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CONNECTICUT STATE ENTOMOLOGIST

FORTY-THIRD REPORT

1943

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-third report of the State Entomologist for the year ending October 31, 1943.

Respectfully submitted,

ROGER B. FRIEND,

State and Station Entomologist

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CONNECTICUT STATE ENTOMOLOGIST

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Work of the Department

The effort to increase food production during 1943 has emphasized the role of insects in agriculture. In any food supply program, the first essential is production, and insects affect this both quantitatively and qualitatively. The control of their depredations, always important, is more so under the present stress, and forms our basic research pattern. In addition to this, the Department is responsible for certain large-scale insect control operations, such as those dealing with the gypsy moth and Dutch elm disease, horticultural inspection and quarantine enforcement, apiary inspection, and direct service to the people of the State in aiding them in the solution of various insect problems.

Since the establishment of the office in 1901, the State Entomologist has directed the preparation of a number of series of bulletins published by the Connecticut Geological and Natural History Survey under the general title of Guide to the Insects of Connecticut. The Survey published Part VI, The Diptera or True Flies of Connecticut, First Fascicle, as Bulletin 64 in 1943. This bulletin contains a section on the external morphology by Professor G. C. Crampton of the Massachusetts State College, the key to the families by Dr. C. H. Curran of the American Museum of Natural History, and the key to species, with distribution records, of the Tipuloidea, the most primitive flies, by Professor C. P. Alexander of the Massachusetts State College.

In the insecticide field, particular attention has been paid to the problem of the more efficient use of these chemicals. This is particularly important at the present time when both labor and materials must be used to the greatest advantage and crop production must not decline. Studies of the effect of diluents ("inert" carriers) in dust mixtures, relation between concentration of toxicant and method of application of dusts, effect of combining other materials with rotenone on the toxicity of dusts containing the latter, efficiency of cryolite as an alternate for rotenone, and value of adhesives and safeners in reducing the number of applications in the orchard spray schedule have all yielded significant results.

We have made progress in our investigations of methods of control of several insect pests of orchard fruits. New insecticides useful in the control of the European red mite offer some promise, and good results with a reduced spray schedule have been obtained. Attempts to secure good control of the apple maggot and other orchard pests with cryolite failed, probably because of poor adhesion to fruit and foliage. By using certain adhesives, the number of applications of lead arsenate necessary to control this pest was reduced from five to three. A new insecticide, containing neither arsenic nor rotenone, appears very promising for apple maggot control in cage tests. Progress has also been made in developing a good control of the Japanese beetle on grapes.

In our work with parasites and diseases of insects three pests have received attention. The distribution of *Macrocentrus ancylivorus*, a parasite of the oriental fruit moth, has been carried out as in previous years. The thermal death point of this fruit moth has been ascertained and that of Macrocentrus will be determined. Although the general infestation of Comstock's mealybug has declined in apple and pear orchards, the release of parasites of this pest is continuing. The most promising natural enemy of the Japanese beetle is the bacterium causing "milky" disease. The distribution of this disease throughout the heavily infested parts of Connecticut has been continued, and an examination of experimental plots indicates an increasing infection of larvae in some areas. This disease is being studied in both field and laboratory.

Among pests of vegetable and field crops, the European corn borer, eastern field wireworm, potato flea beetle, Mexican bean beetle, cabbage worms and Japanese beetle have been the objects of investigations. The European corn borer is a serious pest of sweet corn and in 1943 injured potato vines in many areas. In addition to testing the value of certain insecticides in controlling this insect, an attempt has been made to evaluate the individual treatments of the usual schedule on corn. Cryolite has been found effective against the corn borer on potatoes. The eastern field wireworm seriously injures the potato crop, and its bionomics, injuriousness, and control are being studied. Work with the potato flea beetle, Mexican bean beetle, and cabbage worms has been devoted to the evaluation of certain insecticides and the methods of applying them, and, in the case of the bean beetle, to the effect of different populations of the insect on the host plant. The Japanese beetle has damaged soybeans severely and its control on this crop is being studied.

The so-called imported long-horned weevil, *Calomycterus setarius*, is a potential pest of many plants and a study of its biology and control is in progress. It may become injurious to leguminous crops.

In addition to the Japanese beetle larvae, other Scarabaeidae injure grassland. They belong chiefly to the genera *Phyllophaga*, *Serica* and its allies, *Anomala*, and *Ochrosidia*. Particular attention is being given to the first and last of these.

The gypsy moth, smaller European elm bark beetle, European pine shoot moth and white pine weevil are serious pests of trees. The gypsy moth larvae defoliate hardwood trees of several species and are injurious to forests. We are particularly interested in the outbreaks of this species and are trying to anticipate them in our control operations.

The smaller European elm bark beetle is a pest of street and ornamental elms as well as those in the woodlands but, for quite obvious reasons, more attention is paid to it as a pest of shade trees than in the forest. The beetle and disease are being studied in cooperation with the Department of Plant Pathology and Botany. The beetle is not known to occur in eastern Connecticut. The disease occurs in most towns west of the Connecticut River.

The fluctuations in the population of the European pine shoot moth are being studied in a red pine plantation in North Guilford. The rate of increase of this insect has an important bearing on the success of control measures.

The white pine weevil studies at Rainbow have dealt with the effect of the weevil on young trees. The stands have been under observation for 10 years and this phase of the work is concluded.

A sawfly, *Diprion frutetorum* F., which in the larval stage defoliates red pine trees, has recently become abundant in the State. Mr. J. V. Schaffner, Jr. of the Federal Bureau of Entomology and Plant Quarantine has devoted considerable attention to the pest as it occurs in the northeastern part of this country and has contributed a brief discussion of it to this report.

The problem of protecting street and ornamental trees from pests is often acute. In order to form some basis for estimating the damage to shade trees by defoliating insects, a study of the effect of defoliation on elms is being carried out at Mount Carmel. Borers also affect ornamental trees and shrubs, and the conditions leading to infestation as well as the effect of the borers are often obscure. A study of the dogwood borer, about the biology of which little is known, is in progress and should throw some light on these questions.

The Department is charged with certain control, inspection and quarantine enforcement operations. The control of the gypsy moth involves scouting to determine infested areas, suppression of local outbreaks, and mapping of the types of growth in forested areas. Most of the Dutch elm disease work consists of cooperating with the Federal Bureau of Entomology and Plant Quarantine in preventing further spread of the disease into eastern Connecticut.

The Fish and Wildlife Service of the Federal Department of the Interior cooperates with this Station in controlling rodents in the State. We are particularly interested in meadow and pine mice, which are injurious to apple orchards and young forest plantings, and in rabbits as pests of young fruit trees and nursery stock. The control of mice is very important when the mouse population, which fluctuates in cycles, reaches a peak. Mice are apparently beneficial in the forest under some conditions, for there is evidence that they, together with shrews, prey upon gypsy moth larvae and pupae occurring on the forest floor. Rabbit repellents are being studied intensively.

The mosquito control work in Connecticut is under the direction of a State Board of Mosquito Control of which the Director of this

Station is Chairman. The State Entomologist is Fiscal Agent of the Board. Most of the control work is confined to salt marsh breeding areas, but additional attention is being given to fresh water breeding species, including the carriers of malaria.

The nursery and apiary inspections have been carried out as usual. The severely cold weather during the winter of 1942-43 caused a loss of about 30 per cent of the colonies of bees in the State. Much of this loss could have been prevented by proper care.

Inspectors of the Department aid in the enforcement of the gypsy moth, Dutch elm disease, and pine blister rust quarantines and make such inspections as are necessary for the shipment of plants and seeds to other states and foreign countries.

Abundance and Injuriousness of Pests

The insect pests of crops and trees vary in abundance from year to year. Some are seriously injurious much of the time, but others are economically important only during outbreaks, being insignificant in the intervening years. We attempt to evaluate the general abundance of the economically important species.

The infestation of the European corn borer, *Pyrausta nubilalis* Hübn., in early sweet corn was one of the heaviest on record. Many untreated fields produced no marketable crop. The second generation of the borer was also very abundant and caused some serious losses. The Federal Bureau of Entomology and Plant Quarantine estimated a loss in value of $497,636 to the sweet corn crop and $85,596 to the grain corn crop in six counties in Connecticut in 1943. The crops were valued at $746,096 and $376,067 respectively. The first generation of the borer also heavily infested both Irish Cobbler and Green Mountain potatoes in some fields, causing a severe breakage of the vines and undoubtedly some decrease in the crop. Tomato fruits were infested in some cases, apparently by larvae migrating from other host plants growing nearby.

Aphids were very abundant during July and August. Potatoes and tomatoes were injured by *Macrosiphum solanifolii* Ashm.; cabbage, peppers, eggplant and squash were heavily infested by *Myzus persicae* Sulz.; lima beans were attacked by *Aphis rumicis* Linn., and melons by an undetermined species. Aphids were present to a lesser extent on spinach and beets. In the fall, cabbage aphids were abundant on cole crops, especially broccoli and brussels sprouts, and, to some extent, turnips.

The seed-corn maggot, *Hylemyia cilicrura* Rond., was very destructive early in the season, damage being aggravated by slow germination in cold wet ground and by deep planting of seeds by many gardeners. This insect also injured newly set tobacco plants at Windsor.

The cabbage maggot, *Hylemyia brassicae* Bouché; imported cabbage worm, *Ascia rapae* Linn., and cabbage looper, *Autographa brassicae* Riley, were all injurious. The maggot infestation was about as usual, the damage to unprotected early cabbage being moderate. Radishes seemed to be less affected than in 1942. The cabbage worm appeared earlier than usual and caused a moderate amount of damage. The looper, which has been abnormally abundant the past two years, was very destructive later in the season.

The potato flea beetle, *Epitrix cucumeris* Harris, and the potato leafhopper, *Empoasca fabae* Harris, were abundant, the former injuring potatoes, tomatoes and eggplant, and the latter being accompanied by serious tipburn on potatoes. The Colorado potato beetle, *Leptinotarsa decemlineata* Say, was more abundant than usual but was not a serious pest. The three-lined potato beetle, *Lema trilineata* Oliv., was destructive in some home gardens. The eastern field wireworm, *Limonius agonus* Say, severely injured potato tubers in restricted areas in Hartford County and caused the usual loss to the crop. This insect is one of the most serious pests of our agriculture.

The striped cucumber beetle, *Diabrotica vittata* Fab., was not as abundant as usual, although some loss of seedlings of cucurbits occurred. The squash bug, *Anasa tristis* DeG., was not troublesome.

Both generations of the Mexican bean beetle, *Epilachna varivestis* Muls., were abundant, more so than in 1942, but the high population level of the early 1930's has not been reached.

The garden springtail, *Bourletiella hortensis* Fitch, was abundant early in the season and caused some damage to beet, spinach and pea seedlings in home gardens.

The oriental beetle, *Anomala orientalis* Waterh., was abundant in a cornfield in New Haven, and the larvae destroyed most of the plants on two acres.

The Japanese beetle, *Popillia japonica* Newm., has become a notorious pest in several towns. It is particularly abundant along the shore from Greenwich to Madison, in a broad zone from New Haven north through Hartford to the Massachusetts line, up the Naugatuck Valley to Waterbury, and around New London. The adult feeds on the foliage of many shade and fruit trees, small fruits, shrubs and vines, garden vegetables and flowers, and on early ripening fruits, corn silks, etc. It was quite injurious to the sweet corn crop, eating the silks and tip kernels of the ears, and to several fields of edible soybeans in North Haven. The larval injury to turf was quite conspicuous in some places where no treatment had been applied.

The unusually frequent rains early in the season together with unseasonal heat following the calyx period and during mid-June, the short crop of some varieties, dryness during the middle and latter part of the season which apparently favored egg deposition by the apple maggot, and failure to apply sprays at the proper time because of mechanical and other difficulties all contributed to make orchard pests particularly troublesome.

The apple maggot, *Rhagoletis pomonella* Walsh, continued to be our most important apple pest. Damage was particularly severe in orchards where a full control program was not followed or in portions of well-sprayed orchards near neglected trees. Adult flies lived until harvest time in many orchards and eggs were laid almost continuously throughout August.

The control of the plum curculio, *Conotrachelus nenuphar* Hbst., in apple orchards was hampered by incessant rains early in the season which washed off the sprays as rapidly as they were applied. Many growers failed to control the insect satisfactorily and more than the usual damage occurred.

The codling moth, *Carpocapsa pomonella* Linn., increased sharply in abundance and during the last half of the season was presumably favored by hot dry weather. Some injury to apples occurred. The European red mite, *Paratetranychus pilosus* C. and F., not abundant early in the season, became numerous in August and browned the foliage of apple trees in some orchards. Apple redbugs, *Lygidea mendax* Reut., were abundant and quite injurious. The red-banded leaf roller, *Argyrotaenia velutinana* Walk., was abundant in apple orchards in Wallingford but not so much so elsewhere. Apple leafhoppers were locally abundant and caused severe damage near woodlands in some cases.

The apple leaf-curling midge, *Dasyneura mali* Kieff., was found in Connecticut in an apple orchard in Wilton in June. This insect is new to Connecticut but has been a pest of apples for some years in Massachusetts.

Comstock's mealybug, *Pseudococcus comstocki* Kuw., was less abundant in apple orchards than in 1942. Apple aphids, both rosy, *Anuraphis roseus* Baker, and green, *Aphis pomi* DeG., were relatively few in number. The Japanese beetle, although abundant throughout parts of the State and injurious to many plants, did little damage in commercial apple orchards to either fruit or foliage. The injury to grapevines by this insect was severe in south-central Connecticut and in the vicinity of Hartford.

The pear midge, *Contarinia pyrivora* Riley, caused considerable loss in two pear orchards in Wallingford. The pear psylla, *Psyllia pyricola* Foerst., caused some injury to foliage in late summer. The plum curculio and codling moth were more abundant and injurious than usual on pears.

There having been practically no peach crop in Connecticut in 1943, little can be said about the pests of that fruit. The oriental fruit moth, *Grapholitha molesta* Busck, survived the winter successfully. The peach borer, *Conopia exitiosa* Say, was about as abundant as usual.

The grape berry moth, *Polychrosis viteana* Clem., was more abundant than usual on grapes.

Many of our forest insects were affected by the extremely low temperatures of the winter of 1942-43. These minima differed in different parts of the State. At New Haven the lowest official temperature was -9° F., at Hartford -24° F., at Putnam and Cornwall -23° F., and some unofficially reported temperatures in northern Connecticut were as low as -40° F. The larvae of the smaller European elm bark beetle, *Scolytus multistriatus* Marsh., were noticeably affected by the cold, and a mortality of up to 80 per cent was noted where the insect occurred above the snow line in Litchfield and New Haven counties except in the shore region. As reported by Wallace and Beard (Conn. Agr. Expt. Sta. Bul. 472: 291-305, 1943) the effect of cold becomes operative when the temperature reaches -5 to -10° F. The infestation was very light in 1943 in elm limbs broken by the ice storm of the preceding winter. Infestations of the European pine shoot moth, *Rhyacionia buoliana* Schiff., have declined significantly during the past two years because of the cold winters. Samples of infested red pine twigs from a number of plantations showed complete larval mortality. The larvae of this insect die at -19° F. according to West (Ann. Ent. Soc. Amer. 29: 438-448, 1936). The gypsy moth, *Porthetria dispar* Linn., also suffered an appreciable mortality during the winter. A majority of egg masses exposed above the snow line produced no larvae in the spring. Summers (U. S. D. A. Bul. 1080, 1922) has shown that gypsy moth eggs cannot survive -25° F., and that some are killed at higher temperatures.

The elm leaf beetle, *Galerucella luteola* Müll., was moderately injurious to elms, but the fall canker worm, *Alsophila pometaria* Harr., was very abundant, especially in the southern part of the State where it defoliated many elms, oaks and hickories. A heavy emergence of canker worm adults in November, 1943, presages an outbreak in southern Connecticut in 1944. The elm lacebug, *Corythucha ulmi* O. and D., was very abundant in the Housatonic River Valley and the northern part of the Farmington River Valley. Leaves on many trees were brown in late summer.

The oak leaf miner, *Lithocolletis hamadryadella* Clem., was common on white and swamp white oaks in southern Connecticut, many trees being severely affected.

The fall webworm, *Hyphantria cunea* Dru., was unusually abundant on many species of trees in the northern part of the State, completely defoliating some smaller specimens.

The birch leaf-mining sawfly, *Fenusa pusillus* LePel. (*pumila* Klug), caused conspicuous injury to gray birch, particularly in eastern Connecticut. Black and gray birches in part of North Haven were heavily infested with a species of *Bucculatrix*.

The tent caterpillar, *Malacosoma americana* F., was quite common in the southwestern part of the State. A local outbreak of May beetles, principally, *Phyllophaga hirticula* Knoch, defoliated hardwood trees in Madison in June.

A stand of young white pine in Salem, bruised by goats, was severely infested with the pitch mass borer, *Parharmonia pini* Kell., the larvae apparently entering the trees at the scars. Trees five to six feet high contained six to eight larvae each.

A sawfly new to Connecticut, *Acantholyda erythrocephala* L., severely injured several ornamental white pines planted along the Merritt Parkway.

The pine sawfly, *Diprion frutetorum* F., has been injurious to a few red pine stands in the State during the last few years. It is not widely destructive. The pine geometrid, *Lambdina athasaria pellucidaria* G. and R., was very abundant in a stand of red pine in North Branford, many trees being severely defoliated.

The dogwood borer, *Synanthedon scitula* Harr., has long been known as a pest of ornamental dogwoods. It has also been found of fairly frequent occurrence in the woods, about three per cent of the trees being attacked.

We receive a large number of insect specimens each year from citizens of the State with requests for information about them. A list of the categories is given below, as is also a list of the species received five or more times. The three leading species are household pests, and most of the field ants and hickory borers were also found in a dwelling by the sender.

In addition to the work of the Department covered in this report, members of the staff have published a number of scientific bulletins and journal papers giving the results of their research as well as popular articles about insect pests. A list of these publications is given on pages 320 to 321.

Summary of Specimens Received, 1943

Fruit pests	25
Field, vegetable and truck crop pests	59
Forest and shade tree pests	58
Pests of shrubs and vines	19
Flower garden and greenhouse pests	15
Household and stored food products pests	60
Timber and wood products pests	47
Soil and grassland pests	37
Insects annoying man and domesticated animals	11
Parasitic and predaceous insects	22
Miscellaneous	37
	390

Insects Received Five or More Times, 1943

	Times Received
Carpenter ant, *Camponotus herculeanus pennsylvanicus* DeG.	14
Termite, *Reticulitermes flavipes* Koll.	14
Black carpet beetle, *Attagenus piceus* Oliv.	12
Japanese beetle, *Popillia japonica* Newm.	10
European corn borer, *Pyrausta nubilalis* Hübn.	9
Hickory borer, *Cyllene caryae* Gahan	8
Common stalk borer, *Papaipema nitela* Guen.	8
Field ants, *Lasius* sp.	7
Potato flea beetle, *Epitrix cucumeris* Harr.	6
Seed-corn maggot, *Hylemyia cilicrura* Rond.	6
Spruce mite, *Paratetranychus ununguis* Jacobi	5

INSPECTION OF NURSERIES, 1943

M. P. Zappe

The annual inspection of nurseries as required by Section 2136 of the General Statutes began on June 29, 1943. Two new inspectors, Messrs. Frank Luddington and Richard Mezzotero, were employed to assist Mr. Devaux and the writer during July and August. Mr. Luddington has had some previous experience as a nursery inspector as he was employed at this work during the summers of 1920, 1921 and 1922. Inspection of nurseries was completed on September 30.

In order to save time and conserve gasoline and rubber, the inspectors did not return to New Haven each night when nurseries 30 miles or further away were inspected. In 1942 five inspectors were employed and the work was completed on September 18; this year with four men, the work was finished on September 30. In addition, the inspectors did some work on the Dutch elm disease project.

In the spring and fall of 1943 the nursery business was good. In fact, some of the nurserymen could not fill all their orders because of a shortage of help and the difficulties of transporting stock. In one of the largest nurseries in the State, no cultivation was done during the summer. This was also true of a number of smaller establishments. Weed growth and grass were high and made it more difficult to inspect these nurseries properly. The practice of leaving large holes (where large nursery trees had been dug) unfilled also made inspection work more difficult and hazardous.

Nursery pests in general were a little less abundant than in 1942, although some individual species were more abundant than in the previous year. One of these, the spruce mite, caused considerable injury during the early part of the season. It was noted in 46 nurseries in 1943 and in only 13 in 1942. Oystershell scale was a little more abundant than in 1942. Fall webworm was more abundant than usual, particularly in the eastern part of Connecticut. European pine shoot moth was very much less prevalent than usual. This was also true of both species of *Adelges* (gall aphids) on blue and Norway spruces. Pine leaf scale on red and mugho pines dropped from 23 cases in 1942 to 10 in 1943. The decrease in some of the insect pests in nurseries may perhaps be explained by the fact that abnormally low temperatures during the winter of 1942-43 killed off some of the less resistant species, particularly the European pine shoot moth.

A large number of nurseries (148) had no serious pests, probably due to the fact that we no longer record minor pests which cannot be transported on nursery stock and for which no treatment is required.

Plant diseases were about as abundant as usual and poplar canker much more so than in 1942. In the case of this disease, infection seems to depend upon the size of Lombardy poplars. Older and larger trees are almost sure to be infected. Younger trees are not so apt to have the disease, but it is just a matter of time before they become infected. All diseased trees are broken by the inspectors, and nurserymen are required to cut and burn the broken or marked trees. Many nurserymen no longer grow this species as it is sure to become infected eventually, and at present there are very few (if any) large Lombardy trees alive in this State.

Table 1 gives the number of nurseries infested by the more common pests during the last 10 years.

TABLE 1. TEN-YEAR RECORD OF CERTAIN NURSERY PESTS

Pests	1934	1935	1936	1937	1938	1939	1940	1941	1942	1943
Oystershell scale	104	93	87	84	53	49	57	77	68	78
San José scale	19	17	11	8	2	1	2	7	4	10
Spruce gall aphids[1]	244	285	337	306	312	216	231	227	210	140
White pine weevil	67	98	82	101	97	93	70	61	27	28
Pine leaf scale	66	42	72	60	25	50	48	46	23	10
European pine shoot moth	120	121	108	128	130	110	108	106	54	6
Poplar canker	39	28	28	26	20	14	15	15	11	28
Pine blister rust	7	2	0	4	5	3	3	4	0	2
Nurseries uninfested	21	16	26	25	32	19	33	32	126	148
Number of nurseries registered	381	372	380	377	402	399	376	356	331	318

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

One of the regulations under which peach stock may be grown in Connecticut nurseries is that there shall be no chokecherries growing within 500 feet of any block of peach trees. This means a careful selection by the nurseryman of a suitable field. If hedgerows are not entirely free from chokecherries at time of planting the peach pits, they must be cleaned before seedlings get above ground. Then they must be kept free of chokecherries until the stock is finally grown and dug. Furthermore, the peach stock is inspected for "X" disease twice during the growing season. Only three nurserymen grow peach trees, and in 1943 only two had peach trees to dig, owing to failure of pits to germinate in the spring of 1942. No "X" disease has been found in Connecticut nurseries for several years.

Only one grower applied for the special raspberry inspection. He was granted a special certificate as only one suspicious plant was found and this was removed. In order to qualify for the special certification, two inspections are required, one in June, the other later in the season. If at the first inspection over 8 per cent of the plants are diseased, the grower is disqualified; if less, he may rogue out the diseased plants, but the second inspection must not have over 2 per cent diseased, and these also must be dug out and destroyed.

A total of 318 nurseries were registered and inspected, but all have not finished their required cleanup operations, and these latter have not been issued certificates to date. A classification of nurseries by size is given in Table 2. A total of 4,662 acres of land were devoted to the growing of nursery stock in 1943.

TABLE 2. CLASSIFICATION OF NURSERIES BY AREA

Area	Number	Percentage
50 acres or more	18	6
10 to 49 acres	45	14
5 to 9 acres	28	9
2 to 4 acres	80	25
1 acre or less	147	46
	318	100

The list of nurserymen varies from year to year. This year there are 13 less nurserymen than in 1942, but the acreage devoted to growing of nursery stock is somewhat greater. A few of the nurseries are temporarily out of business, as the owners have either taken up war work or are in the armed forces. Some of the smaller nurseries that have been carried as side lines have been discontinued because the owners did not find it worthwhile to carry on under the present wartime restrictions.

Some of the nurserymen failed to register before July 1, 1943, and, as required by Section 2137 of the General Statutes, were charged for the cost of inspection. Eighteen nurserymen paid the cost of inspection, and $180.00 has been turned over to the treasurer of the Station to be sent to the State Treasury. Nurserymen who failed to pay the cost of inspection and those who failed to clean up their pests were not issued certificates and therefore cannot sell their nursery stock legally.

The cost of inspecting the nurseries, including a few additional visits to see that pests were properly eradicated, was $2,371.55, exclusive of travel expenses.

Other Kinds of Certificates Issued

During the year 147 duplicate certificates were issued to Connecticut nurseries to be filed in other states. Seventy-one dealers' certificates were issued to stores and other dealers who do not grow their own stock. All this nursery stock is purchased from certified nurseries for resale. Under the amended nursery inspection law it is no longer necessary for out-of-state nurserymen to file their duplicate nursery certificates with this office and no shipper's permit is required for nursery stock entering Connecticut. Therefore none were issued. Under the present law, the out-of-state nurseryman has only to attach a copy of his valid certificate to the shipment consigned to Connecticut.

Approximately 401 parcels of nursery stock and other plant materials were inspected and certified for private shipments. Five hundred and eighty-one blister rust control area permits were issued.

Inspection of Imported Nursery Stock

Foreign nursery stock enters the United States at designated ports of entry under special permits issued by the Federal Bureau of Entomology and Plant Quarantine and is released to destination points where it is examined by state inspectors. Before the war large shipments of Manetti rose stocks were imported by rose growers for grafting purposes. During the season of 1942-43 no foreign rose stocks were received in Connecticut, probably due to the war and scarcity of shipping space on boats.

The following shipments of miscellaneous plants and seeds entered Connecticut during the year. This material is allowed entry into the United States in limited amounts under special permit by the Bureau of Entomology and Plant Quarantine. It is sent to Washington, D. C., where it is examined by federal inspectors and then reshipped to its final destination. None of these shipments were examined by state inspectors.

28 ferns
35 perennial plants
19 orchids
24 gladiolus corms
12 miscellaneous shrubs
4 peony roots
7 ounces of seed

QUARANTINE ENFORCEMENT AND MISCELLANEOUS INSPECTIONS, 1943

M. P. Zappe and L. A. Devaux

Many states have quarantines for various pests in order to protect themselves from damage these pests might cause if they were introduced from infested states. This of course hinders the free movement of plants and plant material. Nurserymen and others who do considerable shipping of this type of material are more or less familiar with the requirements of other states. The average person knows very little about such matters and only hears of them when he or she tries to ship plants from Connecticut to other parts of the country. The postal department and transportation companies know that it is illegal to accept plants and plant material for shipment unless accompanied by a valid certificate of inspection. We are often called upon to make inspections and furnish certification for such shipments. In some cases we are obliged to refuse certification because the shipment does not comply with the requirements of the state to which it is consigned. Fortunately, most of the requirements of nearby states are such that we can certify the materials, but it is almost impossible to ship certain plants, fruits, etc. into some of the midwestern and western states.

The European corn borer has spread quite a distance to the west, has crossed the Mississippi River, and is now known to be present in Missouri and Iowa. The federal quarantine has been lifted on this insect, but many states still have their own quarantines to prevent importation of susceptible plants. All of these quarantines will allow movement of host plants of the European corn borer into their states provided they have been inspected and are accompanied by a statement showing freedom from this insect. Of the plants affected by this quarantine, perennials of various kinds and shelled sweet corn are the ones most commonly shipped. A total of 520 European corn borer quarantine inspection tags were issued to certify shipments into 32 states and Canada. A large proportion of these shipments were for seed corn consigned to Canada.

The oriental fruit moth quarantine prevents movement of fruit, used fruit containers and fruit trees. This material can be shipped, but it must be fumigated under supervision in an approved fumigation chamber. The cost of the apparatus is so high that no fruit or fruit trees have been treated for shipment into states having such regulations.

Since the establishment of the Japanese beetle and gypsy moth quarantines in Connecticut, this department has cooperated with the Bureau of Entomology and Plant Quarantine of the United States Department of Agriculture in their administration. 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, Windham and some towns in eastern Litchfield and New Haven counties, is under the supervision of Mr. H. N. Bartley who is in charge of the federal Japanese beetle and gypsy moth office at Waltham, Massachusetts. His inspectors make the necessary inspections to comply with the Japanese beetle and gypsy moth quarantines. In addition, Fairfield County, located within the Japanese beetle quarantined area, is under his supervision. The balance of Litchfield and New Haven counties outside of the gypsy moth quarantined area and the towns of Branford and North Haven in the gypsy moth quarantined area, are under the supervision of Mr. M. P. Zappe who is in charge of the New Haven office.

Japanese Beetle

The Japanese beetle activities consist of seasonal scouting of certain nursery and greenhouse properties 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.

Scouting

Scouting for adult Japanese beetles has been conducted yearly to determine whether or not beetles were present on classified properties. Because of the decrease in the number of classified areas to be scouted the same procedure was used as in 1942, that is, the district inspectors performed the scouting activities instead of scout crews.

Only two districts in the State, containing three classified firms, were scouted during the 1943 season. This work was performed by Mr. J. F. McDevitt, Middletown, Conn., and Mr. D. Harrington, Westerly, R. I. Mr. W. J. Powers, of the Waltham office, assisted the above named inspectors. They began scouting on July 12 and finished on September 17, 1943.

In all, three nursery, greenhouse or other similar establishments were examined from three to four times. A total of 11 adult beetles were found on two of these units. One woodland area was scouted, no beetles being found.

Four firms were removed from the classified list because business conditions did not warrant such classification, and one establishment was removed because of the presence of beetles. One firm relinquished classification in its nursery but retained classification on certified greenhouses.

Inspection and Certification

The total number of plants inspected and certified for shipment to other states and foreign countries was 3,031,312.

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

TABLE 3. NUMBER OF CERTIFICATES ISSUED, 1943

Kind	Farm products	Cut flowers	Nursery and ornamental stock	Sand, soil	Manure	Total
"A"	0	0	3,874	0	0	3,874
"B"	0	0	3,016	0	0	3,016
Total	0	0	6,890	0	0	6,890

No inspections of farm products and cut flowers were made because no towns in Connecticut are within the area which requires such inspection and certification.

Treating

During the past year two nurseries in the State treated nursery stock being shipped out of the Japanese beetle quarantined area with the new and approved ethylene dichloride dip, under our supervision. This method of treating has simplified the procedure considerably, and it is anticipated that more nursery stock will be treated in this way in the future.

Gypsy Moth

The gypsy moth work consists of the inspection and certification of all materials included in the gypsy moth quarantine regulations, occasional scouting of certain areas in order to issue the necessary certificates, and other tasks necessary to the operation of the quarantine.

Inspection and Certification

The total number of plants inspected and certified for shipment to points outside of the quarantined area was 2,076,755. Forest products inspected and certified totalled 32,086 pieces, 209 ½ cords, 1,705,575 board feet and 560 bundles. Stone and quarry products amounted to 420 tons, 125 boxes and 15 pieces. Evergreen products totalled 2,289 bales and 4,282 pieces.

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

TABLE 4. NUMBER OF CERTIFICATES ISSUED, 1943

Kind	Nursery stock	Forest products	Stone and quarry products	Evergreen products	Total
"A"	2,622	144	14	772	3,552
"B"	2,261	630	11	57	2,959
Total	4,883	774	25	829	6,511

Miscellaneous

We are also called upon to certify miscellaneous seed shipments to foreign countries as required by the various foreign regulations. Most of these shipments are consigned to South and Central America and Canada, with an occasional shipment now and then to European countries. During the year 1943, 571 such certificates were used covering 297 shipments of seeds to South and Central America; 33 certificates were used covering 17 shipments to Europe and 311 certificates because of the European corn borer were used covering 80 shipments of seed corn to Canada.

INSPECTION OF APIARIES, 1943

M. P. ZAPPE

There has been no change in the personnel of the bee inspection service since last year. Mr. W. H. Kelsey works in Litchfield and Hartford counties, Mr. Roy Stadel in Fairfield, New Haven and Middlesex counties, and Mr. Elbra Baker in the eastern third of the State.

The inspectors reported that large numbers of bees died during the winter, due to several causes. Extreme winter temperatures were probably the main reason, together with insufficient stores of honey for winter food. In times of sugar shortages there is always a temptation to remove as much honey as possible, and in some cases this was overdone. As a result the bees starved before the spring honey flow started. Winter stores of honey were of poor quality in some sections and undoubtedly added materially to the winter mortality. Out of a total of 14,903 overwintering colonies of bees in the State, 4,372 colonies or nearly 32 per cent were dead when the inspectors visited the apiaries during the spring and summer of 1943.

This is a more serious loss to the apiarist than bee diseases, predators, poisoning, etc. combined. Even some of the bigger beekeepers sustained losses of as high as 50 per cent of their colonies. The winter of 1942-43 was more severe than normal, and the fact that many colonies were only supplied by the so-called "honeydew" for winter made the losses greater. Even in an ordinary winter the mortality is high, and it

Table 5. Thirty-Four Year Record of Apiary Inspection

Year	Number apiaries	Number colonies	Average number 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
1942	2,354	13,777	5.85	1.18	.201
1943	2,635	14,903	5.65	1.05	.186

would seem very much worthwhile for the beekeeper to make a strenuous effort to see that his bees are properly protected and cared for during this season.

This year 2,635 apiaries were inspected in the State, 281 more than last year, with a total of 14,903 colonies, an increase of 1,126 over last year (see Table 5). Subtracting the number of colonies that died during the winter of 1942-43 from the total number of colonies inspected in 1943 leaves 3,246 less colonies of live bees in the State than there were at the same time in 1942, even though there were 281 more apiaries in the State in 1943 than there were in 1942. The average number of colonies per apiary was 5.65 for 1943 as against 5.85 for 1942.

There was a decrease in the amount of American foul brood this year. For the entire State, 3.6 per cent of the colonies were diseased in 1942 but only 2.5 per cent in 1943. The greatest amount of foul brood was found in New Haven County (5.26 per cent) and Fairfield County (4.88 per cent). Both of these figures were substantially lower than in 1942. Most of the diseased colonies were burned either by the inspectors or by the owners. In a few cases where there seemed to be a good chance of saving the colony, it was transferred to clean hives and combs. Two colonies of bees were infected with European foul brood and eight cases of sacbrood were found.

TABLE 6. INSPECTION OF APIARIES, 1943

County	Apiaries		Colonies		Per cent diseased	Per cent winterkilled
	Inspected	Diseased (Am.f.b.)	Inspected	Diseased (Am.f.b.)		
Fairfield	457	63	2,685	131	4.88	27.0
New Haven	342	40	2,088	110	5.26	31.0
Middlesex	156	9	1,186	22	1.85	30.0
New London	331	42	2,044	73	1.27	27.0
Litchfield	359	12	1,962	25	1.27	28.0
Hartford	575	14	2,982	12	.4	25.0
Tolland	217	2	1,000	2	.2	50.0
Windham	198	4	956	3	.4	28.0
	2,635	186	14.903	378	2.53	31.75

TABLE 7. SUMMARY OF INSPECTION

	Apiaries	Colonies
Inspected, 1943	2,635	14,903
Infected with American foul brood	186	378
Percentage infected	7.06	2.53
Average number of colonies per apiary		5.65
Average cost of inspection	$1.05	$.186
Total cost of inspection, 1943	$2,780.63	

The total cost of inspection varies somewhat from year to year. The cost per apiary has been decreasing steadily from the highest, $2.64, in 1921, to the lowest, $1.05, in 1943. The cost per colony ($.186) is a very low figure, having been lower in only two years, 1915 ($.175) and 1938 ($.177).

Financial Statement

January 1, 1943—December 31, 1943

Disbursements

January 1 to June 30, 1943:		
Salaries	$744.00	
Travel	388.90	
Miscellaneous	8.75	
		$1,141.65
July 1 to December 31, 1943:		
Salaries	$987.00	
Travel	632.30	
Miscellaneous	19.68	
		1,638.98
Total disbursements for 1943		$2,780.63

Registration of Bees

Section 2129 of the General Statutes provides that: Each beekeeper 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 the number of colonies belonging to each registrant.

In 1943, 2,635 apiaries containing 14,903 colonies were inspected. However, only 1,689 apiaries consisting of 12,102 colonies were registered. This shows that 946 more apiaries and 2,801 more colonies were inspected than registered by the town clerks. No doubt some unregistered apiaries were not inspected by the apiary inspectors who were unable to locate them. Uninspected bees may be a source of foul brood infection for other bees in the community. Every effort is being made to have all beekeepers register their bees so that they may be inspected and treated if found diseased.

GYPSY MOTH CONTROL

J. T. Ashworth and R. B. Friend

Control Work[1]

Gypsy moth control work had to be curtailed on account of men being drafted into the service and others taking up war production jobs. The force was cut down to a very small percentage of the men usually employed. However, the gypsy moth infestation seemed to be at a low ebb this year, and the situation was helped very much by the extremely low temperatures of last winter, especially in the northern sections of the State. We are indebted to the United States Bureau of Entomology and Plant Quarantine for work done in the western part of the State and we wish to take this opportunity to express our appreciation to Mr. R. A. Sheals, in charge; Mr. S. S. Crossman, assistant to Mr. Sheals, and Mr. H. L. Blaisdell, in charge of field operations.

Type-mapping, a description of which will be found in the Connecticut State Entomologist's Report of 1940 was continued and the towns of Stafford, Chaplin, Scotland and Salem were completed.

During July, a survey was made in all towns east of the Connecticut River to discover any localities where defoliation occurred. Two isolated white oaks were found, one located in Stonington, which was completely defoliated, and one in Somersville, 75 per cent defoliated. Another white oak about 80 per cent defoliated was found in the town of Torrington. The infestation has been found to exist over quite an area in the southern part of Torrington.

A small amount of scouting and creosoting was done by state men in six towns, namely, Colebrook, Brooklyn, Durham, Killingly, Middletown and Norfolk. On and around a single oak tree in the town of Durham, 964 egg clusters were creosoted.

Federal men scouted in 34 towns within the barrier zone and east of the barrier zone in the State and found infestations in the towns of Canaan, Cornwall, Litchfield, Morris, Norfolk, North Canaan, Salisbury, Wallingford, Warren, Washington and Watertown. None of these towns, however, had any very large colonies. A detailed account of these infestations may be found in the table of statistics.

No spraying was done by state crews this spring. Man power was short and there were no dangerous colonies known in the eastern half of the State. However, in the towns of Canaan, Cornwall and Litchfield, federal forces sprayed about 41 acres of woodland and 50 trees in the open, using 1,695 pounds of arsenate of lead and 225 quarts of fish oil. Banding was done in seven towns in the barrier zone. Two thousand eleven bands were applied and, during the larval and pupal season, 1,275 larvae and pupae were crushed.

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[1] July 1, 1942 to June 30, 1943.

TABLE 8. SUMMARY OF STATISTICS, 1942-1943

County	Number towns worked	Infes-tations found	Egg masses creosoted	Number colonies sprayed	Lbs. lead used	Larvae, pupae crushed	Bands applied	Miles scouted	Acres scouted
Fairfield	7	0	0	0	0	0	0	325	86,496
Hartford	1	9	39	0	0	0	0	5	2,867
Litchfield	19	57	359	4	1,695	1,217	1,781	426	112,739
Middlesex	1	1	964	0	0	0	0	0	0
New Haven	12	1	4	0	0	58	230	0	99,423
New London	0	0	0	0	0	0	0	0	0
Tolland	0	0	0	0	0	0	0	0	0
Windham	1	2	30	0	0	0	0	11	75
Totals	41	70	1,396	4	1,695	1,275	2,011	767	301,600

Effect of the Low Temperatures, Winter of 1942-43

The population of the gypsy moth in New England fluctuates noticeably over periods of time, not only over the infested area as a whole but locally as well. In 1942, for example, the records of the Federal Bureau of Entomology and Plant Quarantine show that the defoliation caused by this insect was less than that occurring in any year since 1924, and in 1943 a further decline took place. The causes of these fluctuations presumably involve the effect of such factors as weather, parasites, predators and food supply. There is good evidence that the low temperatures of the winter of 1942-43 killed a large percentage of eggs in Connecticut and appreciably depressed the population of subsequent larvae.

According to Summers (U. S. D. A. Bul. 1080, 1922): "An exposure of between -20° and -25° F. is necessary to kill entire clusters, though some eggs in each cluster may be killed by an exposure to -15°. No eggs will survive an exposure to lower than -25°." Eggs close to the ground, covered by snow during the winter, survive much lower air temperatures.

TABLE 9. HATCHING OF GYPSY MOTH EGGS, 1943, IN PER CENT

Egg masses	Height above ground in feet 1	2	3	4	5	6	7	8	10	12	15	16	18	20	25	28	35	45
1	100	0	0	0	0	0	0	0	10	0	0	0	0	77	0	0	0	0
2	0	0	0	0	73	0	92	7	0	0	81			0		0		
3	94	0	0	0	0	0		0	24		30			0				
4	43	0	31	0		0		0	0					0				
5	82	0	0	13		0		44	34					0				
6	76		0			0												
7	78		0															
8	0		13															
9	74		0															
10	23		0															
11			62															
12			0															

In 1943 the Bureau of Entomology and Plant Quarantine reported that only 23.5 per cent of the egg masses, collected in New England and New York, found over one foot above the ground produced any larvae, and only 33.8 per cent of *all* the egg masses collected (300) produced larvae. In Connecticut, the per cent of hatching was determined for 70 egg masses found at various heights above ground and collected in the northern third of the State. The data are given in the table above. Only 22 of these egg masses produced any larvae. Forty-six of the 60 over one foot above ground failed to produce any larvae, but only two of those 10 within one foot of the ground failed to do so. In February, 1943, the temperature in the northern part of the State dropped to -23° to -24° F. according to official Weather Bureau records. It may have dropped below that in some localities. The temperatures of O° F. and lower during the winter of 1942-43 are given in Table 10.

For the sake of comparison, we have a record of the hatching in 1940 of 151 egg masses collected in Granby and Simsbury. All of these produced larvae, although in three masses the per cent of eggs which hatched was 1.6, 33.5, and 43.0, respectively. Eighteen egg masses within one foot of the ground had an average hatching of 83 per cent, whereas the average hatching of the 151 masses was 80 per cent, or about the same. The masses averaged 479 eggs each. The low temperatures during this winter are recorded in Table 10.

TABLE 10. MINIMUM TEMPERATURES, NORTHERN CONNECTICUT (FAHRENHEIT)

Date	Stations		
	Cornwall	Hartford	Putnam
Dec. 27, 1939	—1°		
Jan. 5, 1940			0°
7,	0		
9,		0°	
10,		—5	—6
11,		—1	
17,	—1		
18,	0		
19,	—3	0	
20,		—5	—4
Feb. 23, 1940			—6
27,	0		—3
Dec. 17, 1942	—10°	—6°	
19,		—3	
20,	—18	—10	
21,	—14	—6	
22,	0	—4	
Jan. 9, 1943	—1		
22,	—6		0°
Feb. 14, 1943		0	—4
15,	—23	—18	—18
16,	—18	—24	—23
17,		—2	—4
18,	—1		
Mar. 4, 1943	—1		
9,	0		—1

As Summers has pointed out, the net effect of cold winter weather is modified by local snowfall and other conditions, such as amount of underbrush and stones and other debris on the ground on which eggs may be laid, and wetness of the soil surface. Moreover, other natural factors mentioned above may exert a tremendous effect on the population. In spite of the survival of 80 per cent of the eggs over the winter of 1939-40 in Granby and Simsbury, the gypsy moth population declined abruptly there in 1940 and has remained low ever since. In the winter of 1939-40, the number of egg masses per acre in eight one-acre plots varied from 299 to 1,403. In the winter of 1940-41, the number on seven adjacent one-acre plots varied from three to nine per acre, in the winter of 1942-43, on the same seven plots, from zero to seven per acre, and in the winter of 1943-44, from zero to three per acre.

RODENT CONTROL

FRANCIS B. SCHULER, Junior District Agent

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

The investigations on the cyclic tendencies of the meadow mouse (*Microtus pennsylvanicus*) and the development of a repellent to protect trees and shrubs from cottontail rabbits have been continued during the past year. In July a cooperative program with the Bureau of Entomology and Plant Quarantine was inaugurated to study the importance of predation by small mammals on large larvae, pupae and adults of the gypsy moth.

Meadow Mouse

The fall census of 1942 conducted in orchards throughout the State indicated a uniform and high population in most of the orchards, with the greatest known density being three times the previously recorded high on a comparable survey. Damage was reported in many orchards throughout the State. There were no reports of damage from orchardists who followed the recommended control practices.

A survey made in May of 1943 and many observations earlier in the spring showed that there had been a considerable reduction in the density of the *Microtus* population. This reduction probably occurred in late winter. Prior to this time, there had been prominent signs of a large population.

The results of the September survey of this year differ considerably from those of a year ago. This year the population was spotty. In many orchards where the cover crop was restricted in growth, due to the lack of rainfall, the orchard floor afforded little protection for the mice, and as a consequence there was a low population density. In orchards on wet locations, or where the rainfall had been adequate enough to produce a nearly normal cover crop, the population was dangerous. In one orchard having these conditions, 102 mice were removed from one acre.

Small Mammal-Gypsy Moth Study

In early September, personnel of this office supervised a census, by deadfall trapping, of two quarter-acre quadrats at Eastford and two at Simsbury, Connecticut. The quadrats were located in areas used by the personnel of the Bureau of Entomology and Plant Quarantine for ecological studies of the gypsy moth. The areas were of the oak-hickory type having a deep, moist litter on the floor. These conditions favor small mammals, and the population is relatively higher than that found on dry sites where the litter is shallow. Evidence gathered by the entomologists indicates the survival rate of the gypsy moth is greater on the dry locations.

At the time this census was conducted in Connecticut, similar work was done in Massachusetts and Pennsylvania on both dry and moist locations. The data collected should be useful on a comparative basis. To be of value this study should be continued for four or more years.

Rabbit Repellents

During the past winter, 45 wild cottontail rabbits, *Sylvilagus transitionalis* and *S. floridanus mallurus*, were trapped for use in studying the deterrent effect of various repellents under pen conditions. The procedure was the same as outlined in the 1941 report. Due to the high mortality among the experimental animals, no recheck tests were conducted on the most promising mixtures.

The following mixtures were tested:

R18a, Asphalt emulsion, ethylene dichloride, water
R21, Nicotine bentonite (Black Leaf 155)
R23a, Tetramethylthiuram disulfide
R26a, KR-237, ammonium thiocyanate
R31a, *Daubentonia drummondii*, ethanol extract, NNO adhesive, water
R31b, *Daubentonia drummondii*, ethanol extract, Nevillac soft resin, alcohol
R31c, *Daubentonia drummondii* (40 mesh screened), Nevillac soft resin, alcohol
R31d, *Daubentonia drummondii* extract, Nu-Film, water
R40a, Copper sulfate, NNO adhesive, dicalite, water
R56a, Cedarwood oil, dicalite, soluble dormant oil spray, water
R57a, Terpineol, dicalite, Nevillac soft resin, alcohol
R58a, Allyl isothiocyanate, dicalite, Nevillac soft resin, alcohol
R59b, Herring oil, dicalite, soluble dormant oil spray, water
R60b, Pilchard oil, dicalite, soluble dormant oil spray, water
R61b, Crotonaldehyde, dicalite, Nevillac soft resin, alcohol
R64b, Oil of myrbane, dicalite, Nevillac soft resin, alcohol
R65, Rezyl 12, asphalt emulsion, ethylene dichloride, copper carbonate, dry lime sulfur
R66, Rezyl 869, remainder same as R65
R69a, Alkyl substitute naphthalene, Nevillac soft resin, alcohol
R70b, Neutroleum alpha, Nevillac soft resin, alcohol
R74a, Sulfurized linseed oil, ethylene dichloride
R75a, Lime sulfur, asphalt emulsion, diatomaceous earth, water
R76, Rezyl 315, asphalt emulsion, ethylene dichloride, copper carbonate, copper sulfate, dry lime sulfur
R80a, N-butyl mercaptan, honey
R82, Para-formaldehyde, dicalite, Nu-Film adhesive, water
R83, KR 162 (lead perthiocyanate), NNO adhesive, Nu-Film, water
R84, KR 121 (perthiocyanic acid), Nu-Film adhesive, water
R85, Copper dimethyldithiocarbamate, Nu-Film adhesive, water
R86, Zinc dimethyldithiocarbamate, Nu-Film adhesive, water
R87, KR 92 (allyl perthiocyanate), dicalite, Rezyl 315 and 53, ethylene dichloride
R88, Monothioglycol, dicalite, NNO adhesive, water
R89, Pinene pentasulfide, Rezyl 315 and 53, ethylene dichloride
R90, Mountain Lion urine, dicalite, NNO adhesive, water
R91, Pentachlorphenol, Nevillac soft resin, alcohol

R92, Santobrite Neutral, Nevillac soft resin, alcohol
R94, Tung oil, turpentine
R94a, Tung oil (foreign), ethylene dichloride
R94c, Tung oil (foreign), turpentine
R94d, Tung oil (foreign), turpentine; modification of R94c
R95, Pine tar emulsion (prepared in Wildlife Research Laboratory)
R96, Pine tar, ethylene dichloride, lime sulfur
R97, Rezyl varnish combination, ethylene dichloride, zinc oxide
R98, Rezyl varnish combination, ethylene dichloride, lithopone
R99, Rezyl varnish combination, ethylene dichloride, zinc sulfide
R100, Anise oil, Vatsol OT, Hercolyn, NNO adhesive, water
R101, Pennyroyal oil, Vatsol OT, Hercolyn, NNO adhesive, water
R102, Oil of Citronella, Vatsol OT, Hercolyn, NNO adhesive, water
R103, Cedarwood oil, Vatsol OT, Hercolyn, NNO adhesive, water
R104, Creosote oil, Vatsol OT, NNO adhesive, water
R105, Bear gall bladder contents, Vatsol OT, NNO adhesive, water
R106, Camphor, Hercolyn, Nevillac soft resin, ethyl alcohol
R107, Acetic acid, Vatsol OT, NNO adhesive, water
R108, Quassia chips, Nevillac soft resin, ethyl alcohol
R110, Tung oil filter cake, Rezyl 869, ethylene dichloride
R111, Tung oil pomace (ground), Rezyl 869, ethylene dichloride
R112, Coal tar, ethylene dichloride
R113, Raw linseed oil, pine tar
R114, Pyrethrum powder, NNO adhesive, water

Summary of Tests

Tests	Repellents in order of effectiveness
1	R31a, R31c, R18a, R40a
2	R26a, R23a, R58a, R31b
3	R56a, R57b, R60b, R59b
4	R64b, R61b, R21, R74a
5	R65, R66, R76, R75a
6	R69a, R70b, R80a, R82
7	R83, R84, R85, R86
8	R87, R88, R89, R90
9	R94, R94a, R94c, R94d
10	R96, R95, R112, R113
11	R110, R111, R31d, R114
12	R106, R97, R98, R99
13	R92, R91, R101, R100
14	R103, R102, R104, R105
15	R96, R106, R107, R108

In the preliminary tests above, repellents 31a, 26a, 83, 96 and 106 indicated a greater deterrent value than the other mixtures. These will be rechecked during the winter of 1943.

MOSQUITO CONTROL[1]

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

Mosquito breeding in the 11,000 acres of salt marshes accepted for state maintenance was well controlled considering the lack of labor. What was accomplished was due entirely to the knowledge gained by the foremen through many years of experience in locating sources of trouble and applying the most effective treatment at the proper time.

The work of the season duplicates that of last year. Shortage of labor forced nearly all work into areas where emergency measures were necessary to hold down mosquito breeding. New Haven County areas were served best because two men besides the foreman were employed through the season. Fairfield County was cared for as well as possible by one foreman. Middlesex County could be only partially covered by one foreman without labor assistance. New London County was neglected, due to lack of labor and the travel distance from New Haven.

Plans for important improvements and major repairs to drainage systems could not be carried out because funds could not be made available. These projects included a new dike and appurtenances to replace the structure at Great Harbor, Guilford, destroyed by storms; new tide gates at Sybil Creek in Branford, and Indian River, Clinton; and a new outlet at Hammock Point in Clinton. Other major repairs needed include correction of tide gate at Beach Park Road in Clinton to improve drainage of the marsh back of Grove Beach; improvement of outlets at Mulberry Point and Indian Cove in Guilford; correction of main drainage ditch at Silver Sands, East Haven, and reditching areas at Great Harbor, Guilford, north of Route 1 highway at Grove Beach, Clinton, and areas drained by Sybil Creek, Branford.

It seems apparent that potential mosquito breeding places on salt marsh areas here may or may not produce mosquitoes, depending entirely upon various natural and artificial conditions or a combination of both. Natural conditions would include tidal action, rainfall, humidity, temperature, storms, migration of minnows and porosity of the soil. Artificial or man-made conditions include design and state of repair of drainage systems, pollution and careless disposal of waste, deliberate or accidental placing of obstructions in the drainage system and poorly planned filling of salt marsh areas. Trouble caused by nature can usually be anticipated and corrections made in time to prevent annoyance, but man-made difficulties cannot always be predicted and many times a serious infestation is the first warning of them. Successful control of mosquitoes is accomplished only when

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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.

field operators are intimately acquainted with all local conditions affecting mosquito abundance, and are enabled to employ corrective measures whenever necessary.

Dr. Dietrich Bodenstein, formerly at Columbia University and Stanford University, was assigned to the staff of the State Board of Mosquito Control as entomologist on December 6, 1943. A small laboratory has been set up and Doctor Bodenstein will carry on mosquito investigations.

Due to the fact that military personnel is already being returned from highly malarious regions, it may be well to review the relationship between mosquitoes and malaria. Persons contract malaria only through the bite of certain mosquitoes and anyone may carry the infection in his or her blood for several years. So far as known there is in Connecticut but one species of mosquito, *Anopheles quadrimaculatus*, commonly transmitting malaria from one person to another by its bite. The infectiveness of a mosquito may be retained all through its lifetime, and the insect may live six or eight months and bite several persons. Research has shown that when the *Anopheles* mosquito draws blood, containing disease spores, from a victim of malaria, these spores must pass through certain changes inside the body of the mosquito, consuming about eight to 14 days, before the disease can be transmitted from the beak of the infected mosquito to another person. Symptoms of malaria may appear after about 10 days.

The malaria carrying mosquito is common in Connecticut, having been found in nearly all towns where examinations of likely breeding places have been made.

The adult female insect deposits her eggs on the surface of fresh clean, still water, usually in a grassy edged spring, ditch or pool, or a quiet lagoon of a lake or pond. The eggs hatch in a few days and the young insects then pass through the larval and pupal stages, lying at the surface of the water partly concealed in aquatic vegetation or floating debris. In less than a week the adult mosquito emerges and is soon on the wing.

Anopheles mosquitoes begin to appear about mid-July and bite during the early evening hours. Anyone with active malaria parasites in the blood may become the source of an epidemic if *Anopheles* mosquitoes occur in that locality and he or she is bitten. A victim of malaria should protect himself from being bitten if possible, and nearby mosquito breeding places should be eliminated. This caution may prevent a serious epidemic. Extensive epidemics of malaria in Connecticut are not anticipated, if the present control practices already provided are enforced.

The General Statutes of Connecticut, revision of 1930, sections 2413, 2414, 2415 and 2416, include the necessary authority for anti-mosquito work. Section 2413 gives the authority for any local health officer, health committee or board of health or selectmen to abolish swampy areas upon written complaint, provided the cost does not exceed $300.00. Section 2414 gives the authority to any health officer to order mosquito breeding in rain barrels, other receptacles and pools near human habitation abolished. Sections 2415 and 2416 apply particularly to the treatment of extensive mosquito breeding areas. This responsibility was originally placed upon the Director of the Connecticut Agricultural Experiment Station but a revision of the law in 1939 created a State Board of Mosquito Control, where the authority now rests. These two sections provide for the elimination of mosquito breeding conditions and the maintenance of the necessary drainage systems to prevent mosquito breeding. Funds may be provided by voluntary contributions or by municipal or state appropriation.

The tabulation below indicates expenditures on work in the field in maintaining state-accepted areas of salt marsh.

TABLE 11. STATUS OF CONNECTICUT SALT MARSH AREAS, 1943

Town	Salt marsh acres	Maintained by State	Year ditched	Cost maintenance, 1943 Labor	Travel	Foremen's time
Greenwich	200	none	1913, 1935	——	——	——
Stamford	300	250	1911	30.88	15.50	70.79
Darien	300	none	1912	——	——	——
Norwalk	600	550	1912, 1928	80.63	25.60	328.15
Westport	400	400	1926, 1927	223.29	92.45	855.59
Fairfield	1,200	1,200	1913	248.65	144.30	723.97
Bridgeport	173	——	——	——	——	——
Stratford	1,315	none	1934, 1936	——	——	——
Milford	630	none	1935	——	——	——
West Haven	463	222	1916, 1935	11.05	1.70	6.50
New Haven	750	600	1912, 1917, 1935	339.13	46.10	289.39
Hamden	571	571	1930	77.35	——	38.60
North Haven	310	none	1935	——	——	——
East Haven	545	500	1917, 1929	353.62	35.30	304.53
Branford	895	895	1916	735.30	95.35	724.36
Guilford	1,085	1,085	1916	1,043.93	148.65	804.94
Madison	1,315	1,315	1916	——	72.20	384.71
Clinton	785	650	1926, 1935	——	75.10	336.73
Westbrook	500	500	1927	51.00	109.90	561.46
Old Saybrook	1,373	none	1935, 1936	——	——	——
Lyme	493	none	——	——	——	——
Old Lyme	1,393	1,393	1929, 1931	——	168.50	509.28
East Lyme	424	none	1935	——	——	——
Waterford	204	none	1935	——	——	——
New London	34	none	1935	——	——	——
Groton	304	304	1931, 1932	——	——	——
Stonington	641	641	1931, 1932	——	——	——
Totals	17,203	11,076		3,194.83	1,030.65	5,939.00

REPORT ON PARASITES AND DISEASES

Philip Garman

Oriental Fruit Moth

Various changes are being made from time to time in our parasite breeding technique. For example, a method of rearing Macrocentrus on the potato tuber worm, developed in California, is being tested in our laboratories. It is hoped that we will be able by this method to supplement production in the spring when green apple stocks rot rapidly. At that time, it becomes difficult to rear sufficient fruit moth larvae to maintain Macrocentrus production. Fruit moth eggs are now being obtained in large numbers on green cellophane, which may eliminate the labor and expense of growing privet used heretofore for this purpose. Studies on survival of Macrocentrus and fruit moth larvae in cold chambers are being made in the hope of increasing the number of parasites carried over winter.

Fifty-nine growers ordered parasites in 1943, and a total of 37,000 Macrocentrus in 144 colonies was distributed. Collections from various peach orchards throughout the State indicate that Macrocentrus survived the severe winter of 1942-43 in most localities, but perished in occasional orchards. Wherever continued liberations have been made the parasites have been for the most part maintained at a high level.

Comstock's Mealybug

Field observations and scouting indicated that there was a general decline in orchard infestations throughout Connecticut. During the summer we received two shipments of mealybug parasites from the U. S. Department of Agriculture, Bureau of Entomology and Plant Quarantine. These comprised 1,250 mummies filled with hibernating *Pseudaphycus* sp. and 11,600 adults of the same species. These were released in three orchards where the mealybugs appeared to be most abundant.

Japanese Beetle

Distribution of the "milky" disease by Mr. Schread and a crew of three men was continued and the area between Hartford and New Haven and north to the Massachusetts line has now been covered. Examination of grubs from various infested districts indicates that the disease is now well established and is spreading rapidly. A decline in beetle population in southwestern Connecticut may be associated with a rise of disease and parasites. Data from experimental plot diggings are reported elsewhere by Schread. These include examinations for both disease and parasites.

The report on the laboratory studies of the "milky" disease is given in another section by Beard.

REPORT ON ENEMIES OF THE JAPANESE BEETLE FOR 1943

J. C. SCHREAD

"Milky" Disease

In early April, 1943, 35,000 Japanese beetle grubs were dug at Meadow Brook Country Club, Hamden. These were inoculated with the "milky" disease organism, *Bacillus popilliae* Dut., and sent to the United States Department of Agriculture laboratory at Moorestown, New Jersey. Approximately 25,000 grubs were processed, providing 270 pounds of "milky" disease spore dust. In June the spore dust was sent to this laboratory in two shipments of 180 pounds and 90 pounds, respectively.

Starting in July a crew of three men under supervision commenced spreading the "milky" disease. Twenty-four towns in five counties received from one to 112 one-half acre treatments each. A total of 963 one-half acres or 481.5 acres received 843 pounds of dust. The towns and number of treatments each received are as follows:

Town	No. Treatments	Town	No. Treatments
Fairfield County		**Middlesex County**	
Bethel	19	Cromwell	29
Redding	2	Middletown	112
Danbury	12	Middlefield	34
Hartford County		**New Haven County**	
Bristol	1	New Haven	1
East Windsor	65	Meriden	89
Enfield	83	Wallingford	112
Southington	85	Cheshire	2
Berlin	47	North Haven	44
East Granby	36	Branford	61
Suffield	2	Guilford	1
Simsbury	80	North Branford	44
		East Haven	1
Tolland County			
Somers	1		

The quantity of spore dust used was considerably in excess of that produced from grubs processed. All material over and above the 270 pounds was provided by the Moorestown laboratory. Owing to delay in the shipments of the "milky" disease spore dust, some towns scheduled for treatments were necessarily dropped until next year.

Positive results are being obtained from the use of the "milky" disease in experimental plots. Data accumulated in the spring and again in the fall show there is much improvement over previous seasons in the establishment and spread of the disease. In the Bridgeport and Hartford areas, the "milky" disease "take" was much higher than elsewhere. In June 43.3 per cent of the grubs in the Hartford area were diseased; in Bridgeport, 18.5 per cent. In the fall a considerable drop in percentage of diseased grubs was noted: 11.6 per cent in the Hartford area and 14.6 per cent in the Bridgeport area. The fall grub population was much greater than the June population. However, soil temperature in the fall was less favorable to the development of the disease. Results so far indicate that the length of time the experimental plots have been established is of importance. Both in Hartford and in Bridgeport the highest percentage of diseased grubs were taken from plots treated with disease in 1939 and the lowest percentage from those treated in 1941.

Soil temperature is an important limiting factor in determining the degree to which *Bacillus popilliae* can be effective, as the organism becomes inactive at 60° F. In the absence of its preferred host, *Popillia japonica* Newm., or other hosts equally favorable to its development, the bacterium remains dormant for a long period of time in the soil. Soil temperatures in early summer are usually in excess of 60° F., and grubs infected with the bacillus at that time become seriously affected and die. A higher percentage of disease could not normally be expected in the fall at which time soil temperatures, in response to a normal drop in air temperature, fall rapidly. By the last week in September and early October, soil temperature has dropped to 55° to 60° F. Checks on the experimental plots were taken at a distance of from 50 feet to one-quarter mile (average, 327 feet). The average percentage of diseased grubs in the check plots in early summer was 25.4 per cent. In the fall this figure had dropped to 3.62 per cent. The average number of grubs per square foot in June was 2.3 in the experimental plots and 2.0 in the check plots. In the fall in the treated plots the number of grubs per square foot averaged 6.0 whereas in the check plots there was an average of 9.1 grubs per square foot.

New Canaan as a check town has given very interesting information. No disease has been released in this town; however, on June 30, 1943, diseased grubs were found in three locations; 71.4 per cent diseased in one location, 50 per cent in the second location and 15.2 per cent in the third location.

A field experiment on an extensive lawn in Bloomfield, in which a single circular spot of spore dust one foot in diameter, containing approximately 200,000,000 spores, was used, was conducted in the season of 1943. Grubs were taken from the experimental plot on five occasions, 20 diggings being the limit each time. Grub populations for each series of diggings show considerable variation from a total of 97 grubs or 4.8 per square foot in June to 316 grubs or 15.8 per square foot in October. All grubs were carefully examined for disease but only one revealed the presence of the bacillus. This diseased grub was taken from a hole 18 feet from the "milky" disease spot.

Mortality During the Winter

It has been commonly thought that a severe cold winter would be disastrous to Japanese beetle grubs with perhaps only those far below the surface of the ground escaping destruction. Fox (1) found that under natural conditions the lowest temperature Japanese beetle larvae can normally withstand is about +15° F. (—9.4° C.)

According to this author, some may die at temperatures in the neighborhood of 22° F. (—5.6° C.) Following exposure of Japanese beetle grubs at a minimum outdoor air temperature of +17° F., 100 per cent mortality ensued (1). Mail (2) points out that, with ample ground cover in the form of snow, a prolonged period of extremely cold weather has little effect in reducing the soil temperature much below the freezing point of water, which is considerably above the temperature injurious to Japanese beetle grubs. Data gathered in late winter, 1943, showed the existence of a certain percentage of winter mortality in widely separated localities in the State. It is thought that, owing to low air temperatures in the absence of snow (as a ground cover), soil temperatures dropped below the lethal of +15° F. for Japanese beetle grubs, resulting in their death. Diggings made between March 31 and April 13, 1943, showed as high as 25 to 42 per cent grub mortality in some beetle infested areas in the State during the winter of 1942-1943.

Tiphia

Scouting for adult *Tiphia vernalis* continued during late May and early June. Twenty-five colony sites were visited, some of them on several occasions. These sites varied in age (from the year of parasite release) from two to eight years; most of them, however, were eight, five and three years old. At only five of the 25 localities scouted were *T. vernalis* seen. Two of these sites, at which the parasite was abundant, were established in 1938. One site, at which only a very few *Tiphia* were observed, was established in 1939, and the remaining two sites at which upward of 100 adults were counted in each instance were established in 1941. The oldest colony sites, established back in 1936 and 1937, failed to reveal the presence of the parasite.

The relative abundance of Japanese beetle larvae and cocoons of *Tiphia vernalis* was investigated during early spring, 1943. The procedure was simply to make systematic soil diggings in the areas in which the wasp was formerly colonized and sift the earth carefully to remove all beetle grubs and parasite cocoons. With information thus gathered, it was possible to arrive at the relationship existing between grubs and parasites. The results of this investigation have brought to light some important information relative to the colonization of *Tiphia*. First of all, the older the colony, the more certainty there is of its permanent establishment and increase in population. Although only 18 per cent of all colony sites were examined, it was found that of this number *T. vernalis* cocoons were present in 100 per cent of the 1936 colony localities, 100 per cent of the 1937, 33 per cent of the 1938 and 14 per cent of the 1939. The 1940-41-42 colony sites were not visited. From the standpoint of percentage of Japanese beetle grub parasitism by *T. vernalis*, it was found that, in the 1936 localities, 45.83 per cent of the grub-parasite material removed from the soil was *Tiphia* cocoons. Only one 1937 parasite locality was visited revealing a parasitism of 1.66 per cent, which is hardly significant. The 1938 colony sites gave 9.3 per cent parasitism and the 1939, 1.54 per cent parasitism, which is likewise too small to be significant. The ratio of grubs to cocoons per digging varied greatly. There were instances in the 1936 colony sites which ran as follows: 1-3, 0-2, 2-1, 1-1, 9-8, 3-2, 7-8, whereas in the 1939 sites they were as follows: 13-1, 13-0, 10-0, 8-2, 9-1, 3-1, 5-0. The average number of grubs per square foot in 1943 at the 1936 *Tiphia* colony sites was 2.3; at the 1937 colony sites there were 5 grubs per square foot; at the 1938 colony sites there were 8.1 grubs per square foot and at the 1939 colony sites there were 5.5 grubs per square foot. Obviously, there exist from two to four times more grubs at the 1938 and 1939 *Tiphia* sites than at the 1936 colony sites. Whether or not the reduced beetle grub population at the 1936 colonization sites in contrast to later years may be attributed entirely to *Tiphia vernalis* parasitism is a matter of conjecture. It is certain, however, that the parasite is intrinsically valuable as a natural agency in suppressing Japanese beetles. High parasitism in some of the colony liberations indicates a depressing effect on grub population.

Forty-two observations were made in August and early September at 22 *Tiphia popilliavora* colony sites. All of the colonizations had been made in 1937 and in 1938. The parasite was taken from or observed at nine of the 22 sites. Seven of the nine were 1938 colonizations, the remaining two, 1937. In one instance (Seaside Park, Bridgeport) *Tiphia* were sufficiently abundant to permit collecting hundreds in a reasonably short time. Using the parasites collected from Seaside Park, five new colonies were released in the central part of the State. There were many *Tiphia* observed at all of the remaining eight colony sites mentioned.

Literature Cited

1. FOX, HENRY, 1935. Some misconceptions regarding the effects of the cold of February 1934 on the larvae of the Japanese beetle, *Popillia japonica* Newman. Jour. Econ. Ent. 28: 154-159.
2. MAIL, G. A., 1930. Winter soil temperatures and their relation to subterranean insect survival. Jour. Agr. Res. 41: 571-592.

LABORATORY STUDIES OF THE "MILKY" DISEASE

R. L. BEARD

Studies are in progress on the mode of infection of Japanese beetle larvae by the bacteria causing the "milky" disease and on the factors which affect the dissemination of the disease. Results of experiments being published elsewhere demonstrate that the incidence of disease following injection of spores into the body cavity follows a characteristic dosage response curve and that relatively high concentrations of spores are required to cause much disease. This indicates considerable resistance on the part of the grubs to infection. Spores injected into the foregut of larvae cause an almost negligible amount of disease. Beetle grubs placed in soil contaminated with different numbers of spores become diseased in a characteristic dosage response, but more than 3,000,000 spores per gram of dry soil are required to cause disease amounting to 60 to 75 per cent of the grubs. These experiments indicate that very little disease can be expected from direct inoculation of the soil, and that the beetle grubs themselves must be depended upon to transmit the disease. This work also gives validity to the spot method of field distribution of spore dust, and suggests that to be most effective, the spot should be concentrated in area and placed among heavy beetle grub populations.

FURTHER EXPERIMENTS WITH STICKERS FOR HOLDING ARSENATE OF LEAD ON PLANT FOLIAGE

PHILIP GARMAN

Continuing the work begun several years ago, comparisons of a number of different adhesives were made, both by the glass slide method and also by washing sprayed plants in an improvised laboratory sprinkler-washer. No oils were used in these tests, the object being to find suitable agents for use with sulfur sprays because oils in general are incompatible with them. In the slide tests, lead arsenate was mixed with increasing amounts of each adhesive and the slides were weighed, sprayed, weighed, washed and reweighed in order to determine the loss. The amount of wash, the amount of lead arsenate and the volume of water were held constant and the sticker alone varied. Differences in the behavior of certain well-known materials soon became apparent. Soaps, such as sodium oleate, caused the arsenate to be removed more effectively as the percentage of soap increased. With skim milk and soybean flour, there was a slight rise in adhesion and then a decline. With aluminum hydroxide gel, there was a steady rise. Still another type of sticker gave a rapid rise and an equally rapid decline. One of the best examples of the latter type of adhesion is afforded by benzyl-ethyl starch (Figure 1) which stuck the spray on very well at 20 per cent (3 parts lead arsenate and .75 parts starch), but not so well above 20 per cent. Casein glue increased the tenacity of the mixture up to 40 per cent but it declined when the sticker was increased above 40 per cent. Triple mixtures, such as lead arsenate and bentonite-skim milk, gave much better adhesion than was obtained with lead arsenate and skim milk alone (Figures 2, 5, 6). Bentonite-flour and bentonite-lime were also inferior to bentonite-skim milk for holding lead arsenate on the glass plates or on plant foliage (Figure 4).

In order to determine the actual removal of arsenate from the slides, analyses were made in several tests by Mr. C. E. Shepard. Results parallel closely the total loss of weight obtained without analysis. Figure 3 gives the total loss of weight in experiments with aluminum gel, compared with the loss of lead arsenate computed from chemical analyses (dash line).

A slow increase in the per cent adhering to the slides was noted in tests with lead arsenate alone (no sticker added) when the actual amount on the slides was increased. This results in a slanting base line rather than a level one which must be used for comparison with lead arsenate-sticker combinations (Figures 1-3).

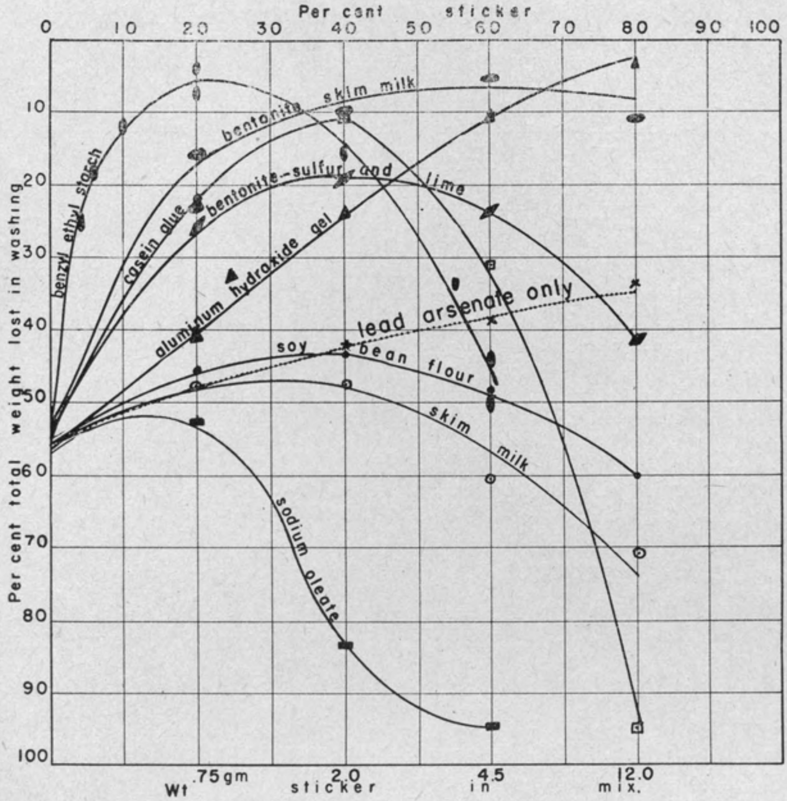

FIGURE 1. Chart showing adhesiveness of lead arsenate when sprayed on glass lantern slides with various "stickers". The materials were settled onto the slides in a settling tower and were washed in a container of distilled water. The washing method consisted of immersion, moving the slide to right or left and removing after each stroke and shaking off the water.

Lead arsenate was used at the rate of 3 gms. in 205 ml. water. This is about four times the concentration usually used in orchard sprays. The sticker varied, as shown in the chart. The curve for lead arsenate was obtained by adding to the original 3 gms. of lead arsenate amounts equal to the amount of sticker used in the sticker tests. The bentonite-skim milk and the bentonite-sulfur and lime were composed of 80 per cent bentonite or 80 per cent bentonite-sulfur, the remainder being either skim milk or lime.

Washing tests with apple, privet and peach foliage, as well as small green apples, confirmed most of the slide results. However, the increasing and then declining adhesion noted in slide tests with such materials as benzyl-ethyl starch, casein glue, etc., could not be verified by washing tests with apple leaves. A slight indication of the decline following an initial rise was, however, observed in the case of waxy privet leaves.

Small scale field tests using young Wealthy apple trees gave evidence that the best non-oil stickers, as determined by laboratory experiments, are not equal to oil preparations for holding on the lead arsenate over long periods. These tests, however, are not yet complete.

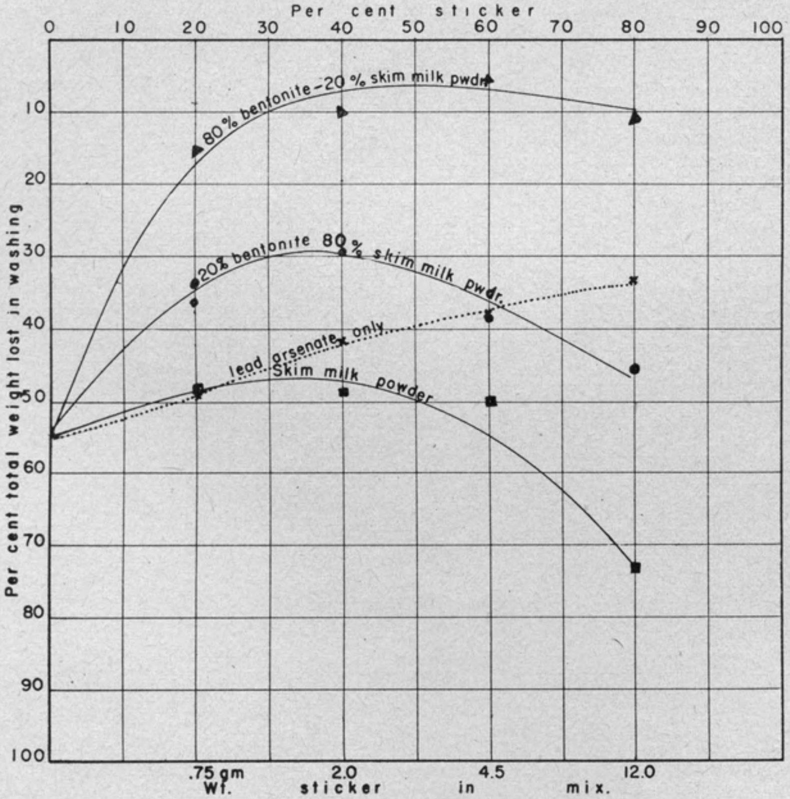

FIGURE 2. Experiments with bentonite-skim milk and skim milk alone as adhesives for lead arsenate. Lead arsenate without sticker given for comparison. Glass lantern slides and the same methods as described under Figure 1 were used.

Summary

In general, considering slide and foliage experiments, it is evident that:

(1) Adhesion as determined by the slide method may increase as the amount of sticker increases, but it may decline, as in the case of pure sodium oleate, or it may rise and then decline.

(2) The best adhesives in these experiments were aluminum hydroxide gel, bentonite-skim milk, benzyl-ethyl starch, bentonite-sulfur with lime, and casein glue. Benzyl-ethyl starch is not on the market at present, and casein glue probably has too much spreader value to allow a heavy deposit build-up. Bentonite-sulfur with lime, bentonite-casein or bentonite-skim milk (80 per cent bentonite, 20 per cent casein or skim milk), and aluminum gel gave fairly satisfactory tenacity in our laboratory experiments both on slides and foliage. These stickers are relatively cheap and all are obtainable. As indicated in the experiments described, aluminum gel must be used in considerable amounts to obtain good adhesion of the spray mixture.

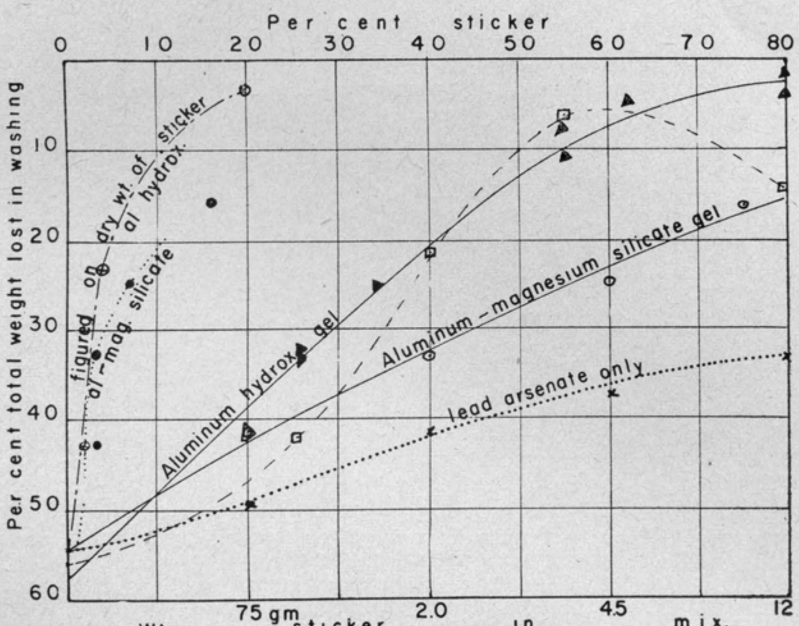

FIGURE 3. Comparison of two aluminum gels for holding arsenate of lead on glass plates. In the test with aluminum hydroxide gel, the dash line gives the results obtained from chemical analyses. Glass lantern slides and the same methods described under Figure 1 were used.

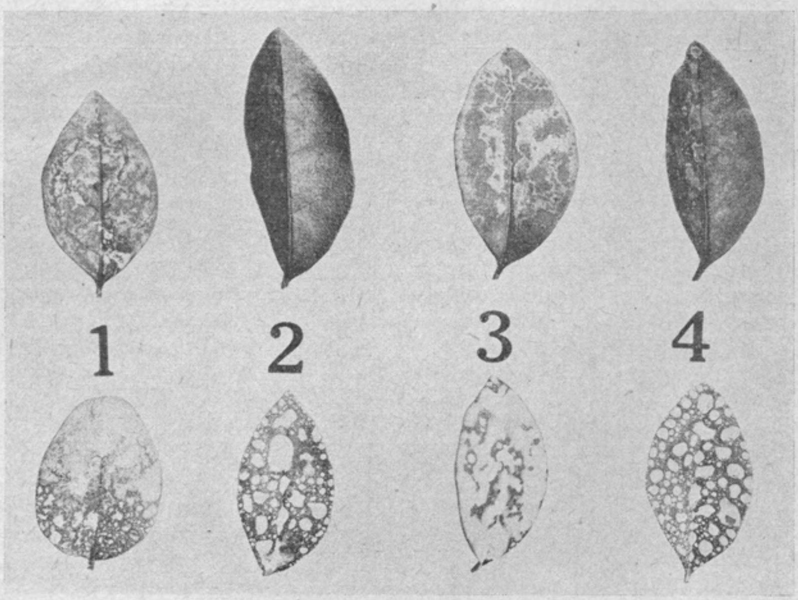

FIGURE 4. Privet leaves sprayed for 10 seconds in a spray tower and the top row washed one hour in a washer delivering 2 gallons per minute. Paired leaves with the same visible deposit before washing.

1. Lead arsenate 3 gms., bentonite 3 gms., flotation sulfur 3 gms., casein 1 gm. to 205 ml. of water.
2. Lead arsenate 3 gms., bentonite 3 gms., flotation sulfur 3 gms., wheat flour 1 gm., water 205 ml.
3. Lead arsenate 3 gms., bentonite 3 gms., flotation sulfur 3 gms., skim milk powder 1 gm., water 205 ml.
4. Lead arsenate 3 gms., bentonite 3 gms., flotation sulfur 3 gms., lime 1 gm., water 205 ml.

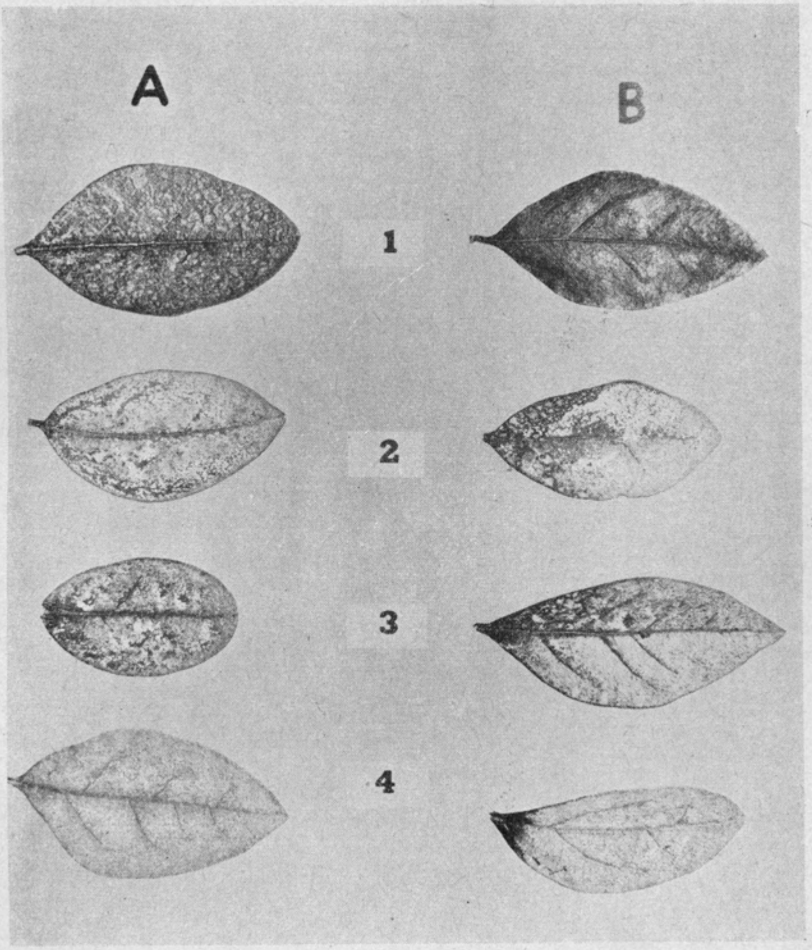

FIGURE 5. Privet leaves sprayed for 10 seconds in a spray tower and Row B washed one hour in a washer delivering 2 gallons per minute. Paired leaves with the same visible deposit before washing.

1. Lead arsenate 3 gms., water 205 ml.
2. Lead arsenate 3 gms., bentonite 1.6 gms., skim milk powder .4 gm., water 205 ml.
3. Lead arsenate 3 gms., bentonite-sulfur (Kolofog) 1.6 gms., lime .4 gm., water 205 ml.
4. Lead arsenate 3 gms., aluminum hydroxide gel 4.5 gms., skim milk .5 gm., water 205 ml.

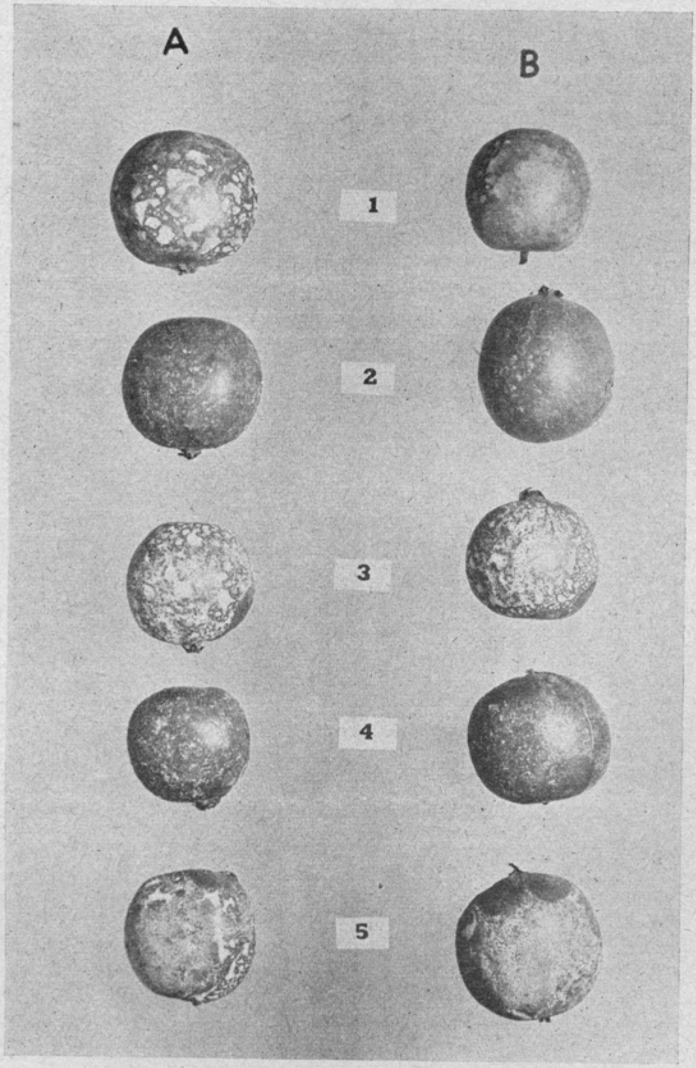

FIGURE 6. Row A unwashed. Row B washed one hour in washer delivering two gallons per minute. Each pair of apples sprayed for 10 seconds in a spray tower; both with the same visible deposit before washing. Note different amounts adhering in Row B.

1. Lead arsenate 3 gms., water 205 ml.
2. Lead arsenate 3 gms., skim milk powder 2 gms., water 205 ml.
3. Lead arsenate 3 gms., bentonite 1.6 gms., skim milk .4 gm., water 205 ml.
4. Lead arsenate 3 gms., Casco glue 2 gms., water 205 ml.
5. Lead arsenate 3 gms., bentonite-sulfur* 1.6 gms., lime .4 gm., water 205 ml.

* Commercial preparation.

FURTHER STUDIES IN SPRAY SCHEDULE REDUCTION

Philip Garman

Spraying experiments at Mount Carmel and Westwoods were continued in 1943. The main objective was to test fungicides as well as insecticides in reduced schedules. The fungicides used were Spergon[1] and Fermate[2]. Results in general continue to confirm previous data, namely, that insect control is nearly or quite equal to that obtained with more extended schedules. None of the 1943 experiments gave insect control (with either full or reduced schedules) equal to the 1941 and 1942 tests. This was largely because of the increased activity of curculio, redbug and apple maggot. For the first time, we obtained satisfactory control of apple scab with the reduced program. While this is very encouraging, it should be repeated in other years and in other orchards.

From work done so far, it seems possible to eliminate two and possibly three sprays from an average eight-spray schedule. In some years and in favorable locations, the entire spray program can probably be reduced to three sprays on scab resistant varieties without loss of effectiveness. (See Conn. Agr. Expt. Sta. Buls. 461 and 472).

It will be noted that the amount of lead arsenate was doubled in two of the reduced schedule sprays. When this is done and a sticker of the type used since 1940 is added, the actual amount of poison on the foliage and fruit is higher throughout the season than can be obtained with the usual dose and more applications. In addition to the increased dose, it is necessary to spray heavily and thoroughly in order to protect the fruit.

Experiments in the Burton orchard as well as those at the Connecticut Agricultural Experiment Station showed that curculio control on fruit from trees with the full schedules containing sulfur was improved by the addition of soybean flour and manganese borate. From these results it would appear advisable to add a spreader to sprays used in reduced schedules. Caution may be needed here, however, since too much spreader may cause the spray to weather more rapidly than is desired.

A general summary of results in control of curculio is given in Table 12. The differences have been analyzed by statistical methods and appear to be significant. A more complete summary of insect, disease and russet control is presented in Table 13. Experiments at Westwoods are shown in Table 14.

Summary and Conclusions

Observations this year indicated that our reduced schedule experiments showed: (1) Poorer curculio control than the extended schedule

[1] Chloranil (tetrachloroquinone: tetrachloro-p-benzoquinone).

[2] Ferric dimethyl dithiocarbamate.

with lead arsenate, sulfur, soybean flour and manganese borate. They were equal to schedules employing lead arsenate and wettable sulfur without spreader-safener. (2) Control of redbugs was also inferior to that obtained by extended schedules containing sulfur, but was not completely satisfactory in any of them since no contact insecticides

FIGURE 7. Baldwin apple trees showing difference in color of the foliage. Tree at the right is infested with European red mites. Treatment: Tree at left received three sprays containing lead arsenate (pink, 3 lbs. to 100, calyx and one cover 6 lbs.), ¾ lb. Fermate, and 1 ½ lbs. aluminum hydroxide gel, in 100 gals. Tree at right received five sprays of lead arsenate 3 lbs. and dry flotation sulfur 5 lbs., in 100 gals. Photo taken September 1.

TABLE 12. ADVANTAGE OF ADDING SOYBEAN FLOUR—MANGANESE BORATE SAFENER AND SPREADER TO FLOTATION SULFUR FOR CURCULIO

(Burton and Connecticut Agricultural Experiment Station Orchards, 1943)

Trees compared	% in favor of spreader-safener	Trees compared	% in favor of spreader-safener
D7 and D6	+13.09	D33 and C34	+17.13
D8 and D13	+ 4.03	D33 and C32	— .32
D5 and D9	+22.50	F12 and F16	+12.32
D9 and D11	+ 5.65	F14 and F16	+ 2.92
E15 and F16	+ .43	E9 and D9	+24.47
E17 and E18	+12.43	E11 and D11	+ 6.78
C24 and C32	+15.83		

Average difference in favor of spreader-safener 9.89

were used in 1943. (3) Red mite control (Figure 7) was better than that secured with full sulfur-lead arsenate schedule. (4) Apple maggot control was consistently better where the reduced schedules were used. (5) Spray russet was less than was produced with the extended program and the foliage was in better condition at the

TABLE 13. CONTROL OF APPLE INSECTS, 1943

Burton Orchard
McIntosh

Treatment[2]	Good[1]	Curculio %	Scab %	Conspicuous russet %
Green	75.04	6.51	4.09	29.36
Blue	60.74	11.67	.95	31.62
White	56.52	20.30	1.42	35.51
Red	63.00	14.60	11.77	6.88
Yellow	53.72	10.97	24.89	7.18

[1] Free of external insect marks, maggot and scab.
[2] Formulae given below

EXPLANATION OF TREATMENTS

Burton Orchard

	Materials for 100 gallons		Sprays
Green	Lead arsenate	3 lbs.	May 6 (Mac. & Del.)
	Dry flotation sulfur	5 lbs.	May 11
	Manganese borate	¼ lb.	May 20–21
	Soybean flour	½ lb.	June 2
			June 17
			July 8
Blue	Same as green only with half the amount of manganese borate and soybean flour		Same as green
White	Lead arsenate	3 lbs.	May 6 (Mac. & Del.)
	Dry flotation sulfur	5 lbs.	May 11
			May 20–21
			June 2
			June 18
			July 8
Yellow	Lead arsenate	3 lbs.	May 6 (Mac. & Del.)
	Aluminum gel	3 lbs.	May 11
	Spergon	¼ lb.	May 20–21
	White oil	½ gal.	June 9
Red	Lead arsenate	3 lbs. (6 lbs. at calyx and 1st cover)	May 6 (Mac. & Del.)
			May 11
	Aluminum gel	3 lbs.	May 20–21
	Spergon	½ lb.	June 9
	White oil	½ gal.	

end of the season. (6) Scab control by the best treatment in the reduced schedule series was superior to that of the full sulfur schedule (Table 14). All in all, our field spray tests during the last three years continue to show promise as regards reduction of the number of sprays and indicate that full success may possibly be obtained with further experiment.

TABLE 14. SCAB AND INSECT CONTROL IN TOWNSEND ORCHARD WITH REDUCED SCHEDULES

Treatment Amounts per 100 gallons	McIntosh Tree No.	 Good[1]	 Scab	Rome Tree No.	 Good[1]	 Scab
		percentages			percentages	
Lead arsenate—3 lbs. at pink,	I12	44.45	9.21	P23	54.16	16.66
6 lbs. at calyx and only cover	G21	19.52	41.71	P25	66.42	2.14
Fermate—¾ lb. plus aluminum	G18	31.99	11.01	P27	84.00	1.33
gel or bentonite and oil	H20	35.08	8.85	P19	59.82	3.57
				D15	58.93	7.83
4 sprays (At prepink, Fermate only)						
Averages		41.29	29.84		65.01	5.46
Lead arsenate—3 lbs. at pink,	K20	53.69	.18	P29	86.11	2.77
6 lbs. at calyx and only cover	M40	59.13	3.19	P31	90.56	.00
Fermate—1 ½ lbs.	E27	21.14	1.14	P33	66.37	2.62
Aluminum gel or bentonite and oil	H27	24.53	4.69	I20	93.68	.75
	O32	37.32	1.67	J17	84.87	3.36
4 sprays (At prepink, Fermate	M14	55.48	4.20	J19	87.33	2.00
only)	O30	80.14	2.36			
Averages		60.79	2.65		84.84	1.72
Lead arsenate—3 lbs.	D3	49.18	9.05	H11	91.46	5.90
Dry flotation sulfur—5 lbs.	E4	42.02	34.43	H17	82.06	3.58
	K25	81.52	7.60	F11	94.80	2.59
6 sprays (At prepink, flotation sulfur only)	K24	43.90	32.07	J21	87.45	5.78
				F7	66.72	12.99
				J27	87.70	2.15
				H5	73.60	3.43
Averages		57.59	19.22		81.57	6.34

[1] Free of external insect marks.

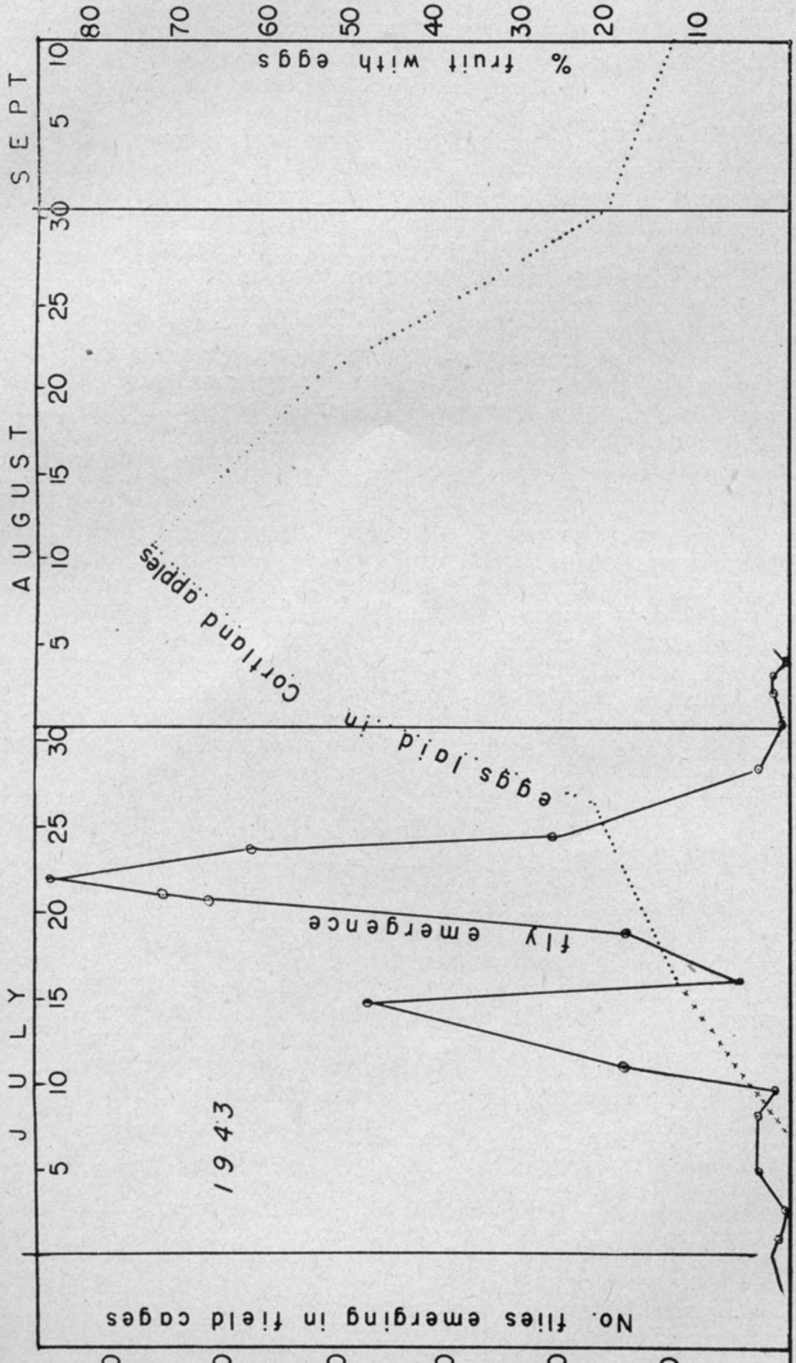

FIGURE 8. Chart showing emergence of apple maggot flies and the egg-laying activities in Cortlands, as determined by examination of apples removed from the trees after exposure for one week at different periods during the summer.

APPLE MAGGOT INVESTIGATIONS

Philip Garman and J. F. Townsend

An investigation of the actual time when apple maggot eggs are laid in Cortland apples was carried on in 1943. Apples were bagged about the first of July and the bags were removed at regular intervals. After removal of the bags, the apples were left on the trees one week before bringing them to the laboratory for counting eggs and punctures. The data show that the flies begin laying eggs about the middle of July or before, and continue into September (Figure 8). It is evident that most of the eggs are laid in Cortlands during the first half of August. Fruit of that variety, therefore, should be protected from the first week in July to the middle of September at least. It will be necessary to determine egg deposition separately in early varieties, such as Astrachan and Gravenstein, as well as later varieties, such as Delicious and Baldwin, in order to get a true picture of the danger period for those varieties.

In the laboratory, tests were conducted with several new insecticides of which dichloro-diphenyl-trichloroethane[1] appears to be the most promising. Cage tests with DDT spray and dust indicate that the dust kills very rapidly at comparatively low concentrations (1 ½ to 5 per cent). So far, the sprays tried in cage tests have been relatively ineffective. Exposure of the chemical under an ultra violet sun lamp did not destroy its effectiveness as a dust. Previous tests showed complete destruction of rotenone when the latter was exposed in the same manner and for the same length of time under the same lamp.

SPRAYS FOR JAPANESE BEETLE CONTROL

J. P. Johnson and Philip Garman

A small, heavily infested vineyard belonging to Mr. Van Doren on Waite Street, Hamden, was selected for experiments with Japanese beetle sprays. The purpose of the work was to test sprays that might afford control with a minimum number of applications. Five different formulae were tried. All treatments were duplicated and one check strip was left for comparison. The materials listed are for 100 gallons of spray.

(1) Lead arsenate, 6 pounds; white oil (80 viscosity), ½ gallon; bentonite, 1 pound, and Ultrawet spreader, ¼ pound.

(2) Basic copper arsenate, 3 pounds; white oil, ½ gallon; aluminum aceto-borate, 1 pound, and benzoic acid, 2 ounces.

(3) Copper arsenate, 3 pounds; soybean flour, ½ pound, and manganese borate, ¼ pound.

(4) Lead arsenate, 6 pounds; Bordeaux mixture (8–8–100).

(5) Copper arsenate, 3 pounds.

[1] Also known as "Gesarol" or "DDT".

Only one application was made, all formulae being applied on the same day, during the morning of June 30.

Frequent inspections showed that formula number 1 afforded the most complete protection, but that number 4 was a close second. Figure 9 shows two of the plots, number 1 (right) and number 3 (left of center), and gives an idea of the difference between the two on August 17. The foliage of the check vines was almost completely destroyed at the time the photograph was made. The differences between numbers 1 and 4 became more apparent as the season advanced, mainly because of the better adhesion of the bentonite-oil. Lead arsenate-Bordeaux mixture, however, gave a reasonable degree of protection for the greater part of the beetle feeding season.

All components of formulae 1 and 4 are obtainable. The ingredients of number 1 should be mixed thoroughly in a bucket with a small amount of water, before dilution. The Bordeaux mixture in number 4 was freshly prepared and was not a commercial product.

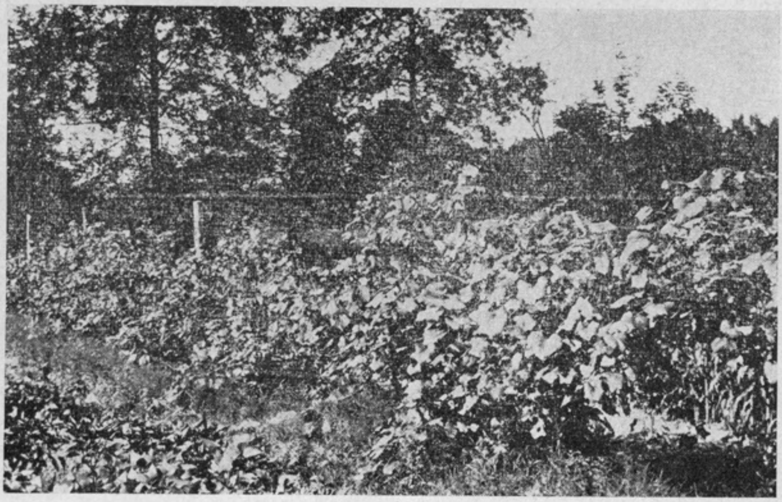

FIGURE 9. Grapevines receiving sprays for control of the Japanese beetle. Vines at right of center received one spray of lead arsenate 6 lbs., 80 visc. white oil ½ gal., bentonite 1 lb., and Ultrawet ¼ lb. in 100 gals. Left of center the vines were sprayed with basic copper arsenate 3 lbs., white oil ½ gal., aluminum acetic borate 1 lb. and benzoic acid 2 ounces. Vines to the right were protected all season with one application on June 30.

WIREWORMS

Douglas E. Greenwood

Wireworms are annually responsible for crop losses in the United States totalling several millions of dollars. These losses are not always apparent since, oftentimes, as in a stand of grain, they are brought about by a reduction in yield rather than in a reduction of marketable value, as on potatoes. Nevertheless, the damage caused by wireworms results in a substantial decrease in the national agricultural production.

The habits of wireworms, in general, are not too clearly understood because of their subterranean existence during a greater part of their lives. Some species pass through a complete life cycle in one year; others require several years. Some species prefer sod land, others prefer land under continuous cultivation. These differences, together with the agricultural practices peculiar to a given region, can make the problem of control either relatively simple or exceedingly difficult.

One of the principal economically important wireworm pests to Connecticut crops is the eastern field wireworm, *Limonius agonus* Say. A discussion of the life history of this species can be found in Bulletin 367 of this Station, but a few remarks on its habits will serve to present our immediate problem more clearly. The eastern field wireworm requires several years to complete its life cycle, so the destructive larval stage is present in the soil over several seasons. This wireworm also prefers sandy loam soils under continuous cultivation. From these habits, it is readily apparent that our principal tobacco and potato land is ideal for the survival and perpetuation of the pest. Other potentially injurious species of wireworms occur throughout the State but the agricultural practices which favor their development do not exist on a wide scale.

Observations on Tobacco

The injury caused by wireworms to newly set tobacco plants did not appear to be greater this year than during the past few seasons. Several reports were received, indirectly, from the East Hartford area where it was necessary to replant as many as three times but, on the whole, most growers considered the injury during 1943 to be negligible.

During the course of the past summer, many hours were spent discussing the wireworm problem with various growers. The greater part of those interviewed expressed the belief that since rye has been used as a winter hardy green manure crop for the maintenance of soil fertility, the wireworm problem has lessened materially in severity. No direct experimental work is available to substantiate this aspect of the problem but it seems perfectly feasible that such a practice could be used as a palliative measure. The period of vulnerability of newly set tobacco to wireworm attack is relatively short so that a green manure, which serves as food for the wireworm, may delay feeding on the tobacco long enough to enable the plants to become larger. Unfortunately, this practice could not be expected to work successfully on a crop such as potatoes since the major wireworm feeding period comes much later in the season, at a time when green manure no longer is an ideal source of food.

Soil samples, taken at random before a field of tobacco was set, revealed a wireworm population ranging from 10 to 25 or more larvae[1] per square foot, or approximately 435,000 to over 1,000,000 per acre. This particular field had had a green manure crop of rye plowed under in the spring. No trace of wireworm injury could be found. The effect of the green manure crop cannot be expressed with certainty but a wireworm population of such proportions could obviously ruin a tobacco setting if no other source of food existed.

Observations on Potatoes

Several days were spent, during the latter part of the digging period, talking with some of the larger growers of the main potato areas in Ellington and South Windsor in order to get a cross section of the wireworm damage in relation to the dry growing season. Most growers expressed the opinion that wireworm injury was less in 1943 than in preceding years and that the crop was relatively clean. This is not in complete agreement with data obtained from the careful examination of tuber samples of several previously chosen fields. The difference may lie in the fact that the growers considered their crops to be clean in comparison with those crops of previous years since a casual examination of some of the supposedly "clean" crops showed many tubers with one, two or three wireworm holes. In those areas where the wireworm populations were known to be high in cultivated land, the degree of damage was severe.

Table 15 shows the per cent tubers injured by wireworms in plots at the Experimental Farm, South Coventry, maintained by the Agronomy Department of the University of Connecticut. This particular range (L–1) represents potatoes grown for the second successive year following 10 different green manures planted in 1941. Each plot is an average of three replicates, including both grade U. S. 1 and grade U. S. 2 potatoes. The tubers were considered injured if they contained one or more wireworm holes. The degree of injury was severe enough to minimize the number of tubers having only one wireworm hole.

[1] Cryptohypnus abbreviatus Say.

TABLE 15. WIREWORM INJURY TO SECOND YEAR POTATOES, SOUTH COVENTRY

Plot[1]	Total tubers	Number injured	Per cent injured	Plot	Total tubers	Number injured	Per cent injured
A	594	369	62.12	F	603	427	70.81
B	623	519	83.30	G	582	437	75.08
C	619	441	71.24	H	621	419	67.47
D	578	400	69.20	I	623	382	61.31
E	579	429	74.09	J	567	327	57.67

[1] A=Red clover, B=Crimson clover, C=Redtop, D=Timothy, E=Red clover—Timothy, F=Red clover—Timothy (both cut and removed for hay), G=Ladino clover, H=Crimson clover (plowed under in September), I=Japanese millet, J=Soybeans.

Table 16 shows the wireworm injury on the adjoining range (L–3). Potatoes grown on this range are first year potatoes following green manures in 1942.

TABLE 16. WIREWORM INJURY TO FIRST YEAR POTATOES, SOUTH COVENTRY

Plot[1]	Total tubers	Number injured	Per cent injured	Plot	Total tubers	Number injured	Per cent injured
A	683	292	42.75	F	673	563	83.65
B	673	316	46.95	G	785	547	69.68
C	673	120	17.83	H	605	303	50.08
D	651	232	35.63	I	599	214	35.72
E	684	220	32.16	J	690	260	37.68

[1] As above, except system G which is Pearl Vetch.

It is apparent, from Tables 15 and 16, that potatoes grown for a second year are more severely injured than first year potatoes following a green manure. This is in keeping with the report, by growers in general, that wireworm injury increases as the potato crop is continued on a given piece of land. Table 18 further bears this out.

Table 17 shows the wireworm injury to potatoes in several two-year rotations as conducted by the Soils Department at the Connecticut Agricultural Experiment Station, Windsor. The results are averages for three replicates, except PP (potatoes after potatoes) which had six replicates. Any tuber with one or more wireworm holes was classified as "injured".

TABLE 17. WIREWORM INJURY TO FIRST YEAR POTATOES, WINDSOR

Plot[1]	Number tubers	Number injured	Per cent injured
PT	299	74	25
PC	312	100	32
PP	592	304	51
PG	288	240	83

[1] PT=potatoes after tobacco, PC=potatoes after corn, PP=potatoes after potatoes, PG=potatoes after grass.

Potatoes following potatoes and potatoes following grass not only had a greater number of tubers injured but also the number of holes per tuber was far greater.

A random sample taken from the bin of a grower in South Windsor showed 98 out of 100 tubers severely injured. The number of holes per tuber ranged from three or four to over 30. The potatoes in the bin, from which the sample was taken, came from a two-acre section of a 60-acre field. Population counts made during the summer on this two-acre piece showed from five to 24 larvae per square foot, in the row, with eight samples having a population less than 10 larvae per square foot, nine samples with from 10 to 20 larvae per square foot, and four samples exceeding 20 larvae per square foot.

With respect to the seasonal habits of the eastern field wireworm, it has been reported that the larvae of this species come to the surface foot of soil with the advent of suitable soil temperatures in the spring, return to lower depths when the soil gets untenably hot and dry in July, return to the top soil again for the main feeding period in August and September, and return to the lower depths in late fall in preparation for the coming winter months. Numerous diggings throughout the summer showed the larvae to be within the top 12 inches of soil at all times. The main feeding period is believed to be in August but this year it began in late July and extended through early October. The larvae move in and out of the potato hill at random and do not concentrate in the rows as does the wheat wireworm, *Agriotes mancus* Say. Consequently, the injury caused by the eastern field wireworm is relatively less severe. One instance of wheat wireworm injury was observed, on a small piece of low, wet soil which had formerly been in clover, which was extremely severe resulting in as many as 50 holes per tuber.

The eastern field wireworm is usually found in sandy soil types which are under continuous cultivation. One instance was observed this past summer in which potatoes were being grown following seven years of hay and grass. Soil samples showed that *Limonius agonus* Say was present at population levels ranging from four or five to 15 or more larvae per square foot. Beetles of this species will oviposit in sod if given no other choice but apparently it is not a very common phenomenon. It is possible that a hayfield may become so sparsely covered that the beetles will select the site as readily as a cultivated field. It is significant that few tubers were injured in the field under observation. The bulk of the larvae concentrated in the turned-under sod which was below the general tuber level.

Table 18 shows the per cent tuber injuries for the same ranges and green manures over a period of four years, each crop treatment being the average for three replicates.

Since the study, for which the original experiment was designed, by Prof. B. A. Brown of the Agronomy Department, Storrs, was primarily to maintain and improve soil fertility, it appears from the data in Table 18 that conditions were also improved for the wireworm. In practically every case, the second year potato crop was more severely injured than the potato crop which preceded it. Yet, in practically every case, the degree of injury has increased over the preceding years. It is very probable that the larval population has increased each year, due in part to more favorable soil conditions, and the potato injury has served as a measure of this increased population. It is possible that the population level remained fairly constant and the feeding increased.

TABLE 18. SEASONAL WIREWORM INJURIES ON POTATOES, SOUTH COVENTRY
PER CENT OF TUBERS INJURED

L—1					L—2					L—3					L—5[1]				
Crop	1940	1941	1942	1943	Crop	1940	1941	1942	1943	Crop	1940	1941	1942	1943	Plot	1940	1941	1942	1943
A	15.5	Green manure	21.7	62.1	A	Green manure	6.5	37.6	Green manure	A	7.1	19.5	Green manure	42.3	6	10.4	43.3	33.3	37.0
B	17.9		39.1	83.3	B		6.7	29.6		B	7.7	16.2		47.0	31	11.3	44.4	24.9	55.6
C	16.0		23.2	71.2	C		14.7	25.1		C	4.8	25.4		17.8					
D	16.3		30.9	69.2	D		8.6	30.6		D	5.4	18.8		35.6					
E	18.9		24.3	74.1	E		9.0	36.3		E	8.5	28.5		32.2					
F	15.7		37.3	70.8	F		5.9	26.8		F	17.6	16.5		83.7					
G	17.3		33.6	75.1	G		12.6	35.0		G	8.6	19.3		69.7					
H	18.7		20.9	67.5	H		17.3	33.3		H	14.7	26.8		50.1					
I	15.9		16.6	61.3	I		11.2	32.0		I	7.3	10.7		35.7					
J	12.7		26.8	57.7	J		10.1	20.1		J	10.2	25.1		37.7					

[1] Potatoes continuously.

Note: Data for 1940-42 contributed by Dr. R. L. Beard of this Station.

CONTROL OF THE EUROPEAN CORN BORER ON POTATOES

NEELY TURNER

Severe infestations of the European corn borer in potatoes occur occasionally in Connecticut (Turner and Zappe, 2). Experiments to find suitable methods and materials for control were conducted in 1937. Early potatoes were artificially infested and treated three times during the period of hatching. The survival of larvae was extremely variable, as noted by Beard (1). Derris dusts and sprays and micronized lead arsenate applied with Bordeaux mixture were apparently somewhat effective in controlling the infestation. During the same season, the natural infestation in Green Mountain potatoes was too variable for evaluation of results of tests.

In 1943 Irish Cobbler potatoes planted early in May were heavily infested by the European corn borer. A schedule of dusts and sprays applied to control the potato flea beetle showed a substantial amount of control of the corn borer. Dusts were applied June 2, 4, 8, 14, 21 and 28, and July 6 and 12. The June 4 treatment was made to replace the June 2 application which was followed by rain. As far as the corn borer was concerned, only the June treatments were important, because few eggs were deposited after July 1.

On July 20 each plant was examined for evidence of entry or exit by corn borer larvae. There were 10 plants in a plot and the plots were randomized in each of four blocks. The results in terms of total number of damaged places on the vines are given in Table 19.

TABLE 19. CONTROL OF EUROPEAN CORN BORER IN POTATOES

Material	Concentration	Number borer entrances	Per cent reduction from check
None—untreated		243	
Tetramethylthiuram disulfide spray	4 lbs. to 50 gals.	84	65.3
	2 lbs. to 50 gals.	113	53.3
	1 lb. to 50 gals.	199	17.8
	½ lb. to 50 gals.	225	7.02
Derris—clay dust	2% rotenone	18	92.5
	1% rotenone	65	73.1
	.5% rotenone	111	54.1
	.25% rotenone	131	45.8
Derris—pyrophyllite dust	2% rotenone	26	89.2
	1% rotenone	50	79.3
	.5% rotenone	65	73.1
	.25% rotenone	100	58.7
Cryolite—clay dust	50% cryolite	24	90.1
	25% cryolite	80	66.9
	12.5% cryolite	72	70.2
	6.25% cryolite	181	25.2

All of the dusts were more effective than the one spray used. At three of the four dosages used, pyrophyllite was a more effective diluent than clay for derris. The cryolite dust was very effective and 50 per cent cryolite, a commonly used concentration, was more effective than .5 per cent or 1 per cent rotenone in derris.

The degree of infestation of potatoes by corn borers varies widely from season to season. Control measures are therefore not required every year. The dusts used, particularly cryolite dust, control flea beetles and are probably justified for that purpose only. The same materials and schedule used for flea beetles should control the corn borer as well. The suggested schedule would be four applications at weekly intervals during June.

Literature Cited

1. Beard, R. L., 1940. Effects of corn borers on potato yield. Conn. Agr. Expt. Sta. Bul. 434: 275–276.
2. Turner, N. and M. P. Zappe, 1937. European corn borer on potatoes. Conn. Agr. Expt. Sta. Bul. 396: 345–346.

THE EFFECT OF DILUENTS ON THE TOXICITY OF NICOTINE BENTONITE IN DUSTS

Neely Turner

The general effect of diluents on the toxicity of nicotine bentonite in dusts for the control of the European corn borer has been shown by Carruth (1). In his tests, walnut shell flour was more effective as a diluent than wood flour, talc or bentonite.

Wilson, Dieter and Burdick (3) and Wilson and Janes (4) have classified diluents according to the electrostatic charge they produce during the dusting process. Walnut shell flour in their tests produced a high electrostatic charge and talc a low charge.

The effect of diluents of these two types on derris root in dusts has been measured (Turner, 2). The materials selected were a pyrophyllite and a clay. These same diluents were used with nicotine bentonite and applied to control the European corn borer in sweet corn.

The nicotine bentonite was Black Leaf 155 containing 14 per cent nicotine. This was diluted to 1, 3 and 9 per cent nicotine content with each of the two diluents. The corn was Marcross planted April 26, 1943, dusted June 15, 20, 25 and 30, and harvested July 12 to 16. The corn was in the mid-green tassel stage when the first application was made, with 53 egg masses (including five hatched) on 10 plants. The last treatment was made when the corn was in full silk. The dusts were applied by hand to the whorl in the first treatment and to shoots or ears in subsequent applications.

The plots were four rows wide and 20 feet long, arranged at random in each of four blocks. Twenty sample plants were taken from the two inside rows at harvest time for dissection, and the number of larvae in the entire plant (exclusive of tillers) and in the ears determined by dissection. The results have been summarized in Table 20.

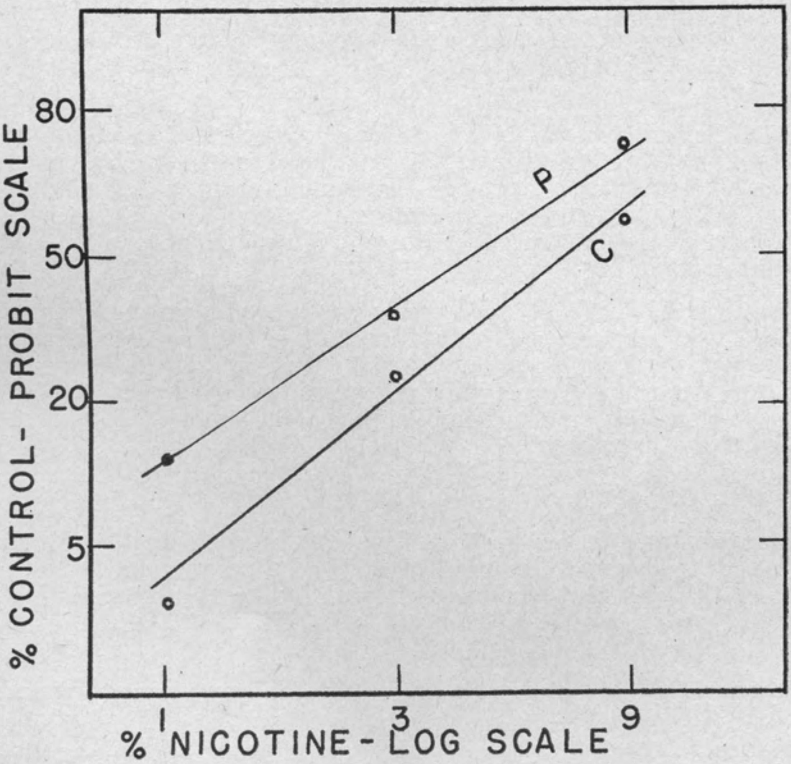

FIGURE 10. Dosage response curves for nicotine bentonite diluted with pyrophyllite (P) and clay (C). Control of the European corn borer.

TABLE 20. EFFECT OF DILUENTS ON TOXICITY OF NICOTINE BENTONITE IN DUSTS

Diluent	Per cent nicotine	Number larvae in 100 plants	Number larvae in ears	Per cent reduction in larvae	Per cent ears borer-free
Pyrophyllite	1.0	1,116	284	12.7	7.5
	3.0	799	195	37.5	8.8
	9.0	335	91	73.8	45.0
Clay	1.0	1,245	297	2.6	7.5
	3.0	966	247	24.4	10.0
	9.0	547	144	57.2	26.3
No treatment		1,278	243		2.5

The percentage reduction of larvae in the plants has been plotted in relation to the dosage of nicotine on the logarithmic-probability grid (Figure 10).

At the level of 40 per cent control, approximately 5 per cent nicotine was required with a clay diluent to equal 3 per cent nicotine with pyrophyllite. At 4 per cent nicotine content with pyrophyllite, the concentration used in commercial treatments, approximately 6.2 per cent nicotine with clay, would provide the same degree of control (48 per cent).

The infestation in the ears followed the same general pattern as in the entire plant — that is, the pyrophyllite diluent was more effective. With three of the six dosages, the number of larvae surviving in treated ears actually exceeded the number in untreated ears. This could indicate that the less effective treatments had changed the relation between number of larvae in the ear and infestation of the rest of the plant.

The percentage of ears borer-free was obtained by visual examination of the husks for signs of infestation before the ear was dissected. The results were not inconsistent with the other data except in the case of 3 per cent nicotine with pyrophyllite. In this case the percentage borer-free was low in relation to the amount of control in the plant and in the ears.

Summary

Approximately 5 per cent nicotine in a nicotine bentonite dust diluted with clay was required to equal the control of corn borers obtained by 3 per cent nicotine with pyrophyllite as a diluent.

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THE EFFECT OF DILUENTS ON THE TOXICITY OF NICOTINE IN DUSTS

NEELY TURNER

The effect of diluents on the volatility of nicotine in dusts prepared from nicotine sulfate has been studied extensively (Campbell, 1; Rudolfs, 2; Thatcher and Streeter, 3, etc.) In general, the use of alkaline materials resulted in higher volatility and greater effectiveness than "inert" or adsorptive materials. There appears to be no information on the effect of diluents in dusts made from free or alkaloid nicotine.

A comparative test of two diluents, pyrophyllite and hydrated lime, was made using nicotine absorbed on a dry carrier, ground tobacco (Black Leaf 10). Dusts were prepared containing 1, 2 and 4 per cent nicotine, and were applied to young cabbage plants infested by aphids on July 21, 1943. Application was made using a small hand duster without a hood or other protective device to confine the dust to the plants. A count of aphids surviving treatment was made 48 hours later. Individual leaves were collected from the plants and the number of aphids surviving on one square inch recorded. The results have been summarized in Table 21 and plotted on the logarithmic-probability grid in Figure 11.

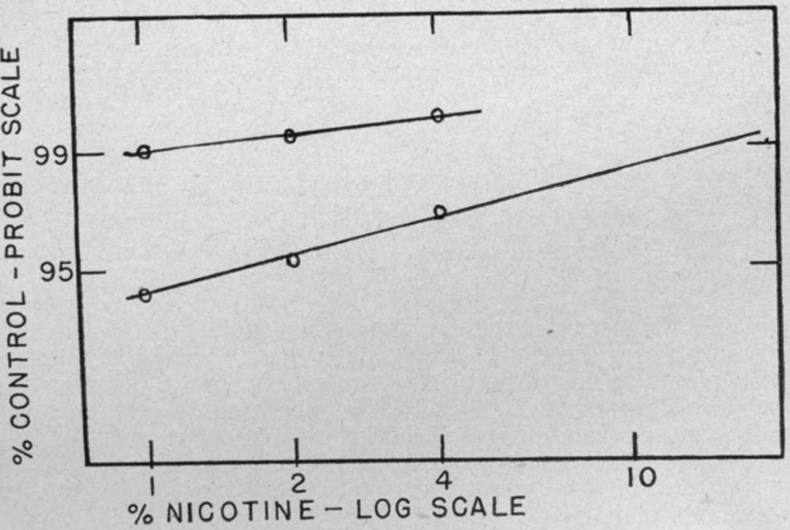

FIGURE 11. Dosage response curves for free nicotine dusts diluted with pyrophyllite (above) and lime (below). Control of aphids.

The dosages and responses were such that the dosage for equal control cannot be obtained except by extrapolation. It is evident, however, that the effectiveness of the lime diluent is considerably less than the pyrophyllite. By extrapolation at the 99 per cent level, approximately 15 per cent nicotine with lime would be required to equal 1.1 per cent nicotine with pyrophyllite. Since extrapolation from 4 per cent to 15 per cent dosage is required to obtain this comparison, little emphasis should be placed on the exact dosage ratio.

TABLE 21. EFFECT OF DILUENTS ON THE TOXICITY OF NICOTINE IN DUSTS

Diluent	Per cent nicotine	Number aphids surviving[1]	Per cent reduction in aphids
None	None	1,029	——
Pyrophyllite	1	10	99.0
	2	8	99.2
	4	6	99.4
Lime	1	67	93.5
	2	47	95.4
	4	26	97.4

[1] On five plants—sample one square inch leaf surface per plant.

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THE EFFECT OF NUMBERS OF LARVAE OF THE MEXICAN BEAN BEETLE ON DAMAGE TO PLANTS AND YIELD

NEELY TURNER

The relation between the number of larvae of the Mexican bean beetle surviving insecticidal treatment and the amount of damage to bean plants as measured in percentages appears to be logarithmic-probability (Turner, 4). The damage measured was that occurring prior to any applications of insecticide in addition to the feeding done by larvae surviving treatment. The implications of this fact were such that an experiment was conducted to study this relationship on untreated plants.

Methods

Bountiful beans were planted May 1 in rows one yard long, and thinned to 10 plants to the yard. A space of three feet was left between blocks to lessen migration. The one-yard plots were randomized in blocks with four replications. A second series of plots was planted May 25 to provide smaller plants for infestation.

When the overwintering adults of the bean beetle started depositing eggs on the plants, each plant was examined at least twice a week and the egg masses marked and counted. All eggs in excess of the number desired were removed. Infestation levels were set at two, four, eight, 16, 32 and 64 larvae per plant. In addition to these levels, one series of plots was left undisturbed and the natural infestation recorded. No particular effort was made to have the larvae distributed evenly over the plants. For instance, in most cases one egg mass of 20 eggs was left on a plot supposed to be infested by 20 larvae.

It was necessary to transfer egg masses to the plots planted May 25 in order to attain the high levels of infestation. This was done by pinning an egg mass on a small section of leaf to the underside of the leaf to be infested.

The amount of damage to the foliage was estimated, by a system already described (Turner, 5), on June 25 and again on July 1. On the latter date about 90 per cent of the foliage of the most heavily infested plots had been destroyed by larval feeding.

Yields were obtained from the weight of dried pods on July 21 for the early plot and August 2 for the late plot. It is recognized that these yields do not represent faithfully the yields of snap beans. However, it has been difficult to obtain satisfactory yield data for snap beans, because of failure to maintain a set standard of size or maturity of the pods. When the pods are left on the plant until they mature and dry, there is no confusion as to their maturity. Such yield data should therefore be dependable, although the yield as recorded is not for green snap beans.

Results

The observations and records have been summarized in Table 22. The relation between infestation and damage to foliage has been plotted on the logarithmic-probability grid in Figures 12 and 13. The relation between infestation and yield has been plotted in Figure 14, with the yield plotted arithmetically and the infestation logarithmically.

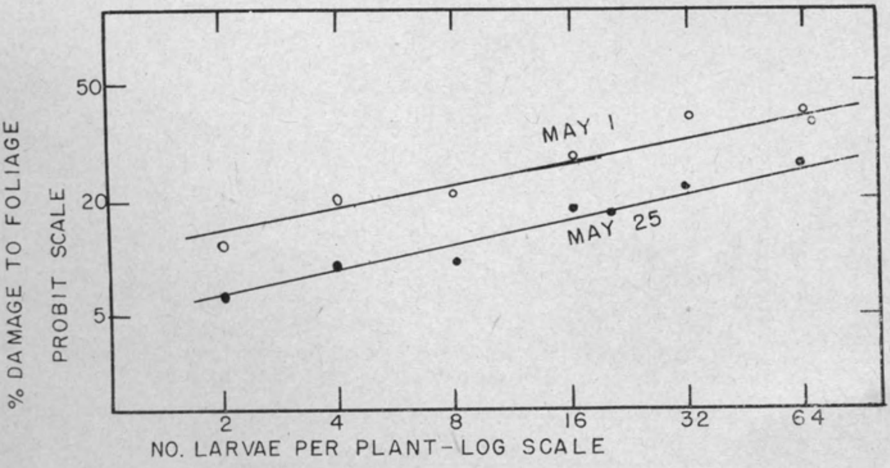

FIGURE 12. Relation between number of larvae of the Mexican bean beetle and damage to foliage on June 25. Dates refer to time of planting.

As was noted for infestation following application of insecticides (Turner, 5), the logarithmic-probability relationship prevails when no insecticides were involved. In other words, the damage increases as the logarithm of the number of larvae rather than directly with the number of larvae. The curves for June 25, when the most heavily infested plots showed about 40 per cent damage (Figure 12), are much flatter than those for July 1. Dimond, Horsfall, Heuberger and Stoddard (1) reported a similar change in slope for dosage control curves for sulfur on apple scab and copper for tomato defoliation diseases. They attributed the steeper slopes to environmental conditions favoring development of the fungus. In the case of the Mexican bean beetle, the observations were made on a single generation of larvae on two days less than a week apart, and therefore environment should not be involved.

In order to determine whether or not the date of hatching of the eggs was concerned, the detailed plot records have been summarized in Table 23. The percentage of eggs that had hatched on June 25 was calculated. In the series planted May 1, there is no tendency for the higher infestations to show a delayed hatching which might influence the amount of damage. Hatching of the May 25 series was more variable but still showed no consistent change which might influence results. Certainly the plot having the natural infestation and only 58 per cent of the eggs hatched on June 25 showed the expected amount of damage from the total number of larvae present.

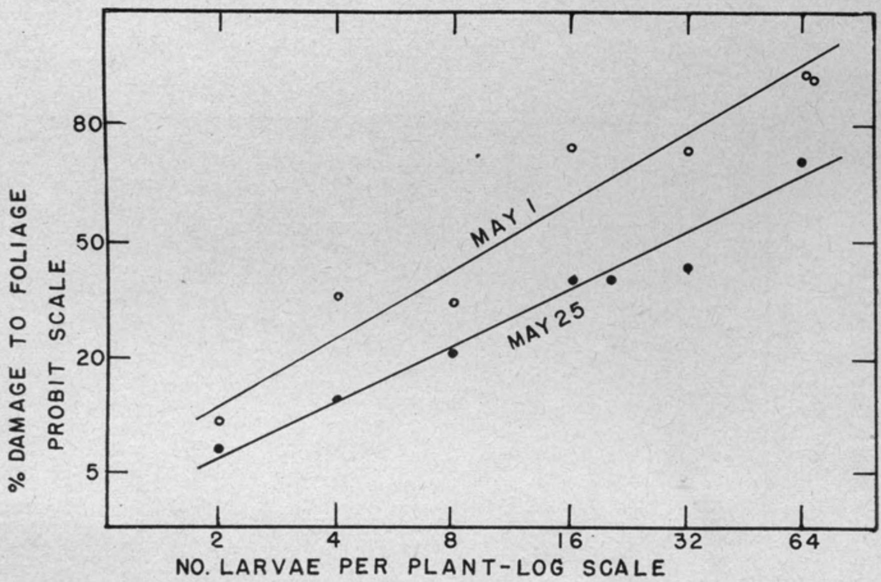

FIGURE 13. Relation between number of larvae of the Mexican bean beetle and damage to foliage on July 1. Dates refer to time of planting.

It is suggested that the change in slope was caused by the numbers feeding. In both series the change in amount of damage to the two - and four-larvae plants was relatively small. The change in amount of feeding on the more heavily infested plants was relatively much larger. In other words the two larvae per plant would presumably cause not much more than 12 per cent damage to the foliage in the course of the season. The larger numbers would cause more damage. Another criterion for this same effect would be the date on which the plants were defoliated. Unfortunately, such records were not kept on this experiment. It would be expected that the most heavily infested plants would be defoliated first, and that less heavily infested plants would follow. However, a degree of infestation too low to defoliate the plants would be reached. This should in effect be reflected in gradually steepening damage curves as the season progressed.

TABLE 22. LEVEL OF INFESTATION BY BEAN BEETLES; DAMAGE TO FOLIAGE AND YIELD OF BEANS

Number larvae per plant	Per cent damage to foliage June 25	July 1	Yield Ounces—12 ft. row
	Planted May 1		
2	12.2	9.4	44.5
4	20.6	34.4	46.5
8	21.3	33.3	41.3
16	30.0	74.2	35.3
32	39.4	73.8	44.0
64	41.9	89.7	20.2
68[1]	37.5	86.9	23.5
	Planted May 25		
2	6.3	6.9	30.5
4	9.4	13.1	33.0
8	10.0	21.3	30.0
16	17.9	38.8	26.5
32	21.3	41.9	23.5
64	26.9	71.9	21.0
20[1]	17.3	39.4	26.0

[1] Normal infestation.

TABLE 23. PERCENTAGE OF EGGS HATCHED ON JUNE 25

Number larvae per plant	Per cent hatched Planted May 1	May 25
2	66.7	100.0
4	86.0	94.0
8	79.0	89.0
16	90.0	67.0
32	97.0	82.0
64	93.4	95.8
Natural	83.3	58.1

The effect of the infestation on yield has been shown in Table 22 and Figure 14. The later planting yielded less than the earlier, at least partly because of dry weather. However, since the attack of the bean beetles occurred at approximately the same time in both plantings, and earlier relative to plant development on the late planting, some decrease in yield due to bean beetle feeding would be expected. The data for the late planting form a straight line when the infestation is plotted logarithmically against the yield. In other words, the yield decreased as the logarithm of the number of larvae present. The variation in the early planting was enormous, and no clear-cut relationship appears. Certainly there is nothing in the data inconsistent with the logarithmic relationship apparent in the later planting.

The method of obtaining the yield ignored damage to pods. In the previous study (Turner, 4) damage to pods was related to infesting population in exactly the same manner.

Discussion

This experiment was not designed to show the reasons for the relationships described. Two obvious possibilities are (1) that the survival of larvae is smaller as the infestation increases and therefore the damage from high infestations is not as much as expected and (2) that each larva does not consume the same amount of foliage, that is, 10 larvae per plant do not eat 10 times the foliage eaten by one larva per plant.

The experiment reported previously (Turner, 4) showed that the number of larvae surviving treatment was related logarithmically to the percentage of damage expressed in probits. Mortality from insecticides might be analogous to mortality from crowding. However, this cannot be accepted as final proof because the residues of insecticides might also influence the amount of feeding. That this probably

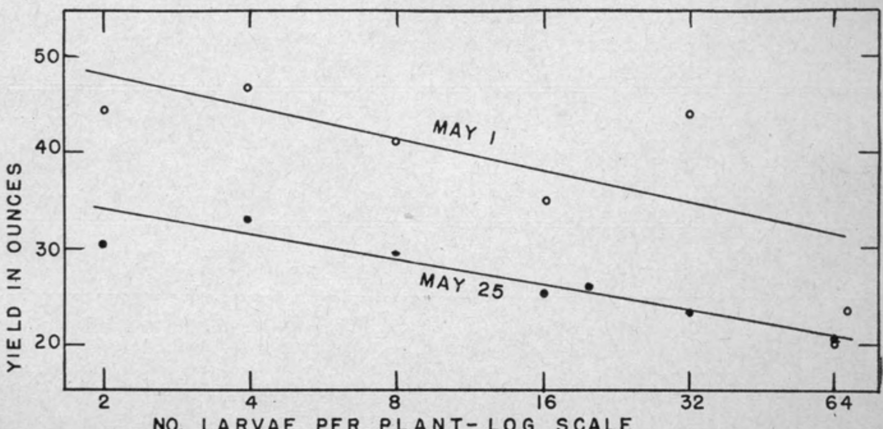

FIGURE 14. Relation between number of larvae of the Mexican bean beetle per plant and yield. Dates refer to time of planting.

occurred was indicated by the fact that the observation for the untreated check did not fit the curve drawn through points observed following treatment.

No observations were made regarding the other obvious possibility, that each larva did not consume the same amount of foliage. It is not beyond belief, however, that larvae crowded together on a plant do not consume as much foliage per larva as one larva on a plant.

The literature seems to contain little information on this general subject. Neiswander and Herr (2) presented data on corn borer population and damage. Their data on population per stalk and stalk breakage shows a relationship much closer to logarithmic than to arithmetic. Two of the three sets of data on infestation and yield show a definite logarithmic effect of infestation. The third is variable and could be either logarithmic or arithmetic. Patch et al. (2a) published data which show a linear relationship between logarithm of number of larvae and probit of percentage of breakage. Later, Patch et al. (3) showed an unmistakable arithmetic relationship between number of borers per plant and yield in a series of experiments conducted over a period of years.

Summary

The number of larvae of the Mexican bean beetle is related logarithmically to the amount of damage to the foliage expressed as probits. The effect of the number of larvae on yield is also logarithmic.

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SPREAD OF THE DUTCH ELM DISEASE IN CONNECTICUT

M. P. Zappe

Since the first Dutch elm diseased tree was found in Greenwich in 1933, the disease has spread slowly to the north and east. At the present time diseased trees have been found in most of the towns west of the Connecticut River. Only a few towns in the northern portions of Litchfield and Hartford counties are still free from the disease. Infected trees have been found in only four towns east of the Connecticut River. A diseased tree was reported in Preston in 1940 but no further cases have been found there since. Old Lyme had the disease in 1934 and no other diseased trees were found until 1942 when another tree was removed. Several infected trees were found in Portland in 1942, and in 1943 a group of small elms was found diseased in the town of East Haddam. No other towns east of the Connecticut River are known to be infected.

The United States Department of Agriculture no longer carries on control operations in the older infected areas. They confine their activities to the areas north and east of the towns of Kent, Warren, Morris, Watertown, Waterbury, Cheshire, Wallingford and Guilford. This roughly corresponds to the area outside of the quarantine lines established in 1941. During the summer of 1943, 109 diseased trees were found and removed in the following 19 towns: Berlin, Bristol, Canton, Durham, East Haddam, Farmington, Guilford, Hartford, Meriden, Middlefield, New Britain, Newington, North Canaan, Plymouth, Portland, Salisbury, Southington, Thomaston and West Hartford. Of these towns eight were infected for the first time this year: North Canaan in Litchfield County, Durham, East Haddam and Middlefield in Middlesex County, and the four adjoining towns of Farmington, Newington, Hartford and West Hartford in Hartford County. All infected trees found in these 19 towns by employees of the Bureau of Entomology and Plant Quarantine have been removed and destroyed. All potential bark beetle breeding material found has also been destroyed.

In the older infected areas, south and west of the area in which the federal men are working, no systematic scouting has been done. In these towns the selectmen and tree wardens have been told to be on the watch for diseased trees and urged to remove and destroy them as soon as they were found. We have notified them of diseased trees found in their towns when brought to our attention. Many of the tree wardens have scouted their own towns and have removed and destroyed the diseased trees. We have cultured and reported samples of suspected elms which have been sent to the Experiment Station and have examined suspicious elms when asked to do so.

THE DEVELOPMENT OF DUTCH ELM DISEASE IN SOUTHWESTERN CONNECTICUT

Philip P. Wallace and George A. Zentmyer

Until the last few years, there has been little opportunity to study the development of the Dutch elm disease in areas where little or no control is practiced. To obtain information on local spread and to serve as a basis for estimating the status of the disease in the older infected areas of Connecticut, five one-half mile-square plots were established in each of four towns in Fairfield County in 1942. (See Connecticut State Entomologist, Forty-Second Report, 1942.)

These plots were carefully scouted in 1942 and 1943. Samples were taken from all suspects and cultures were made to determine the presence of *Ceratostomella ulmi*. The results of these examinations are shown in Table 24.

Table 24. Dutch Elm Disease Sample Plots in Fairfield County

		Greenwich		Stamford		Darien		Norwalk	
		1942	1943	1942	1943	1942	1943	1942	1943
Plots:	Number diseased trees	11	6	23	50	20	24	10	14
	Per cent of total trees diseased	.66	.36	1.7	3.47	1.8	2.14	.84	1.01
Town:	Estimated number diseased	408	223	727	1485	244	293	236	282
Plots:	Diseased trees removed		5		3		3		0
	Per cent diseased trees removed		45		13		15		0
	Diseased previous year, standing		6		20		17		10
	With beetle emergence		5		10		10		3
	Without beetle emergence		1		10		7		7
Town:	Estimated number diseased standing		445		2079		500		520
	Estimated per cent of total trees diseased standing		.73		4.86		3.66		1.86

Since the local spread of the Dutch elm disease is largely dependent upon the emergence of elm bark beetles[1] from infected material within the area, the number of elms potentially effective in spreading the disease within an area may be considered to be those diseased elms from which beetles emerge. Many complex factors determine the effectiveness of these beetles in transmitting and establishing the fungus in nearby healthy elms and this will be discussed in a later paper. In these 20 plots there were 28 diseased elms from which bark beetles emerged in the fall of 1942 or the spring of 1943. The total number of newly infected elms in 1943 was 92, or 3.28 recurrences per diseased tree with bark beetle emergence on these plots.

[1] Consideration is restricted to the European elm bark beetle, *Scolytus multistriatus* Marsh., the principal vector of the Dutch elm disease in the United States. In the occasional localities where *Hylurgopinus rufipes* Eichh. is the vector, these factors will undoubtedly assume somewhat different relative importance.

In the study by Zentmyer et al. (2), large numbers of elm bark beetles emerged throughout the season from a diseased tree at the center of each of three plots, and elms were abundant and well distributed nearby. Fourteen and four-tenths per cent of the elms within a radius of 320 feet became infected the following season; the average number of new infections per plot was 9.33. Since this figure differs considerably from the sample plot average and the conditions for disease spread were somewhat more favorable than usual, a further study was made in the summer of 1943.

The areas surrounding 31 isolated, diseased elms which were found from 1937 to 1940 were carefully examined. Most of these trees were destroyed shortly after infection was determined and records were taken only where there was positive information concerning bark beetle emergence. The numbers of nearby[1] elms varied widely and are believed to approach randomness for this section. These locations are classified and the information is summarized in Table 25.

TABLE 25. THE RECURRENCE OF DUTCH ELM DISEASE NEAR ISOLATED INFECTED ELMS

	Without bark beetle emergence	With bark beetle emergence	Total
Number of locations inspected	21	10	31
Total disease recurrences	2	34	
Mean recurrences per tree	0.1	3.4	
Total number nearby elms	602	324	926
Per cent nearby elms infected	.33	10.5	
Mean number nearby elms	29	32.4	29.9

There is surprisingly good agreement between the observations of disease recurrence for these two sets of studies when they are compared on the basis of new infections occurring per diseased elm from which bark beetles emerged (3.28 and 3.4). Furthermore, the general observation is substantiated that there is an occasional new infection near diseased elms from which no bark beetles emerged. Such recurrences may be due to root grafts or to twig-crotch feeding by bark beetles near the place of attack for breeding; the beetles may have come from infected material of various types. Obviously, the number of recurrences of this type is very low.

When the data for both groups of observations are combined, the average number of new infections per diseased elm with beetle emergence is found to be 3.31. It is believed that the conditions surrounding these 38 elms approach randomness and that these observations may be indicative of the new infections occurring annually in southwestern Connecticut.

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[1] "Nearby" refers to a radius of 200 feet.

TRAP LOG SCOUTING FOR *Scolytus multistriatus*

M. P. ZAPPE

In order to obtain more information on the distribution of the bark beetle, *Scolytus multistriatus,* in Connecticut, it seemed best to place a number of elm log traps in the northeastern towns of Connecticut along the Massachusetts line and also in all the towns on the eastern edge of Connecticut along the Rhode Island boundary. *Scolytus multistriatus* is known to be present west of the Connecticut River and in a few towns east of the river. We did not know just how far east this insect might be found. As some of the federal Dutch elm disease crews were working east of the river, we considered it a good plan not to attempt to trap bark beetles in these towns but to try trapping along the northeastern and eastern boundaries of the State.

According to available records on the distribution of *Scolytus multistriatus*, there is an isolated area of infestation in eastern Massachusetts extending to the north into southern New Hampshire and southerly to include all of Cape Cod. The western edge of this infestation roughly parallels the northern boundary of Rhode Island and almost reaches the northeastern corner of Connecticut. If *Scolytus* could be found in northeastern Connecticut or along the eastern boundary of the State, we might assume that this was an extension of either the eastern Massachusetts area, or the area west of the Connecticut River. In either case, it would be necessary to do more scouting or trapping for *Scolytus* to discover to which area this was connected, or whether both areas of *Scolytus* infestation had met in eastern Connecticut.

On June 8, 9, 10 and 11, 26 piles of elm logs were placed from the northeastern boundary of Connecticut south in the towns on the Rhode Island boundary and westward on Long Island Sound to East Lyme. Each trap pile consisted of four or five logs four feet long and from four to six inches in diameter. Two piles were placed in each town, and the piles were about five miles apart. Elm logs were cut fresh and only about one day's supply cut at a time. The logs were left undisturbed until September 13, 14, 15 and 16. At that time all logs were peeled with the following results.

Town	Larvae found
Eastford	Saperda
South Woodstock	Saperda
East Woodstock	Saperda
Putnam	Saperda, Magdalis
Putnam	Saperda, Magdalis, Hylurgopinus rufipes (a few galleries)
Thompson	Saperda (few)
Thompson	None
Pomfret	Saperda, Magdalis
Pomfret	Saperda (plentiful), one gallery H. rufipes
South Killingly	Saperda (few)
Killingly	Saperda

Plainfield	Saperda
Plainfield	Saperda (plentiful)
Sterling	Logs covered by road relocation
Sterling	Saperda
Griswold	Saperda (few)
Voluntown	Saperda (few)
Voluntown	Saperda (few)
North Stonington	Saperda (few)
North Stonington	Saperda (very few)
Stonington	Saperda (few)
Stonington	None
Groton	Saperda (very few)
Groton	None
Waterford	Saperda (very few), termites
East Lyme	Termites in one log

No *Scolytus* galleries were found in any of the trap log piles and only two cases of *Hylurgopinus rufipes*. *Saperda* sp. larvae were common in nearly all piles and in a few cases were very abundant. *Magdalis* sp. was found in only three piles in or near Putnam. Inasmuch as no *Scolytus multistriatus* was found in any of the trap logs it seems reasonable to believe that there is still quite an area free from this vector of the Dutch elm disease in eastern Connecticut and that the disease may not spread very rapidly in this area.

THE MEASURING AND SAMPLING OF ELM LEAVES

Philip P. Wallace

In the course of experiments to determine certain effects of defoliation of elm trees, it has been necessary to establish a valid basis for measuring and sampling the leaves. The details of the procedure and the relations which were found to exist are reported because of their wide adaptation to related problems.

Measurement

The measurement of tracings of leaves with a planimeter is so laborious and time-consuming that only a very small number of leaves per sample can be handled when many treatments must be measured. If an efficient and more rapid method of measurement can be employed, the precision of estimate can obviously be increased by the use of larger samples, even though the method itself may be subject to somewhat larger error.

Since elm leaves approach an ellipse in shape, and the area of an ellipse is equal to the product of the lengths of the two axes multiplied by a constant, .7854, the application of a similar relationship to the area of elm leaves was investigated. Preliminary measurements and calculations indicated that the relation for elm leaves is more complex, for the areas of large leaves is consistently underestimated and small leaves overestimated when the same constant is applied to both. It was also found that the relation between length and width is so variable that the use of either measurement alone in an equation results in a very large error of estimate. These observations immediately suggest the application of a regression equation of the form $Y = \bar{y} + b\ (X - \bar{x})$, where X = length x width and Y = area.

Measurements were taken of the axes of four groups of 50 leaves, constituting random samples from each of four trees, and the leaf areas were accurately determined with a planimeter. When the logarithms of the products of the axis measurements are plotted against the logarithms of the corresponding measured areas, a rectilinear relationship is observed. However, the data have been retained in the original units of inches throughout for convenience and practical use of the regression equation, although they are plotted on log-log paper in Figure 15.

TABLE 26. SUMMARY OF LEAF MEASUREMENTS
X= LW, Y= Area

Tree	1	2	3	4		Combined
S X	253.27	116.28	137.40	130.43		637.38
S (x^2)	1415.8525	400.4874	564.3186	529.4538		2910.1123
$\bar{x}$	5.0654	2.3256	2.7480	2.6086		3.1869
S Y	171.23	78.96	97.67	89.56		437.42
S (y^2)	651.0965	184.9204	287.7427	249.1450		1372.9046
y	3.4246	1.5792	1.9534	1.7912		2.1871
S (xy)	958.2548	272.0102	401.3210	361.6410		1993.2270
[x^2]	132.9387	130.0667	186.7434	189.2141	638.9629	878.8460
[xy]	90.9064	88.3808	132.9238	128.0148	440.2258	599.2133
[y^2]	64.7022	60.2268	96.0541	88.7252	309.7083	416.2234
b	.6838	.6795	.7118	.6766	.6889	.6818
Red. [y^2]	2.5404	.1721	1.4389	2.1104	6.4368	7.6798

$$Y = 2.1871 + .6818\ (X - 3.1869)$$
$$= .6818X + .0143$$

TABLE 27. ANALYSIS OF VARIANCE

	Degrees of freedom	Sum of squares	Mean square	F
Combined slope, b_c	1	303.3020	303.3020	
Between slopes	3	.1418	.0473	1.45
Between positions	3	1.2625	.4208	12.91
Error about curves for individual trees	192	6.2645	.0326	1.00

The relation between actual leaf area and the product of length by width has been fitted by least squares with a separate straight line for each tree. These calculations are shown in Table 26. The individual curves were then compared by the analysis of variance (Table 27). The largest of the four slopes exceeded the smallest by only 5 per cent and, as would be expected by so small a difference, the second row in Table 27 shows that the data for all four trees could be fitted satisfactorily by four parallel lines having a slope of $b_c = 0.6889$. These lines differed significantly, however, in their vertical positions as shown by $F = 12.91$ in the third row of the table. Since they did not agree statistically, the average shape of the leaves varied from tree to tree and a general mean based on four trees should be considered a provisional figure. Nevertheless, these differences were small enough that the observations did not scatter excessively around a single curve in which tree differences were ignored (Figure 15). The calculation of this curve is shown in the last column of Table 26. It may be written as $Y = 0.6818X + .0143$, which may be used for computing leaf area from the product of length by width. The mean product from a random selection of leaves on a tree may be substituted for X in the above equation to obtain the area of the average leaf. This provides a convenient means for estimating the total leaf area of a tree and eliminates the necessity of constructing and manipulating an alignment chart. Moreover, reasonably accurate measurements can be taken rapidly without removing any leaves from the plant.

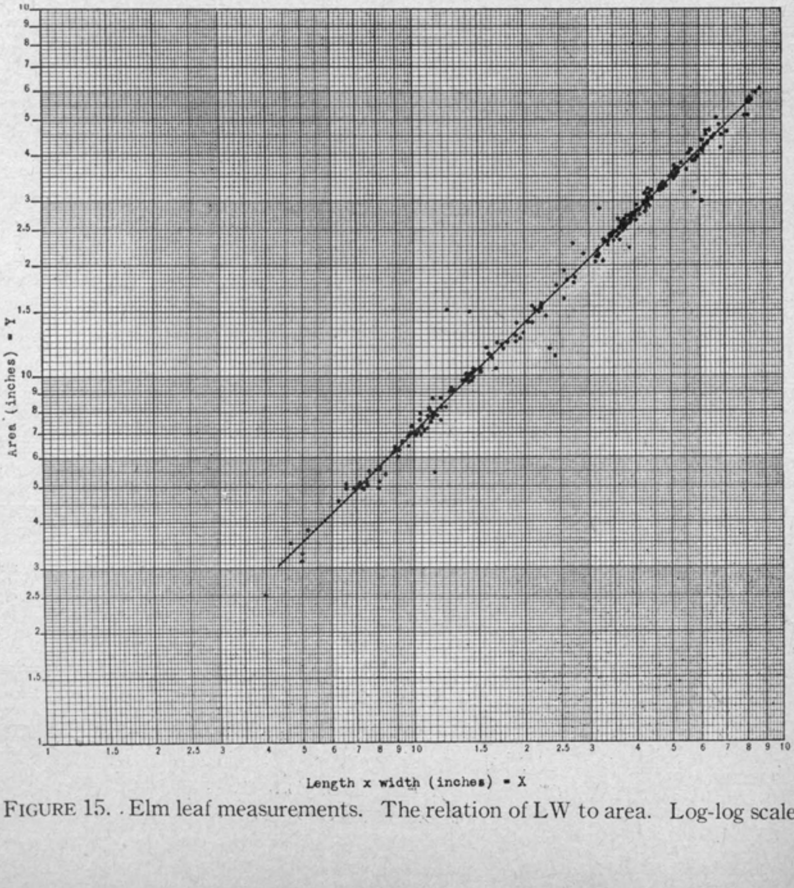

FIGURE 15. Elm leaf measurements. The relation of LW to area. Log-log scale.

Before the publication of this report, the application of similar measurements for determining sugar beet leaf areas was reported by Baten, W. D. and Muncie, J. H., 1943.[1] Although the original data and the method for calculating the regression equation are not available, it appears that the relationship between LW and Y is similar to that found in elm leaves. Computation of the equation as indicated above would undoubtedly produce a precise formula which would automatically adjust the differences which were observed for small and large leaves.

Sampling

It is well recognized that sampling procedure must be determined by the type and accuracy of the information desired, and these factors in turn are often dependent on the feasibility of obtaining and handling the samples. Moreover, the practice of applying highly accurate and laborious measurements or extensive computations of great precision to samples which are themselves subject to gross error is to be deplored.

In the current experiments, it was desired to estimate within an error of approximately 10 per cent the total leaf area of 42 elm trees, 10 to 15 feet in height. The size of the trees was prearranged so that the total number of leaves on each tree could be counted and sampled within a period of two days.

The sample size was arbitrarily set at 50 leaves per tree, or about 10 per cent of the total.

A random sample from a container holding all the leaves from each tree would supposedly constitute a good basis for estimate, but it would require the removal of all the leaves, to the detriment of the investigations. Moreover, it is very difficult to formulate and follow a standardized method for taking without bias a random sample from the leaves on a tree. In this preliminary study, the trees were sampled and all the remaining leaves were removed, following a hard frost in October.

From each of three trees two types of samples were taken, as well as a random sample from the rest of the leaves after they had been removed.

1. T.C.B. sample. Seventeen leaves were removed from the top branch of the crown. Commencing at the tip, proceeding toward the trunk, and back on the opposite side of the same branch, the alternate leaves were removed until the required number was obtained. Another sample of 17 leaves was taken in the same manner at the center of the crown, and 17 more were removed from the lowest branch from the bottom of the crown.

2. Center sample. Fifty leaves were taken from the branches at the middle of the crown in the manner described above.

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[1] Phytopathology 33 (11): 1071–1074.

TABLE 28. COMPARISON OF SAMPLING METHODS

Type of sample	Tree number	Sample Mean leaf area	Tree Total leaves	Estimated total area	Measured total area	Difference	Per cent error	Percentage of total leaves sampled
T. C. B.	1	1.7011	511	869.26	1056.29	—187.04	—17.7	10.0
	2	3.1865	472	1504.03	1676.86	—172.83	—10.3	10.8
	3	2.6780	533	1427.37	1404.81	+ 22.56	+ 1.6	9.6
Center	1	1.8386	511	939.52	1056.29	—116.77	—11.05	10.0
	2	3.4393	472	1623.34	1676.86	— 53.52	— 3.2	10.8
	3	2.3230	533	1238.16	1404.81	—166.65	—11.86	6.6
Random	1	2.2343	511	1141.73	1056.29	+ 85.44	+ 8.09	10.0
	2	3.6934	472	1743.28	1676.86	+ 66.42	+ 3.96	10.8
	3	2.6680	533	1422.0	1404.81	+ 17.19	+ 1.22	9.5

3. Random sample. The remaining leaves were placed in a container and 50 were chosen at random.

The areas of all leaves from the three trees were determined by measuring the leaf axes and applying the formula previously discussed, $SY = (SX)\ .6818 + N\ (.0143)$. The results of the various methods of sampling are tabulated below.

These results have not been analyzed statistically because the information is limited to three replicates and it could be demonstrated that the variance of the standard error of estimate is significantly large. However, a record of the errors of estimate which occurred with these methods of sampling is offered, and it is possible to select that method which has been subject to the least error, even though the precise limits cannot be accurately established.

Omitting the random samples, it appears that the center samples offered a better basis for estimate with an indicated error of about 10 per cent. Moreover, the error for the center samples was fairly consistent and should be more reliable for use in comparing treatments. It is believed that this error can be materially reduced by following the same sampling procedure and disregarding the few very small leaves which occasionally are found.

DIPRION FRUTETORUM (F.)

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The introduction of foreign tree species and the large-scale planting of conifers in reforestation projects have been responsible for a number of new insect problems in America. Some of the insects involved have been known for a great many years and have been relatively unimportant in their native habitats. A defoliator of pines which only recently has begun to attract attention in forest plantations in America is the sawfly *Diprion frutetorum* (F.) This is a European species, and, although described by Fabricius 150 years ago, little can be found in entomological literature regarding its importance on that continent. Hsin (6), in his studies of sawflies in Mecklenburg, Germany, from 1932 to 1934, reported that in one severely infested stand of pines in 1933, five species of *Diprion* were represented, and that *D. frutetorum* was the most abundant. Kuntze (7) studied the parasitization of the larvae in their cocoons during the last stage of an outbreak in western Poland in 1935.

Although the earliest known recovery of *Diprion frutetorum* in the United States was in 1932 from both Massachusetts and Rhode Island, this sawfly first began to attract attention as a serious pest in Connecticut in 1940. The information now at hand indicates that it was established in North America many years before its discovery here.

History in North America

The first published report of the occurrence of *Diprion frutetorum* on this continent was by Gray (5), who found the larvae feeding on Scotch pine in September, 1934 near Niagara Falls, Ontario, Canada. Collins (3) reported its recovery from New Jersey in 1938, the cocoons having been collected from litter in a red pine plantation near Lamington. In 1939 large numbers of sawfly adults which had been reared over a period of years from field-collected material received at the New England Station, Division of Forest Insect Investigations, were sent to the Division of Insect Identification for determination. The late Miss Grace A. Sandhouse, who determined much of this material, identified as *D. frutetorum* one adult reared from a cocoon collected in a Scotch pine plantation at Middletown, R. I., in May, 1932, and one adult reared from a larva collected on Scotch pine at Melrose, Mass., in July, 1932.

In Connecticut, insofar as is known, *Diprion frutetorum* was first discovered on September 1, 1938, at Litchfield by J. R. Hansbrough and the writer. This was reported by Friend (4) in 1941. Since the summer of 1938, infestations have been found in many red pine plantations scattered through Connecticut, Massachusetts, New Hampshire, New York and Rhode Island. C. F. W. Muesebeck has furnished the information that the only specimens in the United States National Museum, outside the range indicated above, are from Harrisburg, Pa., and they were collected in July, 1941.

It seems probable that if a search were made for this insect it would be found to be more widely distributed. Because of their protective coloration and solitary habits, the larvae are easily overlooked unless the infestation is heavy enough to cause noticeable defoliation.

This sawfly began to attract attention as a serious pest in 1940, when M. P. Zappe of the Connecticut Agricultural Experiment Station found it defoliating a 25-year-old plantation of red pine on the New Britain Water Shed in Southington, Conn.

Brown (1) reported it in 1940 as "increasing throughout southern Ontario, being generally in a light infestation, but attaining medium status at Windsor". In 1942 Brown (2) reported it then established through practically all southern Ontario.

Host Plants

In New England the favored food plants of *Diprion frutetorum* are red pine (*Pinus resinosa* Sol.) and Scotch pine (*P. sylvestris* L.) The larvae will feed on Austrian pine (*P. nigra* Arnold) and some others of the hard pine group. As yet, not all of them have been thoroughly tested in the laboratory. In the field, infestations have been found, thus far, only on red pine and Scotch pine. A striking example of food preference was observed during the summer of 1943 at Litchfield, Conn., in two adjoining plantations, both about 30 years old. No evidence of feeding could be found in a plantation of Austrian pine, whereas the adjoining plantation of red pine was generally infested.

Throughout the area of the known distribution of *Diprion frutetorum* in this country, few stands of natural reproduction of its favored food plants exist and, as yet, no infestations have been found in these stands. The most serious infestations, thus far, have occurred in plantations of red pine where the age of the trees is 25 years or more.

Description of Stages

The Adult

These sawflies are stocky, wasplike insects, having the four wings slightly cloudy with brown venation. The male and female are described below.

Male (Figure 16): Length 6-8 mm. Antennae large, black, pectinate; head and thorax black, coarsely sculptured; abdomen having the venter, all of the last two segments, and a wedge extending up on terga 2-7 anteriorly reddish, remainder of dorsum black; legs reddish yellow except coxae, which are largely black.

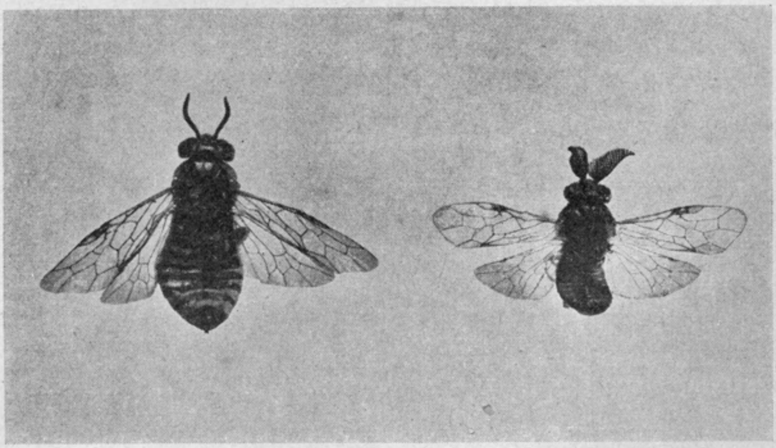

FIGURE 16. Adults of *Diprion frutetorum* (F.) Left, female; right, male. x 2.5 natural size.

Female (Figure 16): Length 7-9.5 mm. Antennae serrate, black, except scape and pedicel, which are yellowish; head black, except areas on vertex, face between antennae, clypeus, a spot on each side below eyes near base of mandibles, and all of palpi, which are yellowish; mandibles reddish; thorax yellowish with the following parts black: most of anterior and lateral lobes of scutum, posterior margin of scutellum, and postscutellum; abdomen yellow, with a transverse band posteriorly on terga 1-7, most of 8, and sheaths of egg-laying organs, which are black; legs reddish yellow with distal end of hind tibiae and last tarsal joints blackish.

The Egg

The freshly deposited egg is yellow, long and narrow, with a concave and a convex side and tapering at each end. It is 1.5 mm. in length. Usually one egg is deposited in a needle (Figure 17). It is inserted in a slit and is entirely concealed, leaving only a yellowish spot around the closed-up slit.

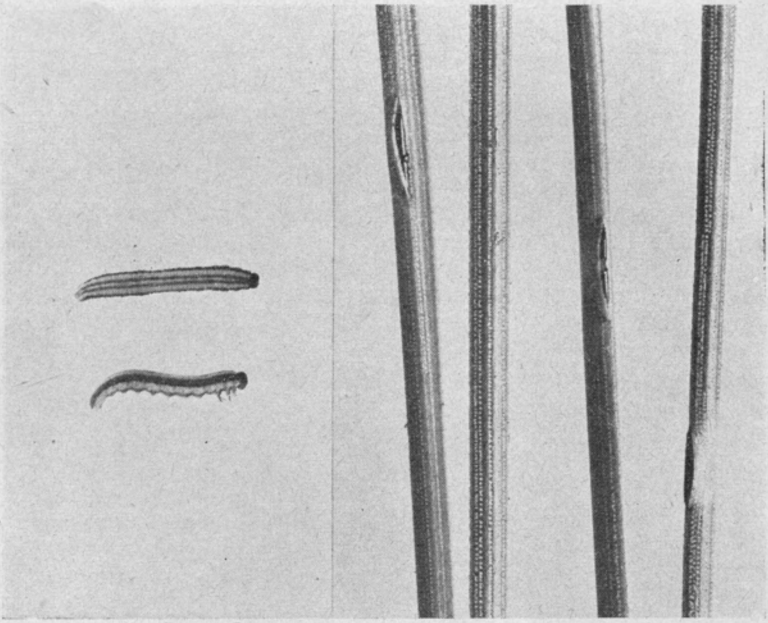

FIGURE 17. Left, fully grown caterpillars of *D. frutetorum,* natural size. Right, eggs, six times natural size.

The Larva

The full-grown larva, prior to molting into the last instar, is about four-fifths of an inch in length (Figure 17). The head is reddish brown, the eye spots and a large blotch on the frontal area are black, and usually near the middle of the blotch is a yellowish, inverted-V-shaped mark. The frons between the eyes is slightly concave. The body is light green with longitudinal dark-green markings as follows: two narrow stripes on the dorsum, a broad lateral and a supraspiracular stripe, and a narrower one at base of legs on each side; legs with black markings on outer side. When the larva molts into the last instar, it loses the darker markings except for the eye spots.

The Cocoon

The cocoon is capsule-shaped, light brown, of a strong paperlike texture, and ranges from 7 to 9.5 mm. in length by about 3 to 4 mm. in width. Occasionally, some are slightly flattened on one side when spun next to a flat surface.

Life History and Habits

There may be one or two generations each year in New England. The insect passes the winter as a prepupal larva in a cocoon and the adults from this generation may emerge from the latter half of May to the last of July. Those of the next generation may emerge over a period from the latter part of July to the first part of September, or remain in the cocoons, in the prepupal stage, until the next spring or later. The peaks of adult emergence in Connecticut usually occur between June 1 and 15 and between July 25 and August 10. In plantations separated by only a few miles there may be a difference of several days in the peaks of emergence and, consequently, in the larval development. Data from field observations show that, in general, the development of the insect in red pine plantations in Southington is from one to two weeks earlier than in Litchfield, about 20 miles to the northwest.

Eggs are deposited singly in slits cut in the needles (Figure 17). In the insectary, hatching takes place in from six to 10 days. Hsin (6), in his studies of this insect in Germany, found that the first larva emerged 11 days after the egg was deposited and the last in 16 days, the development depending on the time of year.

The larvae of the first generation may be found during the period from about June 1 to early in August and those of the second generation from late in July until late in the fall. They are solitary in habits and their color blends with that of the foliage. The growth of the current year is fed upon when necessary, especially by the larvae of the second generation, but the old foliage is preferred. Severe infestations have been found only in plantations where the crowns have already closed.

Occasionally a few cocoons are spun on the twigs of pine, but normally most of the larvae crawl or drop from the trees and spin their cocoons in the litter on the ground.

Since 1938 many collections of larvae and cocoons of *Diprion frutetorum* from various localities in New England and New York have been received at the New Haven laboratory. These have been reared for data on the natural enemies and in the study of the insect's life history. The records of adult emergence indicate that usually there is a slight predominance of females. Parthenogenetic reproduction has been proved in laboratory tests, but unfortunately the progeny were not reared to determine the sex. Hsin (6) found that parthenogenesis in *D. frutetorum* is arrhenotokous.

In captivity, the females, both mated and unmated, died before having deposited all their eggs, and at present no information can be given on the average number per female, deposited in the field. To determine the potential egg production, 12 gravid females were dissected. The number of eggs found in the ovaries ranged from 63 to 96, the average being 84.58 per female.

Injury

Because of the many factors involved in causing mortality of the different stages of this insect, an attempt to forecast just how serious the defoliation will be in an infestation would be hazardous. Population studies in red pine plantations during the last two years have shown that noticeable defoliation may occur when the cocoon population in the spring, prior to emergence of the adults, averages from three to six per square foot.

There have been no reports of *Diprion frutetorum* ever having caused complete defoliation in the United States. The population, however, has been increasing in a number of forest plantations during the last few years, and in Connecticut, the feeding has been heavy in some localities, particularly on the New Britain Water Shed in Southington. Severe infestations have been observed only on red pines and in stands where the crowns have closed. The feeding on thrifty red pines may escape notice until the population has built up to large numbers. The presence of green needle fragments and excrement in the litter on the ground may be the first evidence of a heavy infestation. In plantations at Southington the loss of foliage has been so great by the feeding of this species during the last three or more years that the light filtering through the thinned crowns has favored a prolific growth of weeds, vines and shrubs. Scattered through the area where the infestation has been most severe, single trees and small groups of trees have died or are now in a dying condition. All dead trees examined had been infested by either *Pissodes approximatus* Hopk. or *Ips* sp., and there is evidence that these insects are multiplying in other nearby trees which are in a weakened condition.

Natural Control

The more important natural enemies of *Diprion frutetorum* in Connecticut include rodents and shrews, predaceous bugs of the family Pentatomidae, and the small imported hymenopterous parasite *Microplectron fuscipennis* Zett. The small mammals destroy many of the cocooned larvae in the ground litter. The pentatomids kill a great many larvae during the summer. *M. fuscipennis* is a polyphagous parasite of sawfly cocoons which was introduced from Europe to aid in the control of the spruce sawfly, *Diprion hercyniae* (Htg.) It was first liberated in Connecticut in 1936 in a spruce plantation at Orange. When studies of *D. frutetorum* were begun in Southington in 1941, this parasite was found to be firmly established there and was taking a heavy toll of the cocoons. Based on the examination of sample collections of cocoons, the parasitization by this species each year has been as follows: 1941, 24.8 per cent; 1942, 25.4 per cent, and 1943, 23.6 per cent. Since 1941 this parasite has been found in most of the infestations of *D. frutetorum* in Connecticut. A number of ground-inhabiting insects are known to feed on the cocoons, but no study has been made to determine the true predators and those that act only as scavengers.

The fact that cocoons of this sawfly can be found in the ground litter every month in the year makes conditions generally favorable, insofar as food is concerned, for those ground-inhabiting insects and mammals which include sawflies in their diet. It is believed that such animals have been largely responsible for the relatively slow increase of *Diprion frutetorum* in the United States.

Artificial Control

Effective control can be obtained by the application of lead arsenate sprays as soon as the larvae are found. The powdered lead arsenate should be used at the rate of 4 pounds to 100 gallons of water, with fish oil as an adhesive at the rate of 4 ounces by weight to each pound of the powdered insecticide. This formula is particularly recommended for use in power sprayers, and it should be applied in as fine a mist as possible.

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MISCELLANEOUS INSECT NOTES

A New Apple Pest for Connecticut. The apple leaf-curling midge, *Dasyneura mali* Kieff., was found for the first time in Connecticut orchards during the summer of 1943. The orchard in which it was found is located in the town of Wilton and is approximately seven miles north of Norwalk. Damage of the type shown in Figure 18 was seen throughout the orchard.

The insect has been studied by Prof. W. D. Whitcomb of the Massachusetts Agricultural Experiment Station, who reports three generations a year. No entirely satisfactory means of control were reported by him, although use of nicotine sulfate and molasses, and summer oils applied during the oviposition periods appear to have afforded some relief.

[PHILIP GARMAN]

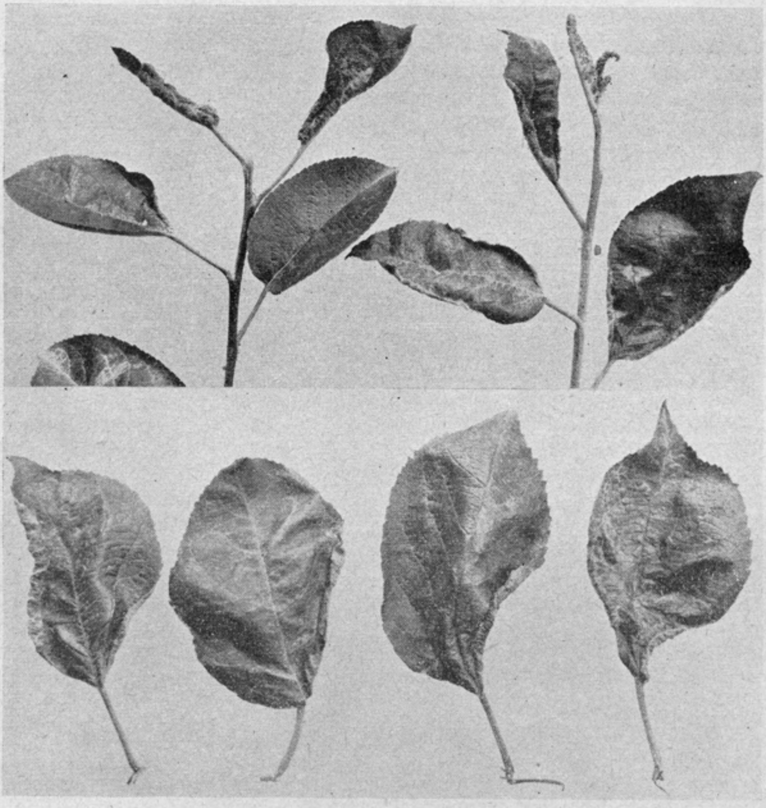

FIGURE 18. Work of *Dasyneura mali*, a new apple pest in Connecticut.

Sweet Corn Damaged by the Larvae of *Anomala orientalis* Waterhouse. Approximately three acres of a 20-acre field planted to sweet corn during the season of 1943 were severely damaged by the larvae of the oriental beetle, *Anomala orientalis* Waterhouse, feeding upon the roots (Figure 19). A few larvae of the Japanese beetle, *Popillia japonica* Newm., were also present but definitely in the minority. Parts of the field were heavy in grass before it was plowed, resulting in egg deposition the preceding season. The injury was noticeable in June, becoming more severe in July. After June 15 there was a deficiency of rainfall which caused the injured plants to wilt rapidly, as the drought was prolonged.

[J. PETER JOHNSON]

Further Notes on the Scarabaeid *Aphonus castaneus* Melsh. One adult *Aphonus castaneus* was reared from larval material[1] obtained

[1] Johnson, J. Peter, 1943. Conn. State Entomologist, Forty-Second Report, Bul. 472: 306–307.

in the fall of 1942. Later, in the summer of 1943, numerous adults were obtained from diggings made in the field to observe seasonal development. The first adults, completely transformed, were found with their pupal skins on July 17. On July 29, more than 66 per cent of the insects were in the adult stage. Diggings were made at intervals during the summer season and no eggs were found. No adults were observed in flight during daylight hours or early in the evening. All adults found were taken from the soil. The last diggings were made on September 21 and these yielded living adults and the remains of two mummified larvae.

In the spring and during the summer, numerous grubs were found that had been killed by a mummifying fungus. Rainfall was plentiful throughout the spring but the summer months were very dry. No record was made of the count of diseased grubs but it was evident that the fungus was responsible for a considerable decrease in the grub populations in the infested areas.

An infested area on one golf course fairway was treated with lead arsenate at the rate of 10 pounds to 1,000 square feet, in the fall of 1942. During June and July, 1943, only an occasional grub could be found in the treated area. Most of the injured turf recovered after the treatment and only the small areas which had dried out completely in 1942 failed to respond.

[J. PETER JOHNSON]

FIGURE 19. Corn damaged by *Anomala orientalis* larvae.

TABLE 29. *Phyllophaga* SPECIES AND HOST PLANTS

Host plant	anxia	crenulata	fraterna	oersteri	fusca	hirticula	ilicis	marginalis	micans	tristis	Total
Alder	8			8	3	85	1				105
Apple			7							3	10
Beech						25					25
Birch, grey		1									1
Blueberry				1	2			1			4
Dogwood		2		1		1					4
Elm	12	2	1	6	5	124					150
Hazel	3	1	1	36	1	105	2	2	2	1	154
Hickory	2	7			1	56		6			72
Oak, white and chestnut		1	1	5		99		1		1	108
Peach	5	3				10					18
Poplar	1				1						2
Raspberry				8	3	19	1			54	85
Rose	1	36		71	8	61			1	1	179
Willow	7	1		3	3	83					97
Miscellaneous	20	9	3	8	10	67			1		118
Light trap	16	30		6	3	182				3	240
Hand collected when emerging		4	15	3	37	44					103
Total	75	97	28	156	77	961	4	10	4	63	1,475

TABLE 30. *Phyllophaga* SPECIES AND DATES COLLECTED

Location	Date	anxia	crenulata	fraterna	foersteri	fusca	hirticula	ilicis	marginalis	micans	tristis	Total
Shelton	5—17—43	3			1							4
Pine Orchard	5—18—43			22		37					3	62
New Haven	5—25—43				3							3
Shelton	5—27—43	2					18					20
Shelton	5—28—43	4					22					26
Shelton	5—29—43				1		2					3
Shelton	6— 2—43	14	10	1	1		39					65
Shelton	6— 3—43	6	24		54	3	64				2	153
Shelton	6—11—43	4	10		15		30				2	61
Mt. Carmel	6—12—43				4	4	8					16
Shelton	6—12—43	2	11		4	1	16					34
Mt. Carmel	6—14—43				4	3	10					17
Shelton	6—14—43		1		3	1	11		3			19
Shelton	6—15—43	2	2		3	1	5		5			18
Madison	6—16—43	24	20	1		4	411			4		464
Shelton and Woodmont	6—18—43		1				1					2
Shelton	6—20—43		5				5					10
Oxford	6—22—43	12	2	2	23	11	264	1			1	316
Shelton	6—23—43		1			1	1					3
Woodmont	6—23—43		1	1	5	3	2					12
Shelton	6—24—43	1			18	3	25	1			44	92
Orange	6—25—43	1	1		3	3	7		2		1	18
Shelton	7— 6—43				19		12	2			10	43
Total		75	89	27	161	75	953	4	10	4	63	1,461

Notes on *Phyllophaga* and Their Host Plants. The year 1943 was a heavy flight year for *Phyllophaga*. This was expected, as considerable turf was destroyed by second-year grubs in 1941.[1] Hand collections were made and a light trap was used at rather regular intervals, when weather conditions permitted, from the middle of May until early in July. The beetles were very active when the temperature was above 70° F. but their activity declined rapidly when the temperature dropped to 60° F. or below, very few beetles being captured in the light trap when the temperature was near 60° . All the light trapping and most of the hand collections were made in Shelton near turf areas not damaged by the grubs in 1941. The infestations were not as heavy as those in Pine Orchard, Madison and Oxford.

In Madison, small ornamental beech, elm, hazel, peach, climbing rose, white oak and willow were severely defoliated. Collections were made there on a warm evening and the drone of hundreds of beetles in the taller trees could be heard from dusk until after 11 P.M. Most of the beetles in Oxford were collected from alder, hazel, hickory and oak. Climbing roses were the preferred host plant in Shelton, where most of the beetles were taken in the urban area. Table 29.

P. fraterna and *P. fusca* were most numerous about the third week in May, with *P. hirticula* appearing the last week in May. *P. hirticula* was without question the predominant species during 1943. *P. foersteri* followed *P. hirticula* in numbers in the area where collecting was done throughout most of the season. Probably more *P. fusca* and *P. fraterna* would have been obtained if it had been possible to be in the field more often in early May. *P. anxia, P. crenulata* and *P. foersteri* were most numerous during the first three weeks of June. *P. ilicis, P. marginalis* and *P. micans* did not appear until the middle of June or later, and *P. tristis* was most numerous in late June. Table 30.

[J. Peter Johnson]

Willow Flea Weevil, *Orchestes rufipes* LeC. While we have a number of specimens of this weevil in our collection, this is the first time it has been reported abundant enough to be noticeable. An outbreak was found on August 17, 1943, on some willow trees in the Stratfield section of Fairfield. A number of broad-leaved willows (*Salix pentandra*) were infested. The trees were partially defoliated and all of the remaining leaves were brown. The leaves showed the characteristic feeding punctures made by the adult weevils and many of the blotch mines made by the larvae.

The eggs are laid in punctures in the leaves about the latter part of June and early July. The larvae or grubs are leaf miners and live inside the leaf tissues. The grubs pupate in the leaves and the adults emerge during August. There is only one generation each year and adults are said to hibernate in soil under the trees or under stones and beneath loose bark.

[1] Johnson, J. P., 1942. White grubs during 1941. Conn. Agr. Expt. Sta. Bul. 461, pp. 523–530.

Two applications of the following spray should give control: 1 1/3 pints of nicotine sulfate, 1 3/5 pints of liquid potash soap to 100 gallons of water. Sprays should be applied about the latter part of June and the middle of July.

[M. P. ZAPPE]

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[1] Inasmuch as the articles in this Report written by members of the Department all bear the authors' names, they are not listed here.

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