rows
Flotation sulfur	(2)	72.8	16.9	1.1	
Lime, fish oil	(3)	72.0	16.3	.7	
Lime, aluminum sulfate	(4)	74.1	16.9	1.6	
Lime sulfur	(1)	65.0	28.0	.6	Baldwin—trees in outer marginal rows
Flotation sulfur	(2)	63.0	29.8	.4	
Lime, fish oil	(3)	67.2	25.6	.6	
Lime, aluminum sulfate	(4)	66.1	21.6	1.8	
Lime sulfur	(1)	75.5	19.7	.6	King—inside trees
Lime, fish oil	(3)	74.5	21.8	1.9	
Lime sulfur	(1)	78.4	14.6	3.1	Russet—inside trees
Flotation sulfur	(2)	79.2	13.7	1.4	
Lime, fish oil	(3)	67.2	21.9	5.4	
Lime, aluminum sulfate	(4)	76.6	17.8	8.8	
Lime sulfur	(1)	83.6	13.8	.5	Spy—inside trees
Lime, fish oil	(3)	85.0	9.4	2.9	
Lime sulfur	(1)	65.0	19.1	8.8	Pippins—inside trees
Lime, fish oil	(3)	17.9	24.5	56.7	

Treatment: All sprays contained 3 pounds lead arsenate per 100 gallons.
Remaining ingredients as follows:
(1) Lime sulfur 1 gal., soybean flour ½ lb., manganese sulfate 2 oz.
(2) Flotation sulfur 10 lbs.
(3) Lime 10 lbs., fish oil 1 qt.
(4) Lime 10 lbs., aluminum sulfate 4 lbs.
Sprays applied May 14 (pink), May 30 (calyx), June 5 (1st cover), June 20 (2nd cover).

Lime, lead arsenate and aluminum sulfate gave as good insect control as lime, lead arsenate and fish oil with less foliage drop. Both gave about the same curculio control as lead arsenate combined with flotation or lime sulfur.

Reduced concentration of lime sulfur (1 gallon to 100 in 1940 and 1 1/4 gallons to 100 in 1941) with manganese sulfate and soybean flour safener was nearly or quite as good as flotation sulfur. The fruit was not quite as smooth as that from the flotation sulfur plots in 1940; and there was more leaf drop in 1941, possibly due to the increased lime sulfur and a change in the manganese sulfate used. This is a very cheap spray and seemed to provide satisfactory control of insects and diseases in the orchard where it was used. By using care in applying this mixture, it was possible during 1940 and 1941 to control scab on Fall Pippin, a susceptible variety.

European red mites became abundant in all sulfur plots in 1940, but were more conspicuous in those receiving flotation sulfur. The mites were not troublesome in 1941, though they began to show on the foliage late in the season.

Yields in 1941 from Baldwin trees receiving no sulfur sprays exceeded by a considerable margin those from trees sprayed with sulfur. For example, in non-sulfur plots there was produced 89 percent of the crop borne in 1940, whereas the sulfured ones produced only 23 percent. The data are not entirely uniform but the averages for all trees are much higher for the non-sulfur plots, and this applies to comparisons with lime sulfur as well as with flotation sulfur. It is believed that some change in the usual spray formulas which include sulfur is needed for the Baldwin in this vicinity. Addition of lime is suggested.

Sprays with aluminum aceto-borate, oil and lead arsenate, compared in 1941 with flotation sulfur and lead arsenate, showed about the same degree of insect control but the fruit in the former plots had significantly less maggot infestation. The foliage on these trees was noticeably better than that on trees receiving both sulfur treatments and remained so to the end of the season. Fruit spray residues were not above tolerance in 1941 with a very dry season, but were so close in some instances as to indicate that applications later than June 7 may not be advisable. Codling moth did not advance in any of the plots, but there was a slight trend towards a lesser amount of externally clean fruit in the special oil-aluminum aceto-borate sticker plots, partly because of poor scab control. Adhesion to the foliage by the latter spray was very good, the material being plainly visible on the trees during 1940 and 1941 until the leaves dropped in the fall. With increased foliage, however, fruit color may not be very good and some of the trees did actually show a considerable amount of green fruit. On the other hand, in view of the excellent quality and quantity of foliage, this type of spray will be further investigated in 1942.

An attempt to introduce fungicides in the aluminum aceto-borate-oil-lead arsenate mixture during 1941 was only partly successful since russeting occurred on the fruit with one material and leaf injury with another. The russeting was probably due to the nature of the spray deposit, which is very uneven and remains on the fruit for such a long period.

A single test with aluminum aceto-borate combined with bentonite and sulfur was not satisfactory. Adhesion was not nearly as good as that of the mixtures containing oil.

Table 21 gives a general picture of the 1940 spray results. It indicates that the curculio infestation was severe and that scab was present in all varieties. Since the figures do not give an accurate comparison of the different sprays, this is given in subsequent tables. The percentage of clean fruit was rather low except for the Spies and very low for the Pippins sprayed with lime, lead arsenate and fish oil.

Table 22 gives a more extended comparison of the "clean" per-

TABLE 22. COMPARISON OF DIFFERENT SPRAYS, 1940
Fruit Free of Scab and Insect Blemishes

I	% clean	II	% clean	% gain for No. II
Flotation sulfur—lead arsenate	72.8	Lime sulfur—soybean flour—$MnSO_4$—lead arsenate	68.6	— 4.2
	63.0		67.2	+ 4.2
	79.2		78.4	— .8
	79.0		76.6	— 2.4
Flotation sulfur—lead arsenate	72.8	Lime—lead arsenate—fish oil	72.0	— .8
	63.0		67.2	+ 4.2
	79.2		67.2	— 12.0
	79.0		48.1	— 30.9
Lime sulfur—soybean flour—$MnSO_4$—lead arsenate	68.6	Lime—lead arsenate—fish oil	72.0	+ 3.4
	65.0		67.2	+ 2.2
	75.5		74.5	— 1.0
	78.4		67.2	— 11.2
	83.6		85.0	+ 1.4
	65.0		17.9	— 47.1
	76.6		48.1	— 28.5
Flotation sulfur—lead arsenate	72.8	Lime—lead arsenate—aluminum sulfate	74.1	+ 1.3
	63.0		66.1	+ 3.1
	79.2		76.6	— 2.6
	79.0		79.6	+ .6
Lime sulfur—soybean flour—$MnSO_4$—lead arsenate	68.6	Lime—lead arsenate—aluminum sulfate	74.1	+ 5.5
	78.4		76.6	— 1.8
	83.6		85.0	+ 1.4
	76.6		79.6	+ 3.0
Lime—lead arsenate—fish oil	72.0	Lime—lead arsenate—aluminum sulfate	74.1	+ 2.1
	67.2		76.6	+ 9.4
	48.1		79.6	+ 31.5
	67.2		66.1	— 1.1

Note: Comparisons made between adjacent trees or trees close together in the various plots.

centages, showing that there was no difference between trees receiving lime, lead arsenate and fish oil, and lime, lead arsenate and aluminum sulfate. The rather large difference between trees receiving sulfur, such as flotation sulfur or lime sulfur, and lime, lead arsenate and fish oil, was due to the presence of scab-susceptible varieties in these comparisons.

The decided advantage for sulfur over non-sulfur sprays is indicated in Table 23. There appears to be no indication that lime, lead arsenate and fish oil was better than lime, lead arsenate and aluminum sulfate.

TABLE 23. COMPARISON OF DIFFERENT SPRAYS, 1940
Scab Control

I	% scab	II	% scab	Gain for No. I
Flotation sulfur—lead arsenate	1.1	Lime—lead arsenate fish oil	.7	— .4
	1.4		5.4	+ 4.0
	1.8		13.2	+ 11.4
Flotation sulfur—lead arsenate	1.1	Lime—lead arsenate—aluminum sulfate	1.6	+ .5
	1.4		8.8	+ 7.4
	1.8		5.2	+ 3.4
Lime sulfur—soybean flour—$MnSO_4$—lead arsenate	.2	Lime—lead arsenate—fish oil	1.6	+ 1.4
	.6		1.9	+ 1.3
	3.1		5.4	+ 2.3
	.5		2.9	+ 2.4
	8.8		56.7	+ 47.9
Lime sulfur—soybean flour—$MnSO_4$—lead arsenate	.2	Lime—lead arsenate—aluminum sulfate	1.6	+ 1.4
	3.1		8.8	+ 5.7
	.5		2.9	+ 2.4
	2.7		5.2	+ 2.5
Lime—lead arsenate—fish oil	.7	Lime—lead arsenate—aluminum sulfate	1.6	+ .9
	5.4		8.8	+ 3.4
	13.2		5.2	— 8.0

Note: Comparisons are made between adjacent trees or trees close together in the various plots.

Table 24 indicates that no one of the four treatments was better in percentage of fruit free of curculio marks. The fact that the infestation was fairly high makes the comparison somewhat more accurate than would be the case had it been low, as it was in 1941.

The assembled results of 1941 experiments, as shown in Table 25, indicate a very low amount of damage from curculio and scab in contrast with 1940. Only one variety showed any amount of scab, the Fall Pippin. We have compared a three-spray schedule without sulfur with a four-spray schedule with sulfur, but in doing this there was applied one-fourth more arsenate of lead in the three-spray schedule because the dosage was held at 6 pounds per 100 gallons in two of the sprays, the calyx and first (the only) cover.

Table 26 gives a comparison of maggot control with the three- and the four-spray schedules. The evidence here is quite clear that

TABLE 24. COMPARISON OF DIFFERENT SPRAYS, 1940
Curculio Control
Figures are percentages marked by curculios

I	%	II	%	Gain for No. 1
Flotation sulfur—lead arsenate	16.9	Lime sulfur—soybean flour—$MnSO_4$—lead arsenate	25.7	+ 8.8
	13.7		14.6	+ .9
	13.4		15.4	+ 2.0
	29.8		25.6	— 4.2
Flotation sulfur—lead arsenate	16.9	Lime—lead arsenate—fish oil	16.3	— .6
	13.7		21.9	+ 8.2
	13.4		33.9	+ 20.5
	29.8		25.6	— 4.2
Flotation sulfur—lead arsenate	16.9	Lime—lead arsenate—aluminum sulfate	16.9	0.0
	13.7		17.8	+ 4.1
	13.4		15.1	+ 1.7
	29.8		21.6	— 8.2
Lime sulfur—soybean flour—$MnSO_4$—lead arsenate	25.7	Lime—lead arsenate—fish oil	16.3	— 9.4
	19.7		21.8	+ 2.1
	14.6		21.9	+ 7.3
	13.8		9.4	— 4.4
	19.1		24.5	+ 5.4
	28.0		25.6	— 2.4
Lime—lead arsenate—fish oil	16.3	Lime—lead arsenate—aluminum sulfate	16.9	+ .6
	21.9		17.8	— 4.1
	33.9		15.1	— 18.8
	25.6		21.6	— 4.0

Note: Comparisons are made between adjacent trees or trees close together in the various plots.

treatments with the special sticker and without sulfur were better in maggot control probably because of better adhesion.

Results shown in Table 27 probably were largely influenced by sprays in 1940 and indicate that there has been an increase in production, both in number of apples and the number of boxes picked from the Baldwin trees. Serious trouble from mites was experienced in 1940 in the sulfur plots and this may be partly responsible for the difference. Both 1940 and 1941 were relatively dry summers and the difference may not be so apparent in other years.

Table 28 is set up to show differences in clean fruit that existed in 1941 between sulfur and no-sulfur schedules. The figures indicate some slight advantage for the four-spray sulfur-lead arsenate schedule although there are two exceptions. This may be taken to indicate that the non-sulfur sprays did not cover quite as well, failing, therefore, to provide as good control for external feeders and scab. Because of the better adhesion of the non-sulfur spray schedules, maggot control (Table 26) counterbalances this difference.

Further analysis of the data secured in 1941, as shown in Table 29, indicates that curculio control was not significantly better in any one treatment. Thus the differences noted in the preceding table are probably due to external feeders which were classed as "other insects" as well as a small amount of scab.

TABLE 25. LEAD ARSENATE WITH "DYNAMITE" TYPE STICKERS Compared with Standard Spray Mixtures, 1941

Treatment		% clean	% curculio	Scab	Variety and Location
Lime sulfur	(1)	88.51	6.49	—	
Flotation sulfur	(2)	89.36	5.92	—	Baldwin—inside trees
Alum. aceto-borate	(3)	91.01	7.74	—	
Alum. ac. + Spergon	(4)	96.82	1.45	—	
Lime sulfur	(1)	82.05	12.38	—	
Flotation sulfur	(2)	79.34	15.53	—	Baldwin—outside rows
Alum. aceto-borate	(3)	87.57	10.62	—	
Alum. ac. + Spergon	(4)	83.75	11.85	—	
Lime sulfur	(1)	95.08	3.01	—	
Flotation sulfur	(2)	94.57	3.49	—	Greening—inside trees
Alum. aceto-borate	(3)	92.91	5.36	—	
Alum. ac. + Spergon	(4)	97.11	1.50	—	
Lime sulfur	(1)	95.08	3.87	—	King—inside trees
Alum. aceto-borate	(3)	93.91	1.44	—	
Lime sulfur	(1)	92.12	5.21	—	
Flotation sulfur	(2)	94.20	1.47	—	Russet—inside trees
Alum. aceto-borate	(3)	91.19	3.83	—	
Alum. ac. + Spergon	(4)	92.38	6.22	—	
Lime sulfur	(1)	87.76	4.41	—	Spy—inside trees
Alum. aceto-borate	(3)	83.38	5.23	—	
Lime sulfur	(1)	93.36	1.59	.06	Pippins—inside trees
Alum. aceto-borate	(3)	72.14	8.72	9.39	

Treatments:
(1) Lime sulfur 1¼ gals., lead arsenate 3 lbs., soybean flour ½ lb., manganese sulfate 2 oz., water 100 gals. Sprays—Apr. 29, May 14, 26, June 12.
(2) Flotation sulfur 8 lbs., lead arsenate 3 lbs., in 100 gals. Sprays—Apr. 29, May 14, 26, June 12.
(3) Lead arsenate 3 lbs. Apr. 29, 6 lbs. May 14, June 7. Aluminum aceto-borate 2 lbs., benzoic acid 4 oz., white mineral oil ½ gal., water 100 gals. Sprays—Apr. 29, May 14, June 7.
(4) Same as (3) with 1 lb. "Spergon" (chloranil) in each 100 gals.

TABLE 26. COMPARISON OF MAGGOT CONTROL IN THE DIFFERENT PLOTS, 1941

Variety	No. trees	No. fruits	Maggoty in treatments[1] III & IV %	No. trees	No. fruits	Maggoty in treatments[1] I & II %	Differences %
Greening	6	13,646	1.60	6	22,425	6.54	4.94
King	2	3,606	6.21	2	4,746	25.81	19.60
Spy	2	11,447	5.39	2	6,858	22.31	16.92
Pippin	2	4,031	.72	2	2,929	22.94	22.22
Sutton	2	6,924	1.90	2	1,486	3.53	1.63
Russet	4	11,604	2.56	4	7,459	6.98	4.42

[1] Explanation of treatments: See Table 25 for quantities.
I Flotation sulfur and lead arsenate—4 sprays.
II Lime sulfur, manganese sulfate, lead arsenate and soybean flour—4 sprays.
III Aluminum aceto-borate, lead arsenate, oil and "Spergon"—3 sprays.
IV Aluminum aceto-borate, lead arsenate and oil—3 sprays.

TABLE 27. COMPARISON OF BALDWIN YIELDS FOR 1940 AND 1941 IN SULFUR AND NON-SULFUR TEST PLOTS

Treatment	No. of apples 1940	No. of apples 1941	1941 % of 1940	Boxes 1940	Boxes 1941	1941 % of 1940
Sulfur						
Lime sulfur, lead arsenate, 1940 and 1941 Trees A, B & C 1 & 2	18,144	1,295	7.1	128	15	11.7
Flotation sulfur, lead arsenate, 1940 and 1941 Trees A, B & C 3 & 4	16,972	8,241	48.5	77	47	61.1
Flotation sulfur, lead arsenate, 1940 and 1941 Trees A 15 & 16	7,574	1,148	15.1	56	10	17.9
Totals and averages			23.2	261	72	27.5
No Sulfur						
Lime, lead arsenate, fish oil, 1940; Alum. aceto-borate, oil, lead arsenate, 1941; Trees A, B & C 5 & 6	16,308	17,074	104	77	106	137
Lime, lead arsenate, aluminum sulfate, 1940; Alum. aceto-borate, oil, lead arsenate, "Spergon," 1941; Trees A, B & C 7 & 8	24,192	9,535	39	165	69	41
Lime, lead arsenate, aluminum sulfate, 1940; Alum. aceto-borate, oil, lead arsenate, 1941; Trees A 13 & 14	6,218	7,875	126	30	49	163
Totals and averages			89.6	272	224	82.3

Taple 28. Comparison of Different Treatments by Trees, 1941
Percentages Free of Scab and External Insect Injuries

Trees	Treatments[1] I	II	III	Gain or loss for Nos. III & IV
A 4 & A 5	77.73		59.29	— 18.44
B 2 & B 5		86.66	83.30	— 3.36
E 14 & E 15		92.87	73.37	— 19.50
B 10 & B 11		93.44	87.52	— 5.92
C 4 & C 5	95.10		95.09	— .01
C 10 & C 11		97.28	96.44	— .84
E 4 & E 5		88.69	93.08	+ 4.39
D 4 & D 6		96.66	93.05	— 3.61
D 14 & D 15		93.79	91.67	— 2.12
	I	II	IV	
A 12 & A 13		93.27	89.17	— 4.10
A 14 & A 15	95.08		80.98	— 14.10
B 14 & B 15	87.03		94.63	+ 7.60
B 8 & D 9	97.42		97.25	— .17
D 10 & D 11	97.25		96.96	— .29

[1] Explanation of treatments:
- I Flotation sulfur and lead arsenate—4 sprays.
- II Lime sulfur, manganese sulfate, soybean flour and lead arsenate—4 sprays.
- III Aluminum aceto-borate, oil and lead arsenate—3 sprays.
- IV Aluminum aceto-borate, oil, lead arsenate and "Spergon"—3 sprays.

Table 29. Comparison of Curculio Control in the Different Plots, 1941
Percentages of marked fruit at harvest

Trees compared	Treatments[1] I	II	III	IV	Differences
A 4 & A 5	14.01			38.02	+ 24.01
A 10 & A 11		8.03		11.07	+ 3.04
A 12 & A 13		2.31	5.84		+ 3.53
A 14 & A 15	2.52		17.18		+ 14.66
B 10 & B 11		2.50		4.31	+ 1.81
D 2 & C 2		5.26	5.87		+ .61
D 3 & C 3	6.47			3.32	— 3.15
C 4 & C 5	3.13			4.44	+ 1.31
D 6 & C 6		2.55		5.21	+ 2.66
D 7 & C 7	2.38		1.04		— 1.34
D 8 & D 9	1.04		1.25		+ .21
D 10 & D 11	1.82		1.89		+ .07
C 10 & C 11		1.40		1.47	+ .07
B 14 & B 15	10.34		5.66		— 4.68
E 14 & E 15		2.64		8.87	+ 6.23
E 4 & E 5		8.90		4.46	— 4.44

[1] Explanation of treatments:
- I Flotation sulfur and lead arsenate—4 sprays.
- II Lime sulfur, manganese sulfate, lead arsenate and soybean flour—4 sprays.
- III Aluminum aceto-borate, lead arsenate, oil and "Spergon"—3 sprays.
- IV Aluminum aceto-borate, lead arsenate and oil—3 sprays.

EUROPEAN CORN BORER

NEELY TURNER

Commercial Control

Highly profitable increases in yield of borer-free early sweet corn have been produced by applying dual-fixed nicotine dust four times, at intervals of five days, in experiments conducted on a commercial scale. In 1940 Market Hybrid sweet corn was planted about April 15, and was dusted June 11, 16, 21 and 28 (the last treatment was delayed two days by rain). A two-row, self-propelled power duster was used for all applications. The dust cost $35.00 an acre, labor $2.00 (at 50 cents an hour) and the use of the machine $4.50, or the total expense was $41.50. The dusted corn, harvested July 18 to 24, yielded 6,910 borer-free ears to the acre and 3,450 infested ears which could be marketed. The entire crop, both infested and borer-free, was sold on the farmers' market for $350. Corn not dusted (from the same field) brought less than $100 an acre for 2,600 borer-free ears and produced about 7,500 infested ears which could not be sold.

The corn was sorted immediately after picking and graded as "borer-free" or "infested". Borer-free ears had no signs of borer feeding and brought $3.50 to $4.00 a hundred ears on the farmers' market. Infested ears from the dusted field sold for $2.50 to $3.00 a hundred ears. The cost of sorting was about the same as the cost of picking.

In 1941, the same variety of corn was planted April 12, and dusted June 4, 7, 12, 18 and 23. Immediately following the first, or June 4 application, a heavy rain fell, making it necessary to repeat the treatment and thus giving five applications instead of the usual four. The cost of the operation was: dust for the five treatments, $35.70; labor, $2.50 (at 50 cents an hour); and the use of the machine, $4.50; or a total of $42.70. The dusted corn produced 11,050 saleable ears which sold for $279.00 on the farmers' market. Corn was marketed from July 8 to 11 and the price was $2.75 to $3.00 a hundred ears for unsorted corn. The acre of corn not dusted produced only 2,800 borer-free ears which sold for $77.50. The infested ears were not sold.

A careful examination of the dusted corn showed that it was 70 percent borer-free, while the untreated corn was only 26 percent borer-free.

In both seasons the experiments were carried out on approximately an acre of corn and the entire operation conducted on a commercial basis. The corn was sold by the grower and the prices given are actual cash payments on the farmers' market and not sales to stores or at retail. It is believed, therefore, that these experiments establish the fact that commercial treatment of early corn to control the European corn borer is both practical and profitable.

Insecticide Investigations

Dual-fixed nicotine dust has been a highly effective material in controlling the European corn borer. However, it is expensive and on account of the processes used in manufacture is not likely to be cheap at any time. Nicotine bentonite dust is a fixed nicotine preparation manufactured by a considerably simpler process and is somewhat lower in price. The two materials were compared in a series of 2 percent, 3 percent and 4 percent nicotine content. Dual-fixed nicotine dust was the more effective material at 4 percent nicotine content but less effective than nicotine bentonite at 2 percent nicotine content. Since the control with dual-fixed nicotine at the 4 percent dosage has been less than desired, nicotine bentonite cannot be considered as a suitable alternate material.

An attempt was made to evaluate the individual applications in the standard treatment schedule of four treatments of dual-fixed nicotine dust at five-day intervals. Dissections of sample plants immediately after each treatment failed to show that any single treatment was outstanding in effectiveness. Furthermore, there was no indication that any outstanding number of borers was killed in any one part of the plant.

Treatment of ears only with both sprays and dusts was compared with the standard schedule of four applications at intervals of five days. The ear treatments were much less effective than the standard schedule, possibly because of poor timing.

The detailed results of these experiments and of others carried out in previous years have been summarized for publication in the near future in a Station bulletin.

SQUASH VINE BORER

Raimon L. Beard

In 1940 experiments suggested that 1 percent rotenone dust was equal, if not superior, to lead arsenate and fish oil for the control of the squash vine borer. However, even the vines on which no treatments were applied produced more squash than was expected on the basis of previous experience. It was believed that an early planting had enabled the vines to attain sufficient size before insect attack to withstand most of the injury. These considerations were the basis for tests made in 1941.

Approximately one-fourth of an acre was divided into sixty plots. In locations chosen at random within the field, twenty plots were planted to Delicious squash on May 1, twenty on May 15 and twenty on May 30. Eight hills were planted in each plot.

Each group of twenty plots was further divided at random into four groups of five replicates. One group of five for each planting date, or fifteen plots in all, was left untreated. A similar number was treated with each of the following materials: lead arsenate and fish oil spray, 1 percent rotenone dust, and a proprietary dust consisting of rotenone-impregnated walnut shell flour. These insecticides were applied five times at weekly intervals, beginning July 2.

During the third week in August, by which time all hatching of the vine borer had been completed and when very few vines had yet succumbed, a relative estimate of the infestation was made by observing the basal portion of each vine. Because of the length and interlacing of the vines it was impracticable to examine carefully their entire lengths or to dissect samples of them to determine the populations of borers. Hence the following table does not represent the percent of total infestation, but only the percent of vines infested at their basal portions where the bulk of insect attack is made.

Table 30. Infestation of Vines at Base in Treated and Untreated Plants

Treatment	Percent of vines infested at base		
	May 1 planting	May 15 planting	May 30 planting
Proprietary dust	32.1	31.5	29.0
Lead arsenate, fish oil	32.1	24.6	27.2
1 percent rotenone	22.6	32.9	15.4
Untreated	48.1	54.4	41.8

Statistical analysis of the complete data from which this summary was taken demonstrates that: (a) no significant differences in infestation can be attributed to date of planting (i.e., all plantings were about equally infested); (b) the treated plots showed a significantly lower infestation than did the untreated plots; (c) the rotenone-treated plots had a significantly lower infestation than plots treated with the proprietary dust, but were not significantly lower than plots treated with lead arsenate.

The field infestation can be considered light for, in contrast to squash plantings in several previous years when practically all untreated vines died by the end of August, comparatively few of the vines succumbed to borer injury. No marked differences in wilting appeared among plots planted on the various dates and among the various treatments.

When mature, the crop was harvested and the yields were as tabulated in Table 31.

An analysis of variance, using the weight data of this table, indicated that differences among the treatments and check were not great enough to be significant, and the apparent value of rotenone in increasing the yield is only suggestive. The low yield obtained from squash planted on May 30, in contrast with the other two plantings, is statistically significant. Much of this difference can be attributed simply to the fact that a shorter growing season prevented

TABLE 31. YIELD OF SQUASH

	May 1 planting		May 15 planting		May 30 planting		Total	
	Number	Pounds	Number	Pounds	Number	Pounds	Number	Pounds
Untreated	44	171.5	33	143.5	36	130.0		
	35	133.5	48	181.5	27	91.0		
	32	143.0	38	194.0	29	121.0		
	34	151.0	28	137.5	33	108.5		
	37	158.0	36	168.0	29	102.5		
	182	757.0	183	824.5	154	553.0	519	2134.5
Proprietary dust	40	146.5	43	242.5	35	124.5		
	38	152.0	37	198.0	31	117.5		
	39	176.5	39	200.5	30	93.5		
	32	127.5	36	156.5	20	101.0		
	35	146.5	29	117.5	26	107.0		
	184	749.0	184	915.0	142	543.5	510	2207.5
Lead arsenate	37	138.5	44	187.0	33	112.5		
	43	196.0	34	121.0	25	116.0		
	45	211.5	38	170.0	32	126.5		
	43	189.0	32	144.5	33	142.5		
	38	202.5	35	137.0	30	122.5		
	206	937.5	183	759.5	153	620.0	542	2317.0
Rotenone	51	196.5	25	120.5	31	148.5		
	33	144.5	35	149.0	31	98.0		
	39	175.5	49	259.5	38	142.0		
	48	197.5	35	165.5	21	69.5		
	36	132.5	39	239.0	27	84.5		
	207	846.5	183	933.5	148	542.5	538	2322.5
Total	779	3290.0	733	3432.5	597	2259.0	2109	8981.5

the full potential crop from being produced, although some can be attributed to squash vine borer injury. Since the three series of plantings were about equally infested, it is believed that the vines of the May 30 planting, because of their smaller size, were more severely injured than the others, and this injury partially caused the lower yield.

WHITE GRUBS DURING 1941

J. PETER JOHNSON

It is believed that more turf was injured in Connecticut in 1941 by white grubs than during any year since the turn of the century. The species responsible were the Japanese beetle (*Popillia japonica* Newm.), the oriental beetle (*Anomala orientalis* Waterh.), the Asiatic garden beetle (*Autoserica castanea* A.), the annual white grub (*Cyclocephala borealis* A.), and the May beetles (*Phyllophaga hirticula* Knoch., *P. fusca* Frohl. and *P. gracilis* Fletcher). All the larvae of these insects, excepting the *Phyllophaga*, have two feeding seasons a year. The first season, extending from August until cold weather, sends the grubs into hibernation some distance below the surface of the soil where they remain until spring. At this time they ascend into the upper few inches of soil and resume feeding until the pupation period, which usually occurs in June or early July. The large *Phyllophaga* grubs begin to feed (Figure 6) immediately after hatching and continue through the entire summer season until late Septem-

Figure 6. Sod rolled back to expose white grubs (*Phyllophaga* sp.) beneath. Madison, Conn.

ber or early October, when they go into hibernation. The second year these grubs are more destructive and feed from early spring until September or October and again hibernate, at depths of from 6 to 24 inches below the surface of the soil. During the third year the grubs may ascend to feed for a week or two and then migrate to a depth of 6 to 8 inches where they pupate and become adults in the fall of the year, emerging the following spring. It is believed that in Connecticut all of the larger white grubs of the genus *Phyllophaga* have a three-year life cycle.

May Beetles

The damage to turf caused by *Phyllophaga* larvae was very extensive as the following tabulation indicates.

Phyllophaga fusca

Town	Location	Date	Area injured
Litchfield[1]	Lawn	7-17-41	¼ acre
Sharon[1]	Lawn	7-17-41	1 acre
Avon[1]	Athletic field	7-26-41	10 to 12 acres
Pine Orchard	Golf course	7-31-41	35 acres
Woodbridge	Lawns and field	8- 1-41	5 acres
Bethany[1]	Lawn	8- 1-41	½ acre
Litchfield[1]	Lawn	8- 4-41	Reported by mail
West Cornwall	Lawn	8- 5-41	Reported by mail
Madison	Golf course	8- 7-41	18-hole course
Madison	Cemetery	8- 7-41	5 acres
Woodbridge	Golf course	8-24-41	3 fairways and rough
Storrs	Lawns	8-26-41	1 acre

Phyllophaga hirticula

Town	Location	Date	Area injured
Avon	Athletic field	7-21-41	10 or 12 acres
Pine Orchard[1]	Golf course	7-31-41	35 acres
Woodbridge[1]	Lawn and field	8- 1-41	5 acres
East Hartford	Lawn	8- 5-41	Reported by mail
Madison[1]	Golf course	8- 7-41	12-hole course
Madison[1]	Cemetery	8- 7-41	5 acres
Groton[1]	Golf course	8-26-41	9-hole course
East Hampton[1]	Cemetery	8-21-41	7 acres
Middletown	Cemetery	8-26-41	4 to 5 acres
Storrs[1]	Lawns	8-26-41	1 acre
Woodbridge	Golf course	9-24-41	3 fairways and rough

Phyllophaga tristis

Town	Location	Date	Area injured
Madison	Cemetery	8- 7-41	Occasional larvae
Middletown	Cemetery	8-26-41	Occasional larvae

Phyllophaga gracilis

Town	Location	Date	Area injured
Cheshire	Lawn	10-10-41	¾ acre

On several warm nights, from May 25 to May 29, 1941, a flight of adult *Phyllophaga* took place in Oxford and Seymour. Several hundred *P. tristis* were observed feeding on and defoliating red raspberry plants. They were also collected while feeding on blackberry and ash. This species, together with *P. forsteri* and *P. crenulata*, was captured in a light trap at the time. *P. forsteri* were also collected while feeding on red raspberry, ash, sweet cherry, walnut, wild cherry and hybrid tea roses. Three *P. fraterna* and two *P. anxia*, together with the above named species, were captured at a porch light in Oxford on May 27. While making diggings for the larvae of *Popillia japonica* in Greenwich, on May 24, 17 *P. fraterna* and one *P. hirticula* were found in the soil. On November 5, four newly formed adult *P. hirticula* were found while digging second-year

[1] Heading indicates the predominant of the two species of *Phyllophaga* found in this town.

grubs of the same species. A number of adult *P. tristis* were collected from under burlap covers used instead of a mulch on fall-planted seed beds in a forest nursery at Barkhamsted. Adults of *P. tristis* also were observed digging into a golf green in Hamden on May 10.

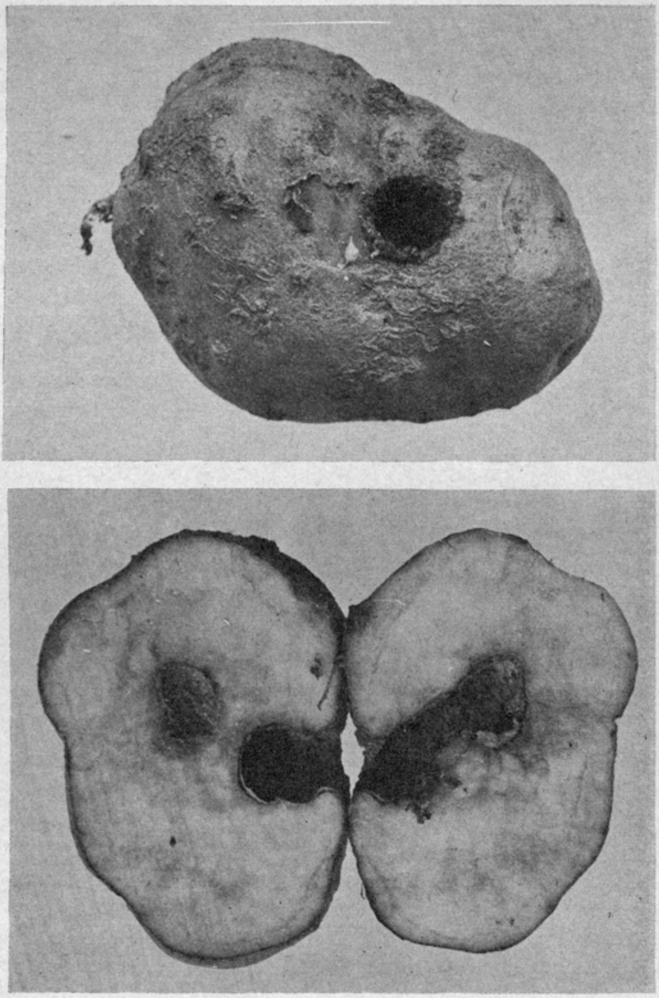

Figure 7. Injury to potatoes by larvae of the oriental beetle, *Anomala orientalis* Waterh.

Oriental Beetle

The grubs of this species were responsible for injuring many lawns in Bridgeport, Hamden, New Haven and West Haven. Practically every lawn was severely damaged along one street in West Haven for a distance of three city blocks. In Hamden, the turf in a hayfield also was killed in numerous small areas.

The first known injury to potatoes by this insect (Figure 7) was recorded in August and occurred a short distance from the hayfield in Hamden. The damage to the potatoes, which were Cobblers and Chippewas, occurred in three fields totalling more than 6 acres. The Cobbler potato field had been planted to lima beans and cabbage the preceding year while the Chippewa field followed a 1940 planting of potatoes. Several hills were dug in one Cobbler field and of a total of 182 marketable potatoes 60 were scarred in a manner to render them unfit for commercial purposes. The injury was similar to that caused by other white grubs but some tubers were entered, as shown in Figure 7. While investigating the source of injury, the soil was removed to a depth of 18 to 20 inches and first, second and third instar *Anomala orientalis* larvae were found to a depth of 12 inches. Two larvae were taken from burrows in the tubers. The soil was very dry when the diggings were made. In a nearby turf border both *Anomala* and *Phyllophaga* were found in the upper two inches of soil, but no *Phyllophaga* were recovered in the potato field which had been under cultivation for several years.

Asiatic Garden Beetle

Grubs of the Asiatic garden beetle were prevalent in a golf course in Hamden and were abundant in localized areas in Darien, South Norwalk and Westport. Turf damage was observed in cemeteries, golf courses and lawns.

Annual White Grub

The annual white grub was destructive to turf in cemeteries, golf courses and lawns in Fairfield, Danbury, Darien, East Norwalk, South Norwalk and Westport. This species is continuing to spread, as the damage in Danbury is the first recorded from that town.

Japanese Beetle

The Japanese beetle continues to increase, damage by the adults and larvae being reported greater this year than in preceding ones. Each year damage is reported from areas previously untroubled by this insect, and adult populations are greater in sections which have been infested for a few years. Summer reports of a larger adult population and damage usually result in more complaints about turf damage. This year a combination of dry weather and grub feeding resulted in more reports of turf damage in and around the suburban areas of the larger towns and cities which have been heavily infested for a number of years. In Fairfield County there are 23 golf courses, totalling 3,783 acres, of which 2,436 are developed. At least 90 percent of these courses have used lead arsenate to treat part or all of their greens and fairways, together with some of the more important rough. Some courses have been in the infested area for over 10 years and have found it necessary to use the chemical treatment a second time.

Notes on Hibernation Depths

While making diggings to obtain the numbers of grubs of several species of Scarabaeidae in October, it was possible to observe the position of the grubs in relation to the surface of the soil. The soil temperature during this period was below 60° F. at 6 inches and varied between 54° and 56° F. to depths of 22 inches. The downward movement to hibernating depths was well under way.

Cyclocephala borealis	—	October 20, 1941, majority upper 2 inches
Popillia japonica	—	October 23, 1941, majority upper 2 inches
Anomala orientalis	—	October 24, 1941, majority 4-8 inches
Phyllophaga gracilis	—	October 23, 1941, two-thirds in upper 2 inches
Phyllophaga hirticula	—	October 21, 1941, majority 9-18 inches
Phyllophaga fusca	—	October 21 and 22, 1941, majority 9-15 inches

The depth at which *P. hirticula* and *P. fusca* hibernated was investigated at the Pine Orchard Golf Course, Branford, and the Madison Country Club, Madison. The two species were present at both sites. At Branford one excavation was made, while in Madison two separate excavations were made about 50 feet apart. In each case the diggings were continued until 100 or more *P. hirticula* grubs were recorded. At Branford, where 43 square feet 30 inches in depth were removed, a total of 151 grubs of the two species were recovered, averaging 3.5 grubs to one square foot. The soil temperature at the Branford site on October 21, 1941, was 56° F. at 3 inches, 54° F. at 12 inches, and 56° F. at 21 inches. The results are given in the following table.

Table 32. Hibernation Levels of Second Year *Phyllophaga* Grubs

Depths inches	*P. hirticula* Branford 10-21-41	*P. hirticula* Madison 11-5-41	*P. hirticula* Total	*P. fusca* Branford 10-21-41	*P. fusca* Madison 11-5-41	*P. fusca* Total
0 - 6	2	2	4	1	3	4
6 - 9	2	20	22	1	13	14
9 - 12	13	69	82	16	10	26
12 - 15	61	24	85	28	4	32
15 - 18	22	7	29	2	0	2
18 - 21	2	1	3	0	0	0
21 - 24	1	0	1	0	0	0
	103	123	226	48	30	78

It is evident that the type of subsoil has an influence on the depths at which the grubs hibernate. In both locations there was a topsoil 6 to 11 inches in depth, and a yellow subsoil with extreme depths from 11 to 30 inches, below which a coarse or fine sand was found. In one excavation at Madison the sand began at depths varying from 11 to 13 inches. Only one grub (*P. hirticula*) was found in the sand 1 inch below the yellow subsoil and at a depth of 12 inches from the surface. In the second excavation at Madison, about 50 feet away from the first, the sand began at depths varying from

15 to 24 inches and the grubs were found down to the sand. At Branford, a coarse sand and fine gravel were situated 20 to 30 inches below the surface and the grubs were found at this depth, but none in the sand.

Notes on *Aphonus castanea* Melsh.

When discussing some field work with Mr. R. T. White, of the U. S. Bureau of Entomology and Plant Quarantine, he mentioned that a large number of larvae were observed on the surface of the turf at the U. S. Submarine Base Golf Course, Groton, Conn. The following is quoted from a letter received from him, dated October 16, 1941:

"Mr. P. J. McCabe and I treated the U. S. Submarine Base at New London with milky disease on July 8, 1941. A gentle rain had fallen during the previous night and on the morning of the 8th a fine mist was still falling intermittently. Since we were anxious to return to New Haven that night, we started treating in spite of the rain. During the treatment of the golf course we noticed full-grown larvae lying over the entire turf area. These appeared lifeless but examination showed them to be alive. A number were collected and the ones given to you were a sampling of said larvae. We estimated at the time that approximately 5 grubs per square foot occurred on the surface over the bulk of the course, some portions containing many more.

"At about 11 a.m. the clouds shifted and the sun came out for the first time during that day. Almost instantly the larvae began digging into the soil and within 15 minutes very few of these larvae remained above ground and after 30 minutes none could be found. No diggings were made to determine the number present in the soil. The material we brought back with us was in bad condition upon our arrival and none was reared."

These larvae conform to the description of *Aphonus castanea* Melsh., as given by Sim (U. S. D. A. Circ. **334**, Dec. 1934).

A Scarabaeid Larva, *Dyscinetus trachypygus* Burm.

On October 8, 1941, while digging for *Phyllophaga* larvae in the rough at the Madison Country Club, Madison, Conn., a small number of grubs about 1 1/8 inches long and 1/4 inch in diameter, with reddish brown head capsules, were found. Several of these larvae were placed in rearing tins in a room held at 80° F. Three adults emerged by September 22, 1941, and were identified as *Dyscinetus trachypygus*. Although the adults of this beetle have been found in Connecticut, it is not an abundant species, and this is the first time the larvae have been collected here.

The Skunk as a Natural Enemy of White Grubs

Skunk feeding on the grubs of the oriental beetle, Asiatic garden beetle, the annual white grub, the Japanese beetle and several species of the May beetles has been general and may be expected in any part of Connecticut where heavy infestations of grubs occur. Evidently skunks are very fond of the grubs as they will dig for them in pastures, cemeteries, golf courses and with equal unconcern in the finest city lawns.

As many as 37 head capsules of grubs have been observed during casual visual inspections of a single mass of skunk excrement. Great numbers of grubs must be devoured by the skunks, as their work has been noted to cover several acres on a single golf course. During the past season every site inspected, except a number of city lawns, showed evidence of skunks' work, and it appears that skunk feeding was more pronounced throughout the State in 1941 than in the immediately preceding years.

It is recognized that such activities of skunks are in general beneficial. However, they will also feed in turf where little or no apparent damage by the grubs occurs. The resulting damage by rooting in such turf often means reseeding. Valuable turf areas protected by chemical treatments which eliminate the grubs should not be subject to skunk damage.

SOME OBSERVATIONS ON PALES WEEVIL INJURY TO WHITE PINE PLANTINGS IN NEW ENGLAND

R. B. Friend and H. H. Chamberlin [1]

The pales weevil (*Hylobius pales* Herbst.) has long been known in New England as the principal factor causing the failure of white pine plantings on recently cut-over pine land. The adult weevils feed upon the bark of the young trees, killing a large proportion of them under certain conditions. In order to avoid severe injury by this insect, it is customary to delay planting white pine on cut-over pine land until the third season after cutting.

The biology of the pales weevil and the injury caused by it, together with means of avoiding this injury, have been discussed by Carter (1) and Peirson (2). The adults are attracted to an area by the odors emanating from freshly cut pine stumps, slash, logs and sawn lumber. They feed upon the bark of young pines or that of the twigs and small branches of older trees. The eggs are laid in small cavities which the adults gnaw in the bark of the roots of stumps. The larvae develop in the roots and become fully grown about the first of September. The pupal period is spent in cells in the roots. The adults of this generation emerge about the first of October and feed, as did the previous generation, until about the last of the month. They hibernate in the soil, usually at the bases of the young trees upon which they have been feeding. The following

[1] Mr. Chamberlin worked on this problem while a student at the School of Forestry, Yale University.

spring, between the latter part of April and the latter part of May, they emerge from their hibernating quarters. According to Peirson they remain near the place of emergence and continue feeding until the middle of June. At this time they migrate, preferably to an area where a logging operation has just taken place.

According to the habits, as given above, there are three periods of active adult feeding during one invasion by the insect, and hence three periods during which injury to a young stand can occur following one cutting operation. These are: (a) during the spring and early summer following cutting, (b) during the subsequent fall, and (c) during the second spring following cutting. Severe injury is confined to trees under about 3 feet in height and over one year old.

Although white pine is the favorite adult host plant, other trees are often attacked. Peirson lists 14 coniferous and two hardwood species on which more or less feeding has been observed. This does not mean that freshly cut stumps of all these species are equally effective in attracting weevils into an area. Pitch pine stumps have been found very attractive, and other pines are probably equally so. Hemlock has been found less attractive than white pine. Wells (3) has found larvae in the roots of dead pines and spruces in a nursery in Pennsylvania.

That young pines nearer stumps are more likely to be killed than those further away has been demonstrated, and our observations confirm earlier reports. The weevils are attracted to the stumps and eat what food they can get in the neighborhood. In the middle of July, 1937, in a planting made in the spring of that year on an area near Keene, N. H., cut over the previous fall and winter, the distances of a number of trees from the center of the nearest pine stump were determined. The data are given in Table 33. The difference in distance from the stump is significant in both plots between uninjured and dead trees. In plot I the difference between uninjured and injured is not significant, and in II the difference between dead and injured is not significant. Inasmuch as the trees classified as "injured" showed all degrees of injury from very slight to very severe, in neither plot would the difference between "injured" and either "uninjured" or "dead" be as striking as the difference between "uninjured" and "dead".

TABLE 33. MEAN DISTANCE OF TREES FROM NEAREST PINE STUMP

Plot	Uninjured		Injured		Dead	
	No. of trees	Distance in feet	No. of trees	Distance in feet	No. of trees	Distance in feet
I	32	8.1 ± .42[1]	93	7.7 ± .28[1]	63	5.7 ± .24[1]
II	30	11.5 ± .72	48	9.2 ± .43	68	8.4 ± .38

[1] Refers to probable error.

The usual method of avoiding pales weevil injury in plantations is to delay planting until the third season after cutting. On areas where natural reproduction is taking place the methods advocated have been to either cut the fall or winter following a heavy seed crop or make a preliminary thinning to stimulate reproduction which will be available when the clear cutting is made (2). It has been suggested that in areas to be planted the slash should be burned over the stumps, and all young natural reproduction removed the spring following cutting. The area could then be planted the second spring after cutting (2).

At the Yale Forest near Keene, N. H., conditions are favorable to the maintenance of a high population of the pales weevil. The frequent cutting of relatively small areas of white pine in the forest and in the surrounding region provides suitable breeding places. As a consequence, plantings made on cut-over land the first spring after cutting have been unsuccessful. There are certain disadvantages to delaying planting until the third season, as a heavy cover of vegetation develops.

Small experimental plantings of 2-1 white pine stock have been made on cut-over pine land in this forest in order to determine the effect of the weevil during the two years following cutting. The trees were planted as soon as the frost was out of the ground in the spring, during the latter part of April or early in May. At the time of examination each tree was classified as "uninjured", "injured" or "dead". Any degree of injury to a living tree threw it into the injured class. The best criterion of weevil damage, however, is the actual mortality of trees, as many recover from a considerable loss of bark.

In the spring of 1935 an area cut over in the fall of 1934 was planted with a 10 x 10 foot spacing. In part of this area the stumps had been scorched with a blowtorch prior to planting, but the slash was left on the ground. Slash and stumps were left untouched in the rest of the area. An examination of the plot on July 17, 1935, revealed 26 percent of the trees dead, 23 percent injured and 51 percent uninjured in the part containing the scorched stumps. One hundred and forty-two trees were examined. In the part where the stumps were not touched, 43 percent of the trees were dead, 15 percent injured and 43 percent uninjured. Sixty-one trees were examined. On October 20, 1935, the trees on 2,000 square feet in each part of the plot were examined. Between 35 and 40 percent were uninjured in each part and half the trees were dead. The scorching of the stumps was not considered effective, but had the slash also been burned before planting, the results might have been different.

This plot was again planted on April 26, 1936, the second spring after cutting. The trees were set out in 18 rows of 10 trees each, 6 feet apart in the rows, rows 18 feet apart. The presence of stumps and slash necessitated some skipping, so only 171 trees were actually planted. On July 18, 1936, there were 18 dead, 14 injured (9 by pales weevil, 5 by other agents) and 139 uninjured trees in the plot. This is a survival of 90 percent, and of the total number planted 81 percent were uninjured. By the middle of July, 1937, a total of 30 percent (including those trees recorded as dead the year previous) had died of all causes.

The results attained indicated that pales weevil injury is most severe the first spring after cutting, may also be severe the subsequent fall, but is much less serious to trees planted the second spring after cutting. This relatively low mortality the second season occurred in spite of the presence of slash and stumps.

In the spring of 1937 two plots, B and C, were planted on an area cut over in the fall and winter of 1936-37. The trees were spaced 6 x 6 feet. There were 25 pine stumps in B, and 10 in C, besides those in the surrounding area. The condition of the trees when examined is shown in Table 34.

TABLE 34. PALES WEEVIL INJURY DURING FIRST AND SECOND YEARS AFTER CUTTING
Planted Spring of 1937

Plot	Trees planted	July 26, 1937			October 19, 1937			April 22, 1938		July 18, 1938
		Dead	Injured	Un-injured	Dead	Injured	Un-injured	Dead	Alive[1]	Alive[1]
B	188	60	94	34	68	44	16	15	45	45
C	146	63	48	35	32	34	17	7	44	42
Total	334	123	142	69	100	78	33	22	89	87
Percent	100	37	43	21	67	23	10	73	27	26

[1] Including those injured but not dying.

The mortality the first spring and early summer after planting was 37 percent in these two plots. An additional 30 percent had died of previous injury and fall feeding by October 19. By April 22 of the second spring after planting the mortality had reached 73 percent. This doubtless occurred before the spring feeding of adults which had hibernated in the plots, as the frost was not all out of the ground at this date, and Peirson states the weevils do not emerge from hibernation until the latter part of April. In other words, the additional dead trees found April 22 over those found October 19 died during the winter or fall of previous injury. Only 2 percent of the trees died between April 22 of the second spring after cutting and the following July 18. This supports the results attained in the first plot. The great majority of the trees which die of weevil injury are killed before the hibernating adults become active the second spring after cutting.

In order to determine the mortality of trees planted the second year after cutting, four plots were planted in the spring of 1938 on land cut over in the fall and winter of 1936-37. Plot D was planted in B above, the gaps caused by weevil injury in the latter being filled in. Plot E was likewise planted in C above. Plot F was planted in the area containing B and C, but about 200 yards from them. Plot G was planted in another area about one mile distant. All trees were spaced 6 x 6 feet. There were 12 stumps in F and 13 in G, besides those in the surrounding area. The condition of the trees when examined is shown in Table 35.

TABLE 35. PALES WEEVIL INJURY THE SECOND YEAR AFTER CUTTING
Planted Spring of 1938

Plot	Trees planted	July 19, 1938			
		Dead	Injured	Uninjured	Percent dead
D	116	6	22	88	5
E	82	9	11	62	11
F	100	14	23	63	14
G	100	3	13	84	3
Total	398	32	69	297	
Percent	100	8	17	75	

Only 8 percent of the trees were killed in these four plots, the greatest proportion in any one plot being 14 percent and the least proportion being 3 percent. Seventy-five percent of the trees showed no injury whatsoever. Inasmuch as many of the trees indicated as "injured" had small feeding scars on the stem, a large proportion of these should recover, and the survival in all plots should be over 80 percent. The weevil damage to these plots exceeded that during the second year in B and C. The reason for this is not clear, as the available information on the habits of the insect would lead one to expect a greater amount of injury the second year to trees planted the first year, than to those planted the second. Unfortunately, the hurricane of September 21, 1938, made further observations on these plots useless.

If a survival of at least 80 percent of a stand set out with a 6 x 6 foot spacing is sufficient, then it is apparent that white pine can be planted on cut-over pine land the second year after cutting instead of the third, under the conditions existing in southern New Hampshire. Our experience at Rainbow, Conn., has been similar. An area of one-half acre was cut over in the winter of 1930-31. White pine, 2 - 1 stock, was planted with a 6 x 6 foot spacing in the spring of 1931. Pitch pine stumps extended throughout the five rows of planted trees on the west side. An examination of the trees on March 10, 1932, showed a loss due to pales weevil of 78 trees out of 134, or 59 percent, in the western six rows. Pales weevil damage in the rest of the plot was negligible. The six rows were replanted in the spring of 1932, the gaps being filled so that the six rows again contained

134 trees. The total loss from all causes the first two years after replanting was 14 trees, or 10 percent.

The reason for the discrepancy between the damage the second year after cutting estimated by Peirson (40 percent of the stand) and that found at Keene is difficult to determine from the data available. Peirson's observations were made on natural reproduction, and his loss the second year was apparently estimated by comparing areas cut the previous fall or winter with those cut a year earlier.

Natural reproduction may be more susceptible to injury the second year after cutting than is 2-1 stock of the same size planted at that time. According to Peirson (2) the adults which emerge in the fall hibernate for the most part in the soil at the base of seedlings on which they have been feeding, and the following spring they begin feeding and remain near the place of emergence until June. It is to be expected, then, that natural reproduction, which is present when the beetles are emerging in the fall and at the base of which the beetles hibernate, would be more severely injured the following spring than stock planted that spring. This assumption is supported by observations at the Yale Forest near Keene, N. H., early in July, 1940, on three plots where the hurricane-felled trees were cut during the fall and winter of 1938-39. In two of these plots (I and II) there were both natural seedlings and planted stock present, but in the third (III) there were natural seedlings only. All the trees examined were 6 inches to 1 foot in height.

In Plot I there were 216 natural seedlings, of which 36 were injured and 180 were unharmed, and 68 planted trees, none of which were injured. In Plot II there were 12 natural seedlings and 106 planted trees, none of them injured. In Plot III there were 100 natural seedlings of which 20 were injured. The seedlings came up through a layer of moss and litter and were damp around the base. Many adult weevils were found in this damp zone on the injured seedlings. The planted trees had soil packed closely around the base of the stem. No adults were found on these trees.

Many factors may influence the proportion of young trees killed by the weevil. The size and density of the trees, the number of stumps present, the proximity of the trees to the stumps, and the presence or absence each spring of new areas attractive to the adults are some of the constituents of the environment which are significant. If no areas containing fresh stumps are available in the vicinity to attract the adult weevils out of an area in which they hibernated, these adults may tend to remain in the hibernating area and feed extensively on the bark of young trees found there. This is at best a guess, however.

In view of the dependence of the abundance of such insects as the pales weevil on the availability of breeding material, regions where little or no such material has been continuously present in recent years should contain a low weevil population, and replanting cut-over pine land to white pine the first spring after cutting should be successful. In the Eli Whitney Forest near New Haven, Conn., such conditions occur. All the white pine, other than a few isolated trees, is on plantations under 40 years of age and, except for sporadic thinnings, no commercial cuttings had been made up to the fall and winter of 1938-39 when wind-thrown timber was salvaged. The pales weevil occurs throughout Connecticut and has been collected in New Haven, but it is not a common insect in this locality and no injury to white pine plantings has been observed in this forest.

In the spring of 1939, following the removal of hurricane-damaged pine the preceding winter, the areas under observation were planted to 2-2 white pine, 2-1 Norway spruce and a very little 2-1 pitch pine. The spacing was approximately 6 x 6 feet, but the planting was very irregular because of the presence of slash. During October, November and December, 1939, all the trees on 18 quarter-acre plots in these areas were examined and the number of stumps recorded.

Only three of the 3,049 trees examined showed any insect injury to the bark, and this injury was not typical of that caused by the pales weevil. Five trees died of unknown causes, probably poor planting or insufficient soil moisture. Twenty-one trees showed symptoms of a chlorotic nature and were not growing. They were classed as "sickly". No pales weevil injury was discovered. The data obtained from these plots are included in Tables 36 and 37.

TABLE 36. CONDITION OF TREES THE FALL AFTER PLANTING
Eli Whitney Forest, 1939

	Killed by weevil	Injured by weevil	Injured by other agencies	Sickly	Dead	Healthy
White pine	0	0	21	8	3	1,689
Norway spruce	0	0	19	10	2	1,185
Pitch pine	0	0	5	3	0	104
Total	0	0	45	21	5	2,978
Percent	0	0	1.5	0.7	0.2	97.6

TABLE 37. NUMBER OF PINE STUMPS IN PLOTS
Eli Whitney Forest, 1939

	Diameter				
	0-4″	5-8″	9-12″	13-16″	17-20″
Number	336	836	731	111	5
Percent	16.6	41.4	36.2	5.5	0.2

That pales weevil injury would have occurred following salvage of the hurricane-damaged timber had the weevils been abundant is indicated by the killing of a number of naturally regenerated seedlings in 1939 in a plot at Rainbow, Conn., where the blown-down timber was salvaged in the winter of 1938-39.

In regions where continuous logging operations have resulted in the building up and maintenance of a large pales weevil population, cut-over pine areas can be planted to white pine the second spring after cutting with an expected loss of not over about 15 percent due to weevil injury. Peirson (2) suggested this as a possible procedure provided the area were free of coniferous seedlings and the slash were burned over the stumps immediately after cutting. The burning of slash and stumps is not essential. The areas studied in Keene, except where noted to the contrary, were free of pine reproduction, and fresh stumps were available in nearby areas as breeding material for adults emerging from hibernation. Both these factors may influence the amount of spring feeding in hibernating areas.

The mere presence of white pine does not indicate a sufficiently high pales weevil population to injure young trees. In regions such as that around New Haven, where no commercial cutting had taken place and breeding material had been scarce or absent for many years prior to cutting, a low weevil population existed in 1939. In fact, as far as injury to the trees planted in the spring of 1939 is concerned, the weevil did not exist. Cut-over pine land in such regions may be safely planted the spring after cutting.

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ELM BARK BEETLES

Philip P. Wallace

Observations on Traps

An extensive project of trapping elm bark beetles was undertaken by the Dutch Elm Disease Eradication unit of the U. S. Bureau of Entomology and Plant Quarantine in Connecticut during 1941. The opportunity to make observations of this project was very much appreciated.[1]

Particular consideration is given to the town of Woodbury, since here a considerable number of traps (18) were placed and the record of samples is complete. Both the elm bark beetles, *Scolytus multistriatus* and *Hylurgopinus rufipes*, are common in this town and the observations made here may well apply to any other similar area.

[1] Mr. T. M. Cannon, of the U. S. Dept. of Agriculture, extended assistance and cooperated throughout this work.

Each trap consisted of 10 elm logs with an average diameter of 5 inches and an average length of 6 feet. Thus the average bark area per trap was estimated to be 78.5 square feet. The logs were all laid in one layer on sleepers, raising them a few inches above the ground. The traps were scattered throughout the town, in various exposures, but so placed that most traps received direct sunlight for about two-thirds of the day. Logs were cut during the latter part of May and early June and immediately placed in position.

Samples were taken during the first week of July, and all logs were removed and burned during the second week of July before any emergence had occurred. A strip of bark 12 inches long and the circumference of the log in width comprised a sample. Limited time and help made it possible to take only one sample per trap. Evidently it is impossible to obtain statistically significant data with this form of sampling, but the work was performed by a number of different men who took a random sample from any log at any location on the log which they happened to cut. The experimental error is subject to great variation but the average for the 18 samples taken at random from 18 different traps may give a satisfactory indication of the average infestation.

The brood galleries per sample formed by *S. multistriatus* varied from 0 to 19 with an average of 2.7; *H. rufipes* varied from 0 to 96 with an average of 27.1. In the 18 samples observed from traps in Woodbury, there were 24 brood galleries of *S. multistriatus* and 512 of *H. rufipes*. By simple calculation the indicated population of adult beetles entering the traps was 2,880 *S. multistriatus* and 61,440 *H. rufipes*.

The total estimated bark area of the 18 traps is calculated to have been 1,413 square feet. If this is compared with the surface of a large tree it is found approximately equal to that of three elms having trunks with an average diameter of 30 inches, 20 feet long, each with five leaders 12 inches in diameter and 20 feet long.

Since *S. multistriatus* is so much more important than *H. rufipes* in the transmission of Dutch elm disease, the trapping project may be evaluated by the number of adult *S. multistriatus* destroyed. The number of galleries per sample, 2.7, is equivalent to 2.0 per square foot, and this is a relatively light infestation. Subsequent to the destruction of these traps observations were recorded of the second generation infestation by *S. multistriatus* in various other elm material in Woodbury, and the average was found to be 9.0 brood galleries per square foot.

Unfortunately, comparable traps were not present for the second generation of adults and the amount of suitable elm bark beetle breeding wood in the vicinity never remains constant. However, it is obvious from these observations that in an area of approximately

34 square miles, the size of Woodbury township, a very great number of traps would be required to materially reduce the population of *S. multistriatus*.

Notes on Abundance of Certain Parasites

It has been suggested that hymenopterous parasites have easy access to and may be more abundant in the galleries of elm bark beetles in small dimension breeding material, since the thickness of bark appears to be quite closely correlated with the diameter of a section of elm.

During July, 1940, an elm heavily infested with *Scolytus multistriatus* was cut and sections were placed in emergence cans. **A** contained 4 logs 18 inches long and 4½ to 7 inches in diameter; **B**, 5 logs 2¼ to 4¼ inches in diameter; **C**, 7 logs 1 to 2⅞ inches in diameter. Emergence of all parasites and of *S. multistriatus* adults was recorded daily until complete on July 17, 1941. The presence of large numbers of *Magdalis* spp., occasional *Saperda tridentata*, *Neoclytus acuminatus*, *Tomaxia bidentata* and others, complicates the determination of the number of parasites actually attacking *S. multistriatus*, but does not affect the number of parasites nor the number of *S. multistriatus* emerging from the various sized logs.

The braconid, *Spathius canadensis* Ashm.,[1] and the chalcid, *Trigonura hicoriae*, are both recorded from a number of different hosts. *Pachyneuron* (*Chiropachys*) *colon* and *Helcon* sp. are apparently less common. Since several different species of bark and wood-boring larvae were present which might have been host to these parasites, they cannot be definitely assigned to *S. multistriatus*. *Magdalis* spp. were much more abundant in the smaller logs and this may account for the much larger population per square foot of *T. hicoriae* in the logs **C**. This species has not been reared from *S. multistriatus* larvae although it commonly emerges from elm. Emergence records of different species are given in Table 38.

TABLE 38. EMERGENCE RECORD

Emer. can	*S. multistriatus*	*S. canadensis*	*P. colon*	*T. hicoriae*	*Helcon* sp.	Total parasites
			1940—August 7 to October 25			
A	2,641	778	88	—	—	866
B	402	239	80	—	—	319
C	16	36	28	—	—	64
Total	3,059	1,053	196			1,249
			1941—May 19 to July 17			
A	3,234	147	—	32	32	211
B	1,754	143	—	133	30	306
C	382	73	—	133	13	219
Total	5,370	363	—	298	75	736

[1] J. C. Schread, of this Station, identified the species of Hymenoptera mentioned.

The records of emergence in Table 39 indicate that a large population of parasites was concurrent with the presence of large numbers

TABLE 39. SUMMARY OF EMERGENCE

Emer. can	*S. multistriatus* emerged	No. brood galleries	Emergence per gallery	Parasites per gallery	Galleries per sq. ft.	Bark area sq. ft.	Total parasites	Parasites per sq. ft.	*S. multistriatus* emergence per sq. ft.
A	5,875	192	30.6	5.6	21.3	9.0	1,077	12.1	652
B	2,156	160	13.4	3.9	25.0	6.4	625	9.75	552
C	398	21	19.0	13.5	4.9	4.3	283	6.6	92.5

of larvae and in these data no correlation exists between the abundance of parasites and log diameter. The habit of these Hymenoptera of depositing eggs in openings through the bark may account for this fact.

Scolytus sulcatus LeC. in Connecticut

Since the supposition that *Scolytus sulcatus* LeC. may transmit Dutch elm disease was confirmed by Buchanan (1), the examination of breeding material in various parts of Connecticut has revealed that this bark beetle is not as uncommon as previously supposed, although this species is still relatively very much less common than *S. multistriatus* Marsh. in elm or *S. rugulosus* Ratz. in apple. The habit of feeding in twig crotches and breeding in the dead and dying wood of several species of trees other than elm suggests the possibility that *S. sulcatus* may harbor the inoculum of the Dutch elm disease fungus for long periods, even though the beetles are believed to be of little importance in disease transmission at the present time.

It is apparent that there has been no appreciable increase in the abundance of *S. sulcatus* in Connecticut recently but, as suggested by Pechuman (2), this insect has received more attention during the past few years. The usual host is apple, but it is recorded (Pechuman) from elm, plum, peach and mountain ash.

At the Connecticut Agricultural Experiment Station, *S. sulcatus* is recorded from a number of towns in Connecticut on various hosts, viz:

1933	Greenwich	plum	by Dilloway
1936	Danbury	cherry	" Chapman
1936	Mount Carmel	elm	" Kaston
1937	Greenwich	crab apple	" Cook
1939	Hamden	elm	" Wallace
1941	East Windsor	apple and elm	" Wallace
1941	Portland	apple	" Wallace
1941	Wallingford	apple	" Wallace
1941	Torrington	elm	" Wallace
1941	Greenwich	pear	" Conyers

The specimens collected on pear were taken from twig crotches. The orchard owner noticed a considerable number of twig tips which had broken over and died. On examination it was found *S. sulcatus* adults had caused the injury while feeding.

Undoubtedly this species is fairly well distributed throughout the State but it is seldom of economic importance.

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MISCELLANEOUS INSECT NOTES

Insects Occurring in Forest Tree Seedling Beds. A number of larvae and a few adult beetles were collected from seedling beds in a forest nursery near Pleasant Valley on April 25, 1941. Many small, legless larvae were present, which later were identified as *Brachyrhinus ovatus L.* Occasional scarabaeid grubs were found and these proved to be the larvae of the rose chafer, *Macrodactylus subspinosus* Fabr. A few adult May beetles, *Phyllophaga tristis* Fabr., were also taken.

All the insects were collected from the surface of the soil immediately under heavy burlap mats, which were used instead of a vegetative mulch on the seed beds. The seeds were beginning to germinate and little or no damage occurred. It was suggested that the insects be collected immediately upon removing the mats to eliminate them as a source of damage. The *B. ovatus* larvae were numerous enough in parts of the bed to cause some damage if not removed. [J. Peter Johnson]

The House Cricket. In September an infestation of house crickets (*Gryllus domesticus*) was reported in a home in Foxon. Upon investigation it was found that the crickets had migrated into the house from a small dump on adjoining property. The bran-Paris green bait was recommended for the control of crickets in the house and it was suggested that the dump be properly covered with soil.

A communication reporting crickets in the home and requesting control methods was received from Manchester on November 5. The bran bait was recommended. [J. Peter Johnson]

The Imported Long-Horned Weevil. *Calomycterus setarius* Roelofs, was reported from the following towns in Connecticut: Danbury, Lakeville, New Milford, Sharon, Stratford, Washington and Westport. One report was received from Katonah, N. Y., where adults were found in an attic.

Adult weevils were abundant in Sharon and Stratford. At two separate locations in Sharon considerable difficulty was experienced with the pests in buildings. Over 2,400 adults were collected from one window well at one location, while English ivy and columbine seedlings were damaged in a greenhouse and cold frame at the other site. The weevils in varying numbers were found in localized areas in the other towns. [J. Peter Johnson]

The Bronze Cutworm, *Nephelodes emmedonia* var. *violans* Guénée. A number of specimens of a cutworm which were feeding on the grass areas of the Merritt Parkway were brought in to the entomological department by a representative of the State Highway Department for identification and control recommendations. These were identified by Messrs. G. H. Plumb and B. H. Walden as the bronze cutworm, *Nephelodes emmedonia* var. *violans* Guénée (Figure 8). Upon visiting the area of infestation it was found that the feeding occurred in the center and bordering grass areas of the dual highway, extending from the western part of Norwalk through New Canaan, Stamford and the greater part of Greenwich. The infestation varied from light to very heavy and the injury to the grass varied accordingly.

It was estimated that the injury was very severe on at least 50 acres where the green grass was eaten to the crowns and only the brown, dead grass was left. In many places feeding evidently began immediately under small trees, as the injured areas appeared as brown, dead circles with the trees as the axes. The height of the feeding period was over by May 19, when large numbers of the caterpillars were migrating, probably to pupation quarters. The caterpillars were particularly active between 6 and 7 a. m., daylight time.

As the season progressed much of the heavy turf, where the feeding had not been excessive or prolonged, recovered. In several areas, especially where the turf had not been very heavy and well established, the grass did not recover very well and weeds gained a foothold.

Lintner, in the First Annual Report of the State Entomologist of New York, 1882, states that the moth is present during August and September. Oviposition takes place during this time and the young larvae, after eating sparingly, hibernate during the winter and resume feeding when the grass begins to grow in the spring. Upon completing their growth in May, they enter the ground and pupate sometime in June or July. They remain in the pupal state for one to two months and emerge as adults.

The occurrence of this insect in such numbers is the first outbreak known to have occurred in Connecticut in over 40 years. The cutworm occurs over a large area of the United States and in Canada, where it occasionally attacks pastureland and cornfields. However, due to the long period the larvae are present when feeding and rest-

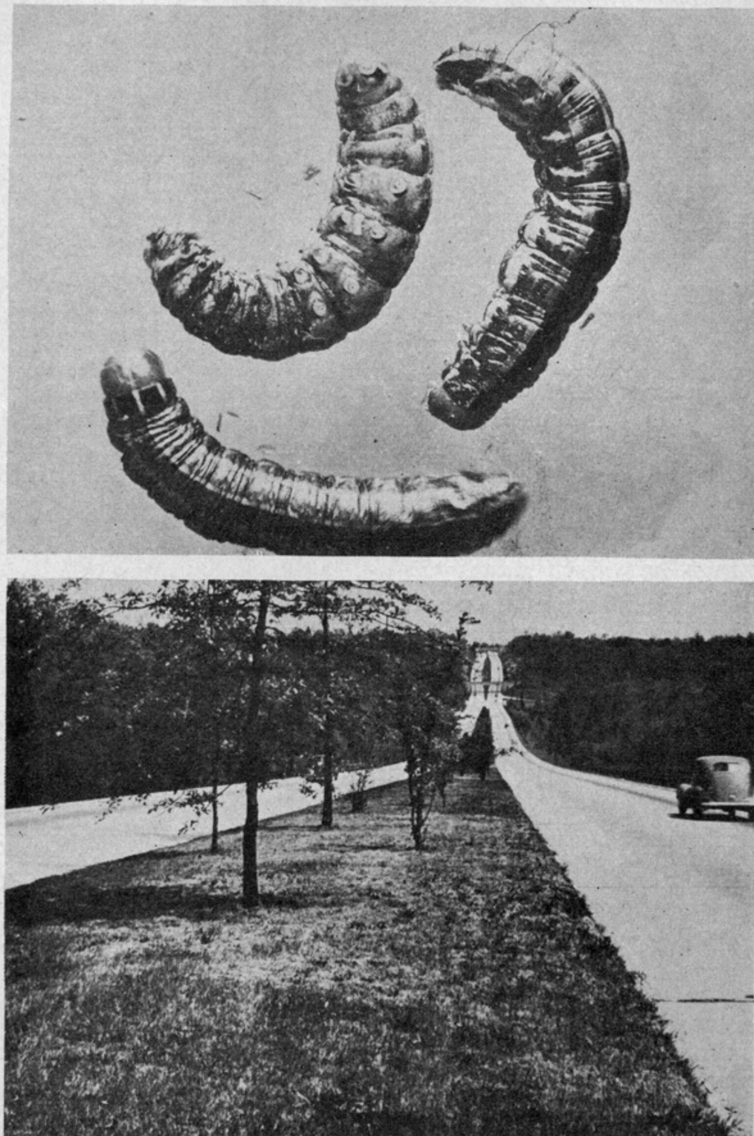

Figure 8. The bronze cutworm, *Nephelodes emmedonia* var. *violans* Guénée. Above, fully grown larvae, natural size; below, typical injury to grass (light areas).

ing in the soil prior to pupation, the insect is subject to attack by many parasites and disease. The usual experience has been that the year following an outbreak the cutworms are comparatively few in number and cause no particular damage. [J. Peter Johnson]

The Chinch Bug, *Blissus hirtus* Mont. The hairy chinch bug damaged many lawns during 1941. Several acres of turf on estates along the coast in the town of Westport were heavily infested with first generation bug populations of more than 1,000 to the square foot. Second generation bugs damaged lawns in Hamden, Hartford and vicinity, and New Haven. A number of fairways containing bent grasses, on a golf course in Hamden, were injured during late August and early September.

During late June and early July experiments with one percent and one-half of one percent rotenone dusts, and tobacco dust containing one percent nicotine, applied at the rate of 25 pounds to 1,000 square feet, were conducted in Westport on a very heavy, dense turf containing a high percentage of bent grass. These experiments, with the exception that a more finely prepared tobacco dust[1] was used this year, were similar to those made in West Hartford in 1940, on a younger and thinner turf. The three dusts used during 1941 in the heavy turf were about equal in effectiveness. In 1940, the standard tobacco dust containing one percent nicotine was somewhat less effective than the two rotenone dusts, although excellent kills were obtained by all three insecticides.

It is evident from the past three seasons' experience in work on the control of the hairy chinch bug in turf that the density of the turf influences the degree of control obtained and that the method employed in applying the insecticide is very important. Applications of dusts by hand fertilizer-distributing machines should be followed by brushing in the material with a lawn broom or the back of a rake. Power lawn dusters and hand-propelled equipment have been developed, with varying degrees of success, for applying dusts to turf. A hand fertilizer-distributing machine with a brush attachment having advantages over similar machines without brushes is now available.

[J. Peter Johnson]

Egg Deposition by *Brachyrhinus sulcatus* Fabr. On April 29, 1941, nine adult black vine weevils, *Brachyrhinus sulcatus* Fabr., were collected from debris about the bases of several large specimens of the upright Japanese yew, *Taxus cuspidata capitata.* The insects were not fresh in appearance, having fine particles of dust and debris adhering to them. It was apparent that these adults had survived the winter and were entering their second season. This was not considered unusual as a few overwintering adults were collected in the spring of 1940. Smith[2] has reported that adults successfully pass through the winter in Pennsylvania.

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[1] The tobacco dust used contained 1.26 percent nicotine as indicated by analysis, while the fineness was as follows:

Mesh	Finer than
No. 100	92%
No. 200	54%
No. 300	26%

[2] Smith, Floyd B., 1932. Biology and control of the black vine weevil. U. S. Dept. Agr. Tech. Bul. **325**.

On May 1, 1941, the weevils were placed in individual cages each consisting of a transparent celluloid cylinder approximately 1 1/8 inches in diameter and 10 inches in length, the base of which was tightly fitted over the exposed end of the cork of a six-ounce widemouthed bottle. A cotton plug covered with tissue paper was inserted in the upper end of the cylinder. The cages, each containing a single branch of Japanese yew, with foliage, about 7 to 9 inches in length, as food for the weevils, were kept on a laboratory bench in a north light at room temperature. The stem of the branch extended through the cork, which was split for this purpose, into the water in the bottle. As soon as the branches were defoliated or dry they were replaced by fresh ones. At first the eggs were removed and counted every 10 days but this was soon changed to coincide with the changing of the foliage.

Three of the weevils died by May 6 and three others by May 16, 1941, without depositing any eggs. One of the remaining three insects lived until January 12, 1942, and laid a total of 1,114 eggs. Another laid 1,731 eggs, dying on February 3, 1942; while the third survived until February 10, 1942, and deposited a total of 2,429 eggs. The insects deposited their eggs on the tissue covering the cotton plug in the top of the celluloid cylinder, on the side of the cage, in crevices in the cork stopper and on the Taxus branch. A large number were just dropped anywhere or dislodged from the Taxus branch to the top of the cork. A summary of the egg deposition is given in Table 40.

TABLE 40. SUMMARY OF EGG DEPOSITION OF THREE OVERWINTERING *Brachyrhinus* WEEVIL ADULTS

Date	Cage No. 2	Cage No. 8	Cage No. 9
May 6, 1941	20	8	5
May 16, 1941	121	73	103
May 26, 1941	128	61	103
June 3, 1941	91	81	110
June 16, 1941	220	132	149
June 29, 1941	149	92	160
July 19, 1941	294	47	66
Aug. 8, 1941	192	51	54
Aug. 30, 1941	334	155	174
Sept. 16, 1941	192	107	244
Oct. 9, 1941	227	169	279
Oct. 27, 1941	130	51	108
Dec. 3, 1941	196	84	87
Jan. 2, 1942	86	3	66
Jan. 27, 1942	49	Dead 1-12-42	23
Feb. 10, 1942	Dead		Dead 2-3-42
Totals	2,429	1,114	1,731

Smith found that adults confined in the greenhouse laid an average of 661.4 eggs the first season and 374.8 eggs the second. The maximum number of eggs deposited by one adult during two seasons was 1,681. Adults caged out of doors laid an average of 216.1 eggs, while one of the insects laid 863 eggs in two seasons. The number of eggs deposited by the individual weevils varied considerably and varied with the species of plant fed upon. However, the maximum egg-laying capacity of the individual apparently was not ascertained, as the results given in Table 40 indicate a greater potentiality.

Smith also found in his study of adults isolated in the greenhouse that a short period of inactivity took place between late October and late December or early January, and November was the only month of the year in which oviposition did not occur. In the above table it will be noted that no counts were made in November. This was not due to lack of oviposition during that month but to the method in which the counts were made. Most of the eggs recorded on December 3, 1941, were deposited during November. However, as the cages did not contain soil or debris, and were kept at room temperature, the existing conditions may have been a contributing factor to the continuous egg deposition.

[J. Peter Johnson]

An Outbreak of *Symmerista albifrons* A. and S. Early in October, 1940, it was reported to the State Entomologist that a section of woodland in the town of Bloomfield was being stripped of its foliage by insects. Several larvae received at the same time were identified as specimens of the red-humped oak caterpillar, *Symmerista albifrons* A. and S. This larva is so-called because of the prominent red to deep orange hump on the eighth abdominal segment. An inspection of the affected area was made, and it was estimated that from 5 to 10 acres were heavily infested.

There is but one generation of this insect a year. The winter is passed as a pupa in a roughly oval cocoon spun in the fallen leaves and other debris on the ground. The adult moths emerge in June and the females deposit their pale green eggs in small masses on the underside of the leaves. The eggs hatch in about two weeks, and the young larvae are at first gregarious, skeletonizing the leaves. Later they disperse and feed individually, eating the entire leaf with the exception of the midrib and the coarser veins. The larvae reach maturity during August or early September. When fully grown they descend from the trees, seek shelter and construct their cocoons.

In August, 1941, the area was visited several times. The woodland consisted of second-growth mixed hardwoods, with oaks predominating and forming the favored food plant. Defoliation apparently had been recurrent for several years, and seemed to be having a marked effect on the trees. A strip survey then was made to determine more specifically the extent of the injury.

A line 400 feet long was run through a portion of the wooded area. All of the trees of DBH 1 inch and greater within 15 feet on either side of the line were tallied as to species, diameter and condition. White oak included 56.96 percent of the total trees tallied, and scarlet oak, 32.17 percent. Thus the oaks made up almost 90 percent of the entire stand. Most of the white oak fell into the smaller diameter classes, having a spread of from 1 to 7 inches, with 82.83 percent in the 1 to 3-inch groups. The scarlet oak was considerably larger and the spread was from 2 to 11 inches, while 70.47 percent were included in the 4 to 8-inch groups. White oak was preferred by the larvae to scarlet, and many of the former were completely stripped. Of the 262 white oaks tallied, 74 (28.21 percent) were in a dying condition and 33 (12.61 percent) were dead; while 4 (2.68 percent) of the scarlet oaks were dying and 11 (7.38 percent) were dead, out of a total of 149 trees.

Other tree species present were red maple, pignut hickory, chokecherry, largetooth aspen, serviceberry and pitch pine. Red maple was the only one of these to occur in any number (about 9.0 percent). None of these species appeared to be fed upon to any great extent, if at all, and no dead or dying trees were noted.

No observations were made regarding parasites present or degree of parasitism nor were predators seen. However, a wilt disease seemed to be present, as many dead larvae were found hanging from the bark in a typically limp condition.

[G. H. Plumb and A. DeCaprio]

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[1] Bureau of Entomology and Plant Quarantine, U. S. D. A.

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