State of Connecticut

PUBLIC DOCUMENT No. 24

Thirty-first and Thirty-second Annual Reports

OF

The Connecticut Agricultural Experiment Station

Being the biennial report for the two years ended October 31,

1908

PRINTED BY ORDER OF THE LEGISLATURE

HARTFORD
PUBLISHED BY THE STATE
1908

PUBLICATION

APPROVED BY

THE BOARD OF CONTROL.

THE TUTTLE, MOREHOUSE & TAYLOR COMPANY

CONNECTICUT AGRICULTURAL EXPERIMENT STATION.

OFFICERS AND STAFF.

STATION STAFF.

Chemists.

Analytical Laboratory.

JOHN P. STREET, M.S., *Chemist in Charge.*

E. MONROE BAILEY, M.S. — C. A. BRAUTLECHT, PH.B.
C. B. MORRISON, B.S. — CLARENCE W. RODMAN, B.S.

Laboratory for the Study of Proteids.

T. B. OSBORNE, PH.D., *Chemist in Charge.*

Botanist.

G. P. CLINTON, S.D.

Entomologist.

W. E. BRITTON, PH.D.

Assistant in Entomology.

B. H. WALDEN, B.AGR.

Forester.

AUSTIN F. HAWES, M.F.

Agronomist.

EDWARD M. EAST, PH.D.

Seed Testing.

MARY H. JAGGER.

Stenographers and Clerks.

MISS V. E. COLE.
MISS L. M. BRAUTLECHT.
MISS E. B. WHITTLESEY.
MISS C. A. BOTSFORD.

In charge of Buildings and Grounds.

WILLIAM VEITCH.

Laboratory Helper.

HUGO LANGE.

Sampling Agent.

V. L. CHURCHILL, New Haven.

TABLE OF CONTENTS.

Report of the Board of Control

of the

Connecticut Agricultural Experiment Station.

To His Excellency, Rollin S. Woodruff, Governor of Connecticut:

The Board of Control of the Connecticut Agricultural Experiment Station, as required by law, herewith submits its report for the two years ending November 1st, 1908.

Professor Wilbur Olin Atwater, of Wesleyan University, died in Middletown, Conn., September 22d, 1907.

The members of the Board of Control of the Connecticut Agricultural Experiment Station, with this notice of his death, desire also to record their appreciation of the great work which Professor Atwater did for the cause of Agricultural Research, both in Connecticut and in the country at large. Active and helpful in encouraging an interest in the subject and in urging the establishment of an Agricultural Experiment Station in Connecticut, he became Director in the first Station established on this continent, in 1875, and his influence contributed very largely to the successful establishment of agricultural experiment stations in other states.

He was also for fourteen years Director of the Storrs Station.

After the United States Department of Agriculture had been created and when the office of Experiment Stations was organized within it, Professor Atwater was appointed its first director, which office he held for three years and did much in shaping its policy and work.

For nearly twenty-seven years and until his last illness, he was a valued member of this Board, contributing to the management of its affairs the faithfulness, experience and good sense which had made him so successful in his other work.

Edwin Hoyt, a member of the Board of Control of this Station continuously since its incorporation in 1877, died at his home in New Canaan, on April 17th, 1908.

Born in 1832, educated in the schools of his native town, he spent a year in further study at the Potter School, at Niagara Falls, and a winter at the Sheffield Scientific School of Yale University, and in 1856 entered the nursery business established by his father, and continued in it until his death.

The nursery became the largest in New England, and Mr. Hoyt became known throughout the country as an expert nurseryman and orchardist. He was a member and an officer in the State Grange, the State Pomological Society, and other agricultural organizations, both state and national, and his papers presented at meetings of such bodies were always concise, convincing, and valued as the opinion of a disinterested and honest expert.

In his native town he was a prominent worker in the cause of temperance, a member of the Congregational Church, and an office holder in it for more than forty years, and interested in every movement for the advancement of his town and the welfare of its citizens.

He had represented his town in the General Assembly, and at the time of his death was President of the First National Bank of New Canaan.

In all the relations of life he showed himself scrupulously honest, generous and broad-minded, a lover of righteousness and a hater of iniquity.

The members of this Board desire to place on record their appreciation of the long, faithful and valuable service which Mr. Hoyt rendered to the Agricultural Station. His interest in it and his services for it began while it was still only talked of as a possibility, and continued as long as he lived.

The General Assembly, by joint resolution approved May 1st, 1907, accepted the provisions of the so-called Adams Act of the Congress of the United States and directed that one-half of the fund appropriated by this act should be given to this Station and one-half to the Storrs Station.

An act of the last General Assembly concerning Printing, Chapter 133, limits the edition of the Station report to 12,000 copies, the number of pages to 400, and provides that it shall be issued biennially. Authority is, however, given to the State Board of Control to limit the number of copies printed and to permit the printing of a larger number of pages of such reports as were made biennial by this act. The Board has authorized the printing of ten thousand copies of the report, not to exceed 900 pages, at the state expense, and allows it to be issued in parts as the material is prepared, so as to place the results of the work before the public as soon as they are ready.

A third act of the Assembly affecting this Station is the Food and Drug Law, Chapter 255, which is quite like the National Law, and charges this Station with the examination of drugs as well as food products, but makes no appropriation for the drug work. The Station, however, has been able to do something in the examination of drugs.

Mr. F. H. Stadtmueller, of Elmwood, was appointed a member of this Board to fill the unexpired term of Mr. Hoyt.

On May 1st, 1907, Dr. A. L. Winton, chemist in charge of the analytical laboratory, after twenty-three years of most valuable service to this Station, resigned to accept the position of chief of the United States Food and Drug Laboratory in Chicago.

On September 1st, 1907, Mr. E. J. Shanley resigned his position as chemist, to take a similar position in the Chicago Food and Drug Laboratory.

On October 1st, 1907, Dr. Kate G. Barber, the Station microscopist, resigned to take a similar position in the Bureau of Chemistry of the United States Department of Agriculture at Washington.

Mr. John Phillips Street, a graduate of Rutgers College, and for eighteen years connected with the New Jersey Station, was appointed to succeed Dr. Winton, on May 1st, 1907.

Mr. C. B. Morrison, a graduate of the Rhode Island Agricultural College, and employed at the time by the Sewage Purification Department of the City of Providence, R. I., was engaged as chemist in September, 1907, and in November, 1907, Mr. Harry R. Stevens, a graduate of the University of Vermont, was also added to the staff as chemist, but was obliged to resign in May, 1908, on account of ill health.

Mr. K. G. Mackenzie, a graduate of Yale University, also served the Station as chemist for five months in 1908.

Mr. C. A. Brautlecht, a graduate of the Sheffield School of Yale University, was appointed to the Station staff as chemist in April, 1908.

In January, 1908, Miss Mary H. Jagger was employed to attend to the work of seed testing.

In October of the same year Mr. Clarence Rodman, a graduate of the University of Pennsylvania, and employed at the time as a chemist in the Philadelphia Water Works, was engaged as chemist.

During the summer months of 1907 and 1908, Mr. Paul Graff was employed to put in order and arrange the additions to the herbarium which are noticed later in this report.

Messrs. F. F. Moon and Allen Hodgson, during the same time, assisted Mr. Hawes in the forest survey of the state.

Six hundred and fifty-one analyses of fertilizers were made in 1907, including all of the two hundred and seventy-nine brands registered for sale in the state, and the results published with appropriate discussion as Part I of the biennial report.

In 1908 six hundred and thirty-one fertilizer analyses were made, and the results are already in type.

In 1907 fifteen hundred and ninety-four food products were examined with reference to adulteration and all cases of adulteration reported to the dairy commissioner, with whom rests the enforcement of the law. A full report on all the samples was issued as Part II of the report.

In 1908 ten hundred and seventy-four analyses of foods, and four hundred and four of drugs were made and reported to the commissioner as before. The results are nearly ready for printing.

Two hundred and thirty-seven samples of feeding stuffs, including nearly if not quite all the brands sold in Connecticut, were analyzed in 1907, and the results published and discussed in Part III of the report. In 1908 about the same number have been collected and are now being examined.

Examinations and analyses have been made of all the brands of arsenical insecticides which could be found in the state, twenty-three in number, and the results printed in Bulletin 157.

As usual, a good deal of miscellaneous analytical work has been done, and also work in testing and improving analytical methods.

One hundred and fifty-four pieces of measuring apparatus for the Babcock test have been tested for creameries and individuals. Nine pieces were condemned as inaccurate.

The work done during 1907 and 1908 in the laboratory for protein research, supported in part by the Carnegie Institution and in part by the Adams fund, may be summarized as follows:

A full report on the Chemistry of Protein of the Wheat Kernel has been made and published by the Carnegie Institution as Publication 84.

A new substance, a dipeptide of proline and phenylalanine, has been isolated from one of the wheat proteins. This substance is important, not only in connection with the structure of wheat protein, but in connection with the chemistry of proteins in general.

Quantitative determinations have been made of the proportions of decomposition products yielded by a considerable number of vegetable proteins, and the results have been published.

Similar determinations have been made in a number of animal food substances to compare with the others, and to determine whether or not wide differences in decomposition products existed between animal food substances similar to those in vegetable proteins.

The extended study of the determination of the different forms of nitrogen in a large number of vegetable and animal proteins has been finished.

Experiments with the nucleic acid of wheat have settled an important point in the chemistry of this class of substances which has been the subject of much controversy.

The results of the work of this laboratory have been given in twenty-one papers published in scientific journals.

During 1907 and 1908 the entomological department has spent much effort in subduing the gipsy moth at Stonington, the only place in the state where it has been found. The infested area has been isolated as well as could be by the destruction of shrubs and bushes on all sides of it, and has been made considerably smaller, and within the area all larvae, pupae and egg masses discoverable by men working from November, 1906, to September, 1908, have been destroyed. Fourteen thousand trees were banded and inspected daily during the caterpillar season of each year, and fifty-five hundred caterpillars, two hundred pupae, and one hundred and forty-one newly laid egg masses were destroyed.

By act approved June 5th, 1907, the General Assembly of 1907 appropriated $1,000 for fighting the gipsy moth, and provided that the State Board of Control might supply additional funds to the amount of $10,000, if, in their judgment, it should be necessary. Five thousand dollars have been spent from this appropriation, one hundred dollars supplied by the State Board of Agriculture, and $1,513.34 from the regular state appropriation for the entomologist.

A new orchard pest, the peach saw-fly, which proved to be a new species, was studied, and its life history determined and described. It was very abundant in the peach orchards of one sections of the state, and threatened great injury. Under the direction of the entomologist spraying with arsenate of lead controlled the pest perfectly.

Experiments on the effectiveness of the fumigation of nursery stock with five different gases have been concluded.

Tests of remedies against the cabbage maggot and squash borer have been completed on the Station grounds at Mt. Carmel.

Examinations of localities where mosquitoes breed have been made, particularly at Beaver Swamp, New Haven, infected with the malaria-bearing mosquito, and by request of health officers, at the state rifle range, East Haven, and in the region about Stamford.

A paper on the Orthoptera of the state has been prepared for the Natural History Survey by Mr. B. H. Walden, and a general introduction to the insects of the state by Dr. Britton.

The insect collection now contains nearly 3,500 species, and over 30,000 specimens.

Ninety-two nurseries and seventy orchards and gardens have been inspected, and 338 samples of insects identified in answer to inquiries.

Four papers on entomological subjects have been prepared for scientific journals or reports.

The work of the agronomist, in large part supported by the Adams fund for scientific research, may be summarized as follows:

Dr. East has finished a preliminary study of the factors involved in the improvement of the potato, the relation of physical and chemical characters to quality, and the amount of fluctuation of these characters, a work begun at the University of Illinois, in 1901, completed here, offered as a thesis for the doctorate degree, and published by the Illinois Station as Bulletin 127.

A study of the physiology of the production of seed and of the difficulties attending hybridization in the potato, in which over seven hundred varieties have been under observation, has been finished and the results published.

In a study of inheritance of fluctuations within a bud propagating line (potatoes), using the nitrogen fluctuation for the observed character, the second generation has been grown.

The crosses between varieties of potatoes made in 1907 were grown in 1908, in order to study the inheritance of different unit characters.

In a study of the graft hybrids in potatoes it has been shown that no transference of coloring matter can be made, and certain errors in published work on the subject have been explained.

Some interesting results on bud variation have been obtained which offered a new explanation for the phenomenon.

The experiment at Elmwood in increasing by selection the protein content of a variety of corn has been continued. At the station at Granby several hundred crosses of corn have been made to determine the inheritance of various characters, and the second generation of several previous crosses have been grown, as well as the third generation of certain inbred varieties.

The coöperative tests in corn breeding, started in 1905, have, in 1908, been left entirely to the coöperators.

In studying the laws of inheritance with tobacco, which is a plant better suited to the purpose than any other of economic value grown here, 125 varieties have been grown for classification, for observation as to commercially desirable kinds, and, chiefly, to obtain varieties with different unit characters to use in heredity experiments.

In the greenhouse an experiment with tomatoes is in progress to determine whether it is possible by abnormal treatment of the developing seed to change in any way the usual characters of the offspring. The question is one of great economic importance.

Field, laboratory, and pot experiments have been made to test the availability of potassium in fine ground feldspar, so far without decisive results.

On the Station farm land the study of soil needs and improvement by rotations, cover crops, green manures and fertilizers has been continued with observations on fall and spring seeding with clover, together with experiments in spraying and other means of combating insect and fungus attacks; the latter under the direction of the entomologist and botanist.

Four papers on the subject of Dr. East's work have been read at meetings of specialists or published in scientific journals.

The botanist, Dr. Clinton, was absent on leave for two months in 1908, to do some preliminary work on the inoculation of the brown tail moth with the Empusa disease for the State of Massachusetts. This was done at Harvard University under the direction of Prof. Thaxter, formerly botanist of this Station.

Besides study and observation on the fungous troubles of crops in all parts of the state, collecting and arranging additions to the herbarium, and conducting experiments on the Station experiment land and in the greenhouse, the study of the botanist during the last two years has been chiefly on the following subjects:

1. The "Calico" disease of tobacco and chlorosis in other plants.
2. The downy mildew of Connecticut. (For the State Natural History Survey of the state.)
3. A study of 100 varieties of muskmelons, especially regarding their resistance to blight and adaptability to Connecticut conditions.
4. The root rot of tobacco.
5. Certain Peridermia and their telial stage.
6. Potato blight.

On the Station's experimental forest the forester has continued experiments on the economic planting of white pine, and on different methods of seeding and planting forest trees, on fertilizing young trees by growing cow peas, on the progress of the white pine disease, and the best treatment of the pine weevil.

The forest nursery contains about 950,000 seedling trees, mostly one-year-olds, and 300,000 seedlings in addition have been sold at cost to landowners.

Four acres of pine growth 30 years old have been bought in Enfield for experiments in thinning.

The increased interest in forest planting is shown by the facts that about 100,000 forest trees were planted in the state in 1906, 350,000 in 1907, and 600,000 in the present year.

A number of landowners in marketing their mature lumber are doing the work by improvement thinnings planned by the Station forester.

As state forester, Mr. Hawes has carried on improvement thinning and planting work both at the Portland and Union forests. A tract of 130 acres of waste land frequently burned over has been bought for a state forest in Simsbury, and 20,000 trees already planted.

The fire warden service has been greatly improved and a pamphlet of instructions to fire wardens, containing also a list of wardens with telephone calls of those who have them, has been distributed.

In 1908, alone, the wardens reported 156 fires, burning over 10,807 acres, of which 6,100 were sprout and timber land. 568

cords of cut wood were destroyed. 1,347 men were employed in fighting fire, and the total amount paid them by state, county, and town was about $9.00 per fire.

In Simsbury, alone, a single patrol during the danger season of April and May put out 35 fires before any considerable damage was done.

A forest survey has been made of Litchfield and Fairfield counties, and in coöperation with the Yale Forest School of New Haven County, estimating the quantity and kind of the standing timber. All wood lots of over ten acres are plotted on topographic sheets. The map is completed and the report prepared on the wood supplies and wood industries of these counties.

Miss Jagger has made five hundred and thirty-five examinations of seeds, a part on samples sent by seedsmen and buyers, and a part bought by our sampling agent in different parts of the state.

Twenty-eight thoroughbred Guernsey cows and twenty-nine Jerseys have been tested for advanced registry by monthly determinations of production of milk and of butter-fat. The tests of twelve Guernseys and ten Jerseys have been finished, and eleven were withdrawn before the year's test was finished.

At present seventeen Guernseys and eighteen Jerseys are being tested.

Within the period covered by this report the Station has acquired by purchase for its collections several hundred species of European fungi, and the herbarium of J. N. Bishop, of Plainville, containing between two and three thousand specimens.

Dr. W. A. Murrill, of the New York Botanical Garden, has given the Station one hundred specimens of the common Polyporei.

Mr. James Shepard, of New Britain, has given the Station the herbarium of his daughter, recently deceased, Miss Celia Antoinette Shepard, containing one thousand or more species, chiefly from Connecticut, but including many from other states and foreign countries.

Prof. S. W. Johnson, formerly director of this Station, has given, conditionally, to its library five hundred bound volumes and many pamphlets from his valuable agricultural library. These include sets of a number of valuable journals, almost impossible to get now from book dealers, and works on scientific agriculture which represent its history and development from the early years of the last century.

Members of the staff have made addresses at one hundred and six institutes, grange meetings, and other agricultural gatherings.

The Station has coöperated with the United States Department of Agriculture in tobacco breeding work and in a study of the improvement of sweet corn by selection of seed.

In the two years the Station has published one report of four hundred and twenty-three pages, with thirty-three plates, and one-half its biennial report of four hundred and fifty-three pages, with forty-seven plates. It has also issued six bulletins aggregating one hundred and forty-one pages, with nine plates and figures, and four bulletins of immediate information, aggregating twenty-three pages and nine figures. The editions range from eight thousand to ten thousand copies.

In the two years fourteen thousand three hundred and forty-two letters and manuscript reports have been written and mailed from the Station.

All of which is respectfully submitted.

(Signed) WILLIAM H. BREWER, *Secretary*.

NEW HAVEN, CONN., November 1, 1908.

REPORT OF THE TREASURER, 1907

E. H. JENKINS, in account with The Connecticut Agricultural Experiment Station for the fiscal year ending September 30, 1907.

RECEIPTS.

Balance on hand, October 1, 1906:		
Analysis Fees	$522.15	
Insect Pest Appropriation	650.00	
		$1,172.15
State Appropriation, Agriculture	$10,000.00	
State Appropriation, Food	2,500.00	
State Appropriation, Insect Pest	3,000.00	
State Appropriation, Gypsy Moth	2,500.00	
United States Appropriation, Hatch	7,500.00	
United States Appropriation, Adams	3,750.00	
Analysis Fees	2,900.00	
Miscellaneous Receipts	46.45	
From the Lockwood Estate	10,800.00	
		42,996.45
Total		$44,168.60

DISBURSEMENTS.

E. H. Jenkins, Salary	$2,800.00
W. H. Brewer, "	100.00
V. E. Cole, "	800.00
L. M. Brautlecht, "	600.00
A. L. Winton, "	1,458.33
J. P. Street, "	1,041.67
T. B. Osborne, "	2,200.00
E. M. Bailey, "	1,350.00
Kate Barber, "	1,066.66
E. J. Shanley, "	991.66
C. B. Morrison, "	18.75
W. E. Britton, "	1,700.00
G. P. Clinton, "	2,000.00
A. F. Hawes, "	1,291.66
E. M. East, "	1,700.00
J. B. Olcott, "	375.00
H. Lange, "	866.67
V. L. Churchill, "	760.00
William Veitch, "	633.33
T. E. Keitt, "	60.00
W. Drushel, "	150.00
R. W. Langley, "	358.90
Labor	3,366.21
Publications	583.29

Postage	$ 160.45
Stationery	283.94
Telephone and Telegraph	211.65
Freight and Express	149.98
Gas and Kerosene	329.21
Coal	1,302.05
Water	157.39
Chemicals and Laboratory Supplies	1,194.35
Agricultural and Horticultural Supplies	331.17
Miscellaneous Supplies	250.26
Botanical Supplies	72.20
Fertilizers	255.29
Feeding Stuffs	118.53
Library and Periodicals	594.68
Tools and Machinery	300.74
Furniture and Fixtures	137.40
Scientific Apparatus	82.33
Traveling by the Board	79.40
Traveling by the Staff	623.19
Traveling in connection with Adams Fund Investigations	178.76
Tobacco Experiment	75.30
Fertilizer Sampling	206.27
Food Sampling	341.21
Insurance	28.20
Insect Pest Appropriation to State Entomologist	3,650.00
Contingent	193.45
Forestry and Lockwood Expenses	2,256.85
Gypsy Moth Appropriation to State Entomologist	2,500.00
New Buildings	88.12
Betterments	115.27
Repairs	698.22
Rental of Land	120.00
	$43,357.99

Balance on hand, October 1, 1907:		
Analysis Fees	$307.79	
State Agricultural Appropriation	502.82	
		810.61
Total		$44,168.60

NEW HAVEN, CONN., November 5, 1907.

THIS CERTIFIES that we have examined the accounts of E. H. Jenkins, Treasurer of The Connecticut Agricultural Experiment Station, for the year ending September 30, 1907, compared the same with the vouchers therefor and found them correct.

WILLIAM P. BAILEY,
EDWARD S. ROBERTS,
Auditors of Public Accounts.

REPORT OF THE TREASURER, 1908

E. H. JENKINS, in account with The Connecticut Agricultural Experiment Station for the fiscal year ending September 30, 1908.

RECEIPTS.

Balance on hand, October 1, 1907:		
Analysis Fees	$307.79	
State Agricultural Appropriation	502.82	
		$810.61
State Appropriation, Agriculture	$10,000.00	
State Appropriation, Food	2,500.00	
State Appropriation, Insect Pest	3,000.00	
State Appropriation, Gypsy Moth	2,500.00	
United States Appropriation, Hatch	7,500.00	
United States Appropriation, Adams	4,750.00	
Analysis Fees	8,799.98	
Sale of Tobacco	65.97	
Sale of Farm Products	228.25	
Miscellaneous Receipts	433.52	
From the Lockwood Estate	9,177.40	
		48,955.12
Total		$49,765.73

DISBURSEMENTS.

E. H. Jenkins, Salary	$2,800.00
W. H. Brewer, "	100.00
V. E. Cole, "	850.00
L. M. Brautlecht, "	650.00
J. P. Street, "	2,500.00
T. B. Osborne, "	2,200.00
E. M. Bailey, "	1,550.00
C. B. Morrison, "	925.00
H. R. Stevens, "	500.00
K. G. Mackenzie, "	363.50
C. A. Brautlecht, "	450.00
R. S. Graves, "	70.00
W. E. Britton, "	2,000.00
G. P. Clinton, "	1,833.32
A. F. Hawes, "	1,800.00
E. M. East, "	1,900.00
J. B. Olcott, "	200.00
H. Lange, "	925.00
V. L. Churchill, "	825.00
William Veitch, "	675.00
H. W. Kiley (Labor)	728.00
Wm. Pokrob, "	728.00
C. D. Hubbell, "	728.00

M. Howley (Labor)	$ 280.00
Labor	2,426.42
Publications	1,445.17
Postage	229.91
Stationery	210.79
Telephone and Telegraph	144.92
Freight and Express	128.49
Gas and Kerosene	428.36
Coal	1,469.00
Water	189.96
Chemicals and Laboratory Supplies	1,283.56
Agricultural and Horticultural Supplies	209.91
Miscellaneous Supplies	164.42
Botanical Supplies	15.00
Fertilizers	241.14
Feeding Stuffs	102.53
Library and Periodicals	612.28
Tools and Machinery	75.85
Furniture and Fixtures	462.63
Scientific Apparatus	85.47
Traveling by the Board	53.28
Traveling by the Staff	1,149.18
Traveling in connection with Adams Fund Investigations	193.80
Tobacco Experiment	1,272.47
Fertilizer Sampling	164.10
Food Sampling	229.83
Insurance	275.25
Insect Pest Appropriation to State Entomologist	3,000.00
Contingent	119.50
Forestry and Lockwood Expenses	1,899.88
Gypsy Moth Appropriation to State Entomologist	2,500.00
Betterments	795.51
Repairs	1,412.90
Grounds	200.00
Rental of Land	130.00
	$48,902.33
Analysis Fees on hand, Sept. 30, 1908	863.40
Total	$49,765.73

NEW HAVEN, CONN., October 14, 1908.

THIS CERTIFIES that we have examined the accounts of E. H. Jenkins, Treasurer of The Connecticut Agricultural Experiment Station, for the year ending September 30, 1908, have compared the same with the vouchers therefor and found them correct.

WILLIAM P. BAILEY,
EDWARD S. ROBERTS,
Auditors of Public Accounts.

CORRECTIONS AND ADDITIONS.

Bulletin 163, page 13. Second paragraph from bottom. The Stearns Lime Co. offer water-slaked lime at $5.00 in bulk, $6.00 in bags, and delivered about $7.25. This makes the cost of pure lime and magnesia 60 cents per 100 pounds, instead of 73, as given in the Bulletin.

Report, page 4, twentieth line, strike out "Wheeler's Havana Tobacco Grower."

page 11, sixteenth line from the bottom, for 652 read 651.

pages 56, 60, 74. The fertilizer bearing the name of E. B. Clark Co., Milford, Conn., is made by that firm at its works at Communipaw, N. J. On pages 56, 60 and 74 of the Report it is stated that the fertilizer is "made for" E. B. Clark Co. This is an error.

pages 56 and 57. The price of Olds and Whipple's Home Mixture is $38.00 per ton, instead of $28.00, as given in the table. The percentage difference is 13.1.

page 115. Lime-Kiln Ashes, last line, under 18944, for "103" read 54; for "101" read 39.

page 119. The statement that the I. M. P. Plant Food contains essentially 55 per cent. of nitrate of potash and 45 per cent. of phosphate of soda is incorrect. It consists essentially of phosphate and nitrates of the alkalies. A more particular statement is not justified by the figures.

page 271, second line from top, for "weight" read weigh.

page 510. The cost price of Manchester's Formula, No. 20767, is $30.00 per ton, instead of $32.00, and the percentage difference 4.4, instead of 11.3.

page 528, last line of table, the dealer's price is $45.00 and the calculated valuation $34.56.

page 534, note, read 530 instead of 529.

page 725, last paragraph. The Hominy Feed sold by M. F. Barringer, Philadelphia, was shipped with a guaranty of composition, as required by law.

page 727, second paragraph. After One ex, strike out A1. The manufacturer states that the One ex is the lowest grade of distillers' grains and the mark A1 had never been used in connection with it.

The feed represented by sample **20710** was not made by the Biles Co.

To the explanation regarding Dried Distillery Grains on pages 176 and 726 may be added the following note regarding the several kinds of distillery grains sold by the J. W. Biles Co.:

Four ex is the product of alcohol distilleries, consisting of 88 to 90 per cent. of corn residues with 10 to 12 per cent. of "small grains," chiefly malted barley, with a few oats coming as an unavoidable mixture in the barley.

Two ex, the product of Bourbon whiskey distilleries, contains 60 to 80 per cent. of corn residues and 20 to 40 per cent. residues of "small grains," chiefly rye and malted barley, with a few oats.

Rye grains, the product of rye whiskey distilleries, may consist wholly of rye residues, or of rye and malted barley, with a few oats, or they may have a large admixture of corn.

One ex grains are from vinegar and yeast factories, containing about 50 to 60 per cent. of corn residues and 40 to 50 per cent. of "small grains."

page 729, after the words, *"Biles' Union Grains* contain," insert cotton seed meal. The manufacturers state that the oat product is very small in quantity and comes entirely from the oats which all malted barley contains as an accidental mixture, the ingredients of the mixture being distillery grains, linseed and cotton seed meal, hominy feed, wheat middlings and bran and barley malt sprouts.

page 777, last line, for "Ridley" read Riley.

PART I.

Report on Commercial Fertilizers, 1907.

By E. H. JENKINS, *Director,* and JOHN PHILLIPS STREET, *Chemist in charge of the Analytical Laboratory.*

This station is required by statute to analyze yearly at least one sample of every commercial fertilizer which is offered for sale in the state. "Stable manure and the products of local manufacturers of less value than ten dollars per ton," are excepted. The station is also required to publish these analyses yearly.

DUTIES OF MANUFACTURERS AND DEALERS.

The General Statutes, sections 4581 to 4590, inclusive, make the following requirements regarding commercial fertilizers:

1. The seller is responsible for affixing to every package sold, a label which shall correctly give the number of pounds in the package, name of the fertilizer, name and address of the manufacturer, place of manufacture and a statement of composition, expressed in a way approved by this station.

Attention is called to the requirement of law that the name of the manufacturer and place of manufacture must be stated on the label. The place of manufacture is the place where the materials which compose the manufactured article are mixed and put together. The manufacturer is the person or firm which owns or controls the manufacturing plant or machinery.

2. The seller is responsible for the payment to the station director, on or before May first, annually, of an analysis fee on every brand sold by him.

3. Before any brand of fertilizer is sold in the state, the agent or seller must file with the director of this station two

certified copies of the statement named in 1, and a sealed glass jar containing not less than one pound of the fertilizer, with an affidavit that it is a fair average sample.

The agent or seller is free from the three obligations just stated only when the manufacturer or importer fulfils them instead.

4. In any case the agent or seller must annually report to the director of this station his name, residence and post office address and the names of the fertilizers which he sells, with the names and addresses of the manufacturers or importers.

Copies of the statutes regarding fertilizers will be sent on application.

The statement of composition referred to in the statute must conform to the following requirements, which are approved by this station:—

A statement of the percentages of Nitrogen, Phosphoric Acid (P_2O_5) and Potash (K_2O), and of their several states or forms, will suffice in most cases. Other ingredients may be named if desired.

In all cases the percentage of *nitrogen* must be stated. Ammonia may also be given when actually present in ammonia salts, and "ammonia equivalent of nitrogen" may likewise be stated.

The percentages of water-soluble and citrate-soluble phosphoric acid may be given separately or together, and the term "available" may be used in addition to, but not instead of, water-soluble and citrate-soluble.

The percentage of acid-soluble phosphoric acid may be stated or omitted.

In case of bone, fish, tankage, dried meat, dried blood, etc., the statement of chemical composition must take account of the two ingredients, nitrogen and phosphoric acid.

For potash salts the percentage of potash (potassium oxide) must always be given; that of sulphate of potash or muriate of potash may also be stated.

The analysis fee for any brand will usually be ten, twenty or thirty dollars, according as one, two, or all three of the ingredients—nitrogen, phosphoric acid and potash—are contained or claimed to exist in the fertilizer.

OBSERVANCE OF THE FERTILIZER LAW.

During 1907 thirty-six individuals or firms have entered for sale in this state two hundred and seventy-nine brands of fertilizers, viz:

Special manures for particular crops	126
Other nitrogenous superphosphates	98
Bone manures and "bone and potash"	23
Fish, tankage, castor pomace and chemicals	32
Total	279

Here follows a list of manufacturers who have paid analysis fees as required by the fertilizer law, and the names or brands of the fertilizers for which fees have been thus paid for the year ending May 1st, 1908:

Firm.	*Brand of Fertilizer.*
American Agricultural Chemical Co., The, 2 Rector St., N. Y. City.	A. A. C. Co.'s Acid Phosphate, Grass and Oats Fertilizer, Complete Manure with 10% Potash, Tobacco Starter and Grower, Grass and Lawn Top Dressing, Southport XX Special, Complete Tobacco Manure, H. G. Tobacco Manure, Castor Pomace, Fine Ground Bone, Dry Ground Fish, Muriate of Potash, Nitrate of Soda, Bradley's Niagara Phosphate, Eclipse Phosphate, Farmers New Method Fertilizer, Corn Phosphate, Potato Fertilizer, Manure, Superphosphate, Complete Manure for Potatoes and Vegetables, Complete Manure for Top Dressing Grass and Grain, Church's Fish and Potash, Crocker's Ammoniated Corn Phosphate, Potato, Hop and Tobacco Fertilizer, Darling's General Fertilizer, Farm Favorite, Potato Manure, Dissolved Bone and Potash, Blood, Bone and Potash, East India A. A. Ammoniated Superphosphate, Potato Manure, Great Eastern General, H. G. Vegetable, Vine and Tobacco Fertilizer, Northern Corn Special,

Firm.	*Brand of Fertilizer.*
American Agricultural Chemical Co., The, 2 Rector St., N. Y. City—*Continued.*	Packers' Union Universal Fertilizer, Potato Manure, Gardeners' Complete Manure, Animal Corn Fertilizer, Quinnipiac Climax Phosphate, Corn Manure, Potato Phosphate, Manure, Phosphate, Market Garden Manure, Read's Practical Potato Special, Standard Superphosphate, Vegetable and Vine Fertilizer, Wheeler's Bermuda Onion Grower, Corn Fertilizer, Potato Manure, Havana Tobacco Grower. Havana Tobacco Grower, Wm's & C's Americus Corn Phosphate, Potato Manure, Ammoniated Bone Superphosphate, H. G. Special Fertilizer, Potato Phosphate.
Armour Fertilizer Works, The, Baltimore, Md.	Grain Grower, Bone, Blood and Potash, High Grade Potato, All Soluble, Ammoniated Bone with Potash, Bone Meal, Complete Potato, Corn King, Market Garden, Fish and Potash, Fruit and Root Crop Special.
Baker, H. J., & Bro., 100 William St., N. Y. City.	Castor Pomace.
Berkshire Fertilizer Co., Bridgeport, Conn.	Berkshire Ammoniated Bone Phosphate, Complete Fertilizer, Grass Special, Potato and Vegetable Phosphate, Tobacco Special, Fine Ground Bone.
Boardman, F. E., Route 1, Middletown, Conn.	Boardman's Complete Fertilizer.
Bohl, Valentine, Waterbury, Conn.	Self Recommending Fertilizer.
Bowker Fertilizer Co., 60 Trinity Place, N. Y. City.	Bowker's Acid Phosphate, Corn Phosphate, Complete Alkaline Tobacco Grower,

Firm.	*Brand of Fertilizer.*
Bowker Fertilizer Co., 60 Trinity Place, N. Y. City—*Continued.*	Bowker's Early Potato Manure, Farm and Garden Phosphate, Fine Ground Fish, Fisherman's Brand Fish and Potash, Fresh Ground Bone, Hill and Drill Phosphate, Lawn and Garden Dressing, Market Garden Fertilizer, Middlesex Special, Potato and Vegetable Fertilizer, Potato and Vegetable Phosphate, Sure Crop Phosphate, Tobacco Ash Elements, Starter, Gloucester Fish and Potash, Stockbridge Special Complete Manure for Corn and all Grain Crops, Stockbridge Special Complete Manure for Grass Top Dressing, Stockbridge Special Complete Manure for Potatoes and Vegetables, Stockbridge Tobacco Manure, Canada Hardwood Ashes, Castor Pomace, Muriate of Potash, Nitrate of Soda, XX Bone.
Brainard, H. K., Thompsonville, Conn.	"High Grade."
Buffalo Fertilizer Co., The, Buffalo, N. Y.	Bone Meal, Celery and Potato Special, Buffalo Tobacco Producer, Farmers' Choice, Fish Guano, Garden Truck, Ideal Wheat and Corn, Top Dresser, Vegetable and Potato, Muriate of Potash, Nitrate of Soda.
Clark, Everett B., Co., The, Milford, Conn.	Clark's Special Mixture.
Coe-Mortimer Co., The, 24 Stone St., N. Y. City.	E. F. C's. Celebrated Special Potato Fertilizer, E. F. C's. Gold Brand Excelsior Guano, E. F. C's. H. G. Ammoniated Bone Superphosphate for All Crops, E. F. C's. New Englander Corn and Potato Fertilizer, E. F. C's. Red Brand Excelsior Guano for Market Gardening,

Firm.	*Brand of Fertilizer.*
Coe-Mortimer Co., The, 24 Stone St., N. Y. City—*Continued.*	E. F. C's. XXX Bone, Genuine Peruvian Guano, Chincha Grade, Lobos Grade, Peruvian Market Gardeners' Fertilizer, Peruvian Guano Base, Tobacco Fertilizer, Peruvian Guano Base, Vegetable Grower, Peruvian Guano Base.
Connecticut Fat Rendering & Fertilizer Corp., New Haven, Conn.	Tankage.
Connecticut Valley Orchard Co., Berlin, Conn.	C. V. O. Co.'s H. G. Special.
Cooper's Glue Factory, Peter, 13 Burling Slip, N. Y. City.	Pure Bone Dust.
Dennis, George L., Stafford Springs, Conn.	Bone.
Eldredge, T. H., Norwich, Conn.	Eldredge's Special Fish and Potash Fertilizer, Superphosphate.
Frisbie, L. T., Co., The, Box 1253, New Haven, Conn.	Frisbie's Fine Bone Meal.
James, Ernest L., Warrenville, Conn.	James' Bone Phosphate, Ground Bone.
Kelsey, E. R., Branford, Conn.	Bone, Fish & Potash.
Listers' Agricultural Chemical Works, Newark, N. J.	Ammoniated Dissolved Bone, Corn and Potato Fertilizer, Potato Manure, Special Tobacco Fertilizer, Standard Bone Superphosphate of Lime, Success Fertilizer, Bone Meal.
Manchester, E., & Sons, Winsted, Conn.	Manchester's Formula.
Mapes F. & P. G. Co., The, 143 Liberty St., N. Y. City.	Average Soil Complete Manure, Cereal Brand, Complete Manure "A" Brand, Corn Manure, Dissolved Bone, Economical Potato Manure, Fruit and Vine, Potato Manure, Seeding Down Manure, Tobacco Ash Constituents, Manure, Wrapper Brand, Starter, Improved,

Firm.	*Brand of Fertilizer.*
Mapes F. & P. G. Co., The, 143 Liberty St., N. Y. City—*Continued.*	Top Dresser, Improved, Full Strength, Half " Vegetable Manure, or Complete Manure for Light Soils.
National Fertilizer Co., Bridgeport, Conn.	Chittenden's Ammoniated Bone Phosphate, Complete, Tobacco, Conn. Valley Tobacco Grower, Conn. Valley Tobacco Starter, Dry Ground Fish, Fish and Potash, Formula "A", "B", H. G. Special Tobacco, Market Garden, Potato Phosphate, Soluble Bone and Potash, Tobacco Special with Carb. Potash, XXX Fish and Potash.
New England Fertilizer Co., 43 North Market St., Boston, Mass.	N. E. Corn & Grain Fertilizer, High Grade Potato Fertilizer, Perfect Tobacco Grower, Potato Fertilizer, Superphosphate, Ground Bone.
North Western Fertilizing Co., Chicago, Ill.	North Western Empire Special Manure, Market Garden Phosphate, Superphosphate, 10% Manure, Potato Fertilizer.
Olds & Whipple, Hartford, Conn.	O. & W's. Complete Tobacco Fertilizer, Corn and Potato Fertilizer, Grass Fertilizer, Grey Pomace, H. G. Potato Fertilizer, Special Phosphate, Vegetable Potash.
Parmenter & Polsey Fertilizer Co., Peabody, Mass.	A. A., P. & P. Potato, Plymouth Rock, Pure Ground Bone, Special Potato, Star Brand.
Rogers & Hubbard Co., The, Middletown, Conn.	Hubbard's Complete Phosphate, Fertilizer for Oats & Top Dressing,

Firm.	*Brand of Fertilizer.*
Rogers & Hubbard Co., The, Middletown, Conn.—*Continued.*	Hubbard's Grass and Grain Fertilizer, Market Garden Phosphate, Potato Phosphate, Soluble Corn and General Crops Manure, Potato Manure, Tobacco Manure, Pure Raw Knuckle Bone Flour, Strictly Pure Fine Bone.
Rogers Manufacturing Co., The, Rockfall, Conn.	All Round Fertilizer, Complete Potato and Vegetable, Fish and Potash, H. G. Corn and Onion, Grass and Grain, Oats and Top Dressing, Soluble Tobacco, Tobacco and Potato, Grower, Tobacco Starter, Pure Ground Bone, Knuckle Bone Flour.
Russia Cement Co., Gloucester, Mass.	Essex A 1 Superphosphate, Complete Manure for Corn, Grain and Grass, Complete Manure for Potatoes, Roots and Vegetables, Dry Ground Fish, Grass and Top Dressing, Market Garden and Potato Manure, Special Tobacco Manure, Tobacco Starter, XXX Fish and Potash.
Sanderson Fertilizer & Chemical Co., New Haven, Conn.	Atlantic Coast Bone, Fish and Potash, Sanderson's Corn Superphosphate, Fine Ground Bone, Fish, Formula A., B. for Tobacco, Potato Manure, Special with 10% Potash, Top Dressing for Grass and Grain, Muriate of Potash, Nitrate of Soda, Sulphate of Potash, Double.
Shay, C. M., Fertilizer Co., The, Groton, Conn.	Shay's Corn Manure, Grass Fertilizer, Potato Manure, Pure Ground Bone.

Firm.	*Brand of Fertilizer.*
Shoemaker, M. L., & Co., Philadelphia, Pa.	"Swift-Sure" Guano for Truck, Corn and Onions, Phosphate for General Use, Phosphate for Potatoes, Bone Meal.
Swift's Lowell Fertilizer Co., 40 North Market St., Boston.	Swift's Market Garden Manure, Perfect Tobacco Grower, Special Grass Mixture, Vegetable Manure, Lowell Animal Brand, Bone Fertilizer, Dissolved Bone and Potash, Empress Brand, Ground Bone, Potato Manure, Phosphate, Acid Phosphate, Muriate of Potash, Nitrate of Soda.
Wilcox Fertilizer Works, The, Mystic, Conn.	Dry Gound Fish Guano, Pure Ground Bone, Wilcox's Complete Bone Superphosphate, Fish and Potash, Grass Fertilizer, H. G. Fish and Potash, Tobacco Special, Potato Fertilizer, Onion and Vegetable Manure, Special Superphosphate, Acid Phosphate, Muriate of Potash, Nitrate of Soda, H. G. Sulphate of Potash.
Woodruff, S. D. & Sons, Orange, Conn.	Woodruff's Home Mixture.

The analyses which follow are chiefly useful as a guide in making purchases for the next year. Most of them are of brands which are offered year after year in Connecticut and the analyses serve to show whether or not these brands are maintaining their original quality.

The larger part of the year's supply of fertilizers is shipped into the state just before planting time, much of it after river navigation is opened. Many brands are not in market till the middle of April. Obviously these trade conditions make it absolutely impossible for the station to sample and analyze the two hundred and seventy-nine brands of fertilizers sold in Connecticut and tabulate and publish the results in time to show the composition of all of them before they are bought and applied.

When new brands are offered, the station endeavors to analyze such brands at once and to distribute the report of the results as quickly and widely as possible. Farmers can aid greatly by calling the attention of the station promptly to new kinds of fertilizers which are offered for sale.

SAMPLING AND COLLECTION OF FERTILIZERS.

During April, May and June, Mr. V. L. Churchill, the sampling agent of this station, visited ninety-seven towns and villages in Connecticut to draw samples of commercial fertilizers for analysis. These places were distributed as follows:

Litchfield County	11
Hartford County	25
Tolland County	5
Windham County	10
New London County	10
Middlesex County	10
New Haven County	17
Fairfield County	9
	97

In these places six hundred and fifty-three samples were taken, representing all but three of the brands which have been entered for sale in this state.

The sampling agent could not find on sale the American Agricultural Chemical Co.'s High Grade Tobacco Manure, National Fertilizer Co.'s Ammoniated Bone Phosphate, nor Parmenter & Polsey's Star Brand.

As no samples of either of these brands were deposited by the manufacturers at the station, it was impossible to make analyses of them.

With these exceptions, an analysis has been made of every brand of fertilizer which has been entered at the station for sale in Connecticut.

When several samples of a single brand are drawn in different parts of the state, the analysis is usually performed, not on any single sample, but on a mixture made of equal weights of all of the several samples. Thus, it is believed, the average composition of the goods is more fairly represented than by the analysis of single samples.

The station agent is instructed in every case to open at least three packages of each brand for sampling, and, if the number of packages is very large, to take a portion from every tenth one, by means of a sampling tube which withdraws a section or core diagonally through the entire length of the bag or barrel.

As a rule, the station will not analyze samples taken from dealer's stock of less than one ton, from stock which has lain over from last season, or from stock which is improperly stored, as in bags lying on wet ground, or exposed to the weather, etc.

The station desires the coöperation of farmers, farmers' clubs and granges in calling attention to new brands of fertilizers, and in securing samples of all goods offered for sale. *All samples must be drawn in strict accordance with the Station's Instructions for Sampling, and must also be properly certified.* A copy of these instructions and blank certificates will be sent on application.

A sample taken carelessly or incorrectly is quite certain to work injustice both to the seller and buyer. Accuracy of sampling is just as necessary as accuracy of analysis. The sampling is, in reality, a very important part of the analysis.

ANALYSES OF FERTILIZERS.

During the year 652 samples of commercial fertilizers and manurial waste-products have been analyzed. A classified list of them is given below and the results of their examination are given in detail in the following pages.

Samples are analyzed as promptly as possible in the order in which they are received. As soon as an analysis is completed, a copy of it is sent to the party who furnished the sample and also to the manufacturer, in order that there may be opportunity for correction or protest, before the results are published.

DESCRIPTIONS AND ANALYSES OF FERTILIZERS.*

The samples referred to in the following pages were drawn by the station agent, unless the contrary is stated.

*The analyses of fertilizers included in this chapter have been made by Mr. Street, chemist in charge, with the assistance of Messrs. Bailey, Shanley and Drushel and Miss Barber, station chemists, and of Mr. Lange. The results have been tabulated and discussed by the director.

The analyses were made by the methods adopted by the Association of Official Agricultural Chemists and the results are always expressed in percentages, or parts per hundred by weight, of the material examined.

Every percentage given has been determined by two separate analyses, usually made by two chemists working independently, and all calculations are also made in duplicate.

In order to avoid confusion, each sample, as it is received, is given a consecutive number, by which it is distinguished in the laboratory. As the numbers had become so large as to be somewhat unwieldy, the numbering was begun again at unity in 1900.

CLASSIFICATION OF THE FERTILIZERS ANALYZED.

	No. of Samples.
1. *Containing nitrogen as the chief active ingredient.*	
Nitrate of soda	15
Sulphate of ammonia	1
Dried blood	2
Cotton seed meal	199
Castor pomace	8
Linseed meal	1
2. *Containing phosphoric acid as the chief active ingredient.*	
Dissolved phosphate rock	9
Basic slag	1
Precipitated bone	1
3. *Containing potash as the chief active ingredient.*	
Carbonate of potash	2
High grade sulphate of potash	4
Double sulphate of potash and magnesia	6
Muriate of potash	10
Kainit	1
4. *Containing nitrogen and phosphoric acid.*	
Bone manures	23
Slaughter-house tankage	17
Dry ground fish	10
5. *Mixed fertilizers.*	
Nitrogenous superphosphates	123
Special manures	130
Home mixtures	11
6. *Miscellaneous fertilizers and manures.*	
"Vegetable potash"	2
Cotton hull ashes	24
Wood ashes	20
Lime and lime-kiln ashes	11
Others, miscellaneous	20
Total	651

I. RAW MATERIALS CHIEFLY VALUABLE FOR NITROGEN.

NITRATE OF SODA OR SODIUM NITRATE.

Nitrate of Soda is mined in Chili and purified there before shipment. As offered in the Connecticut market it contains about 15.70 per cent. of nitrogen, equivalent to 95.3 per cent. of pure sodium nitrate. The other usual constituents are moisture and small quantities of common salt and Glauber's salts.

Shipments differ somewhat in composition. The lowest percentage of nitrogen found in any sample this year is 15.06, equivalent to 91.4 per cent. of sodium nitrate.

Fifteen samples have been analyzed, as follows:—

19178. Sold by Coe-Mortimer Co., N. Y. Sampled from stock of W. H. Burr, Greens Farms.

19401. Sold by National Fertilizer Co., Bridgeport. Sampled from stock of H. A. Bugbee, Willimantic.

19181. Sold by S. D. Viets & Co., Springfield, Mass. Sampled from stock of A. N. Graves, Windsor Locks.

19065. Sold by Buffalo Fertilizer Co., Buffalo, N. Y. Sampled from stock of J. G. Schwink, Meriden.

18976. Sold by Wilcox Fertilizer Works, Mystic, Conn. Sampled from stock of seller.

18953. Sold by Am. Ag. Chem. Co., N. Y. City. Sampled from stock of Spencer Bros., Suffield.

18919. Sampled from stock of S. D. Woodruff & Sons, Orange.

18924. Sold by and sampled from stock of Sanderson Fertilizer and Chem. Co., New Haven.

19180. Sold by Bowker Fertilizer Co., N. Y. Sampled from stock of Bowker Branch, Hartford.

19179. Sold by Parmenter & Polsey, Peabody, Mass. Sampled from stock of T. J. Pring & Bro., Wallingford.

19406. Sold by Swift's Lowell Fertilizer Co., Boston. Sampled from stock of E. E. Burwell, New Haven.

18983. Sold by National Fertilizer Co., Bridgeport. Sampled from lot bought by Connecticut School for Boys, Meriden.

18830. Sold by Swift's Lowell Fertilizer Co., Boston. Sampled from lot bought by Andrew Ure, Highwood.

19292 and **19293.** Sampled from separate bags of nitrate which were quite unlike in color. Bought of H. K. Brainard, Thompsonville, by C. C. Chapin.

ANALYSES OF NITRATE OF SODA.

	Coe-Mortimer.	National Fert. Co.	Viets.	Buffalo Fert. Co.	Wilcox.	A. A. C. Co.	Woodruff.	Sanderson.	Bowker.	Parmenter & Polsey.	Swift's Lowell.	National Fert. Co.	Swift's Lowell.	H. K. Brainard.	H. K. Brainard.
Station No.	19178	19401	19181	19065	18976	18953	18919	18924	19180	19179	19406	18983	18830	19292	19293
Percentage amounts of															
Nitrogen found	15.60	15.47	15.24	15.68	15.80	15.64	15.54	15.52	15.52	15.40	15.20	15.60	15.48	15.36	15.06
Nitrogen guaranteed	15.0	15.0	----	15.6	15.0	15.0	----	15.7	15.0	15.6	15.0	15.8	15.0	----	----
Cost per ton	$53.00	55.00	55.00	58.00	60.00	60.00	60.00	60.00	60.00	60.00	60.00	----	----	----	----
Nitrogen costs cents per pound	17.0	17.7	18.0	18.5	19.0	19.2	19.3	19.3	19.3	19.5	19.7	----	----	----	----

The percentage of nitrogen ranges from 15.06 to 15.80 and averages 15.50, about the same as last year.

The retail cost of nitrogen in this form has ranged from 17 to 19.7 cents per pound. In mixed car lots for cash it has been bought for considerably less than 17 cents.

SULPHATE OF AMMONIA.

This material, made on a large scale as a by-product of gas-works and coke-ovens, usually contains over 20 per cent. of nitrogen in form of ammonia, or the equivalent of 94-97 per cent. of pure ammonium sulphate.

A single sample from S. D. Woodruff & Sons contained 20.60 per cent. of nitrogen.

DRIED BLOOD.

This is blood collected in slaughter houses which is cooked to thoroughly coagulate it, dried by pressure and artificial heat, and then ground. Prepared in this way it contains about 14 per cent. of nitrogen. Lower grades mixed with tankage and other material, and containing 10 to 12 per cent. of nitrogen, are also on the market.

Two samples have been analyzed. **19174**, sold by Swift's Lowell Fertilizer Co., Boston, sampled from stock of E. E. Burwell, New Haven, contained 10.96 per cent. of nitrogen and cost $45.00 per ton, making the cost of nitrogen 20½ cents per pound. **18825**, sold by the same company to Andrew Ure, Highwood, contained 9.88 per cent. of nitrogen.

COTTON SEED MEAL.

(ANALYSES ON PAGES 22 TO 29.)

This material is of two kinds, which are known in trade respectively as undecorticated and decorticated. In the manufacture of decorticated meal, which is the only grade which Connecticut farmers can afford to buy for a fertilizer, cotton seed is first ginned to remove most of the fiber, then passed through a "linter" to take off the short fiber or lint remaining, then through machines which break and separate the kernels from the hulls. The kernels are cooked and the oil is expressed. The cake from the presses is ground or shipped to Europe in slabs and is used as a cattle feed and fertilizer. Formerly the hulls were burned for fuel in the factories, and the resulting ashes, which contained from 20 to 30 per cent. of potash, were used in this state as a tobacco fertilizer.

The hulls have, however, come into extensive use as a cattle feed in the South, and now sell for this purpose at prices which forbid their use as a fuel. A larger proportion of them is now left in the so-called "decorticated meal" than ever before, which accounts for the gradual lowering of the feeding and fertilizer content of this valuable product. It is a not uncommon practice also to grind the hulls fine and mix them with the ground cotton seed cake. Buyers who are only anxious to get a "smooth" meal are quite likely to have these fraudulent mixtures worked off on them.

The color and the "smoothness" of the meal give no knowledge of its content of nitrogen and hence of its fertilizing value. The dry meals which are dark, because of over-cooking or of slight fermentation, are, in our experience, as likely to have a high content of nitrogen as the bright yellow meals.

In view of the fact that more than 5,000 tons of cotton seed meal, costing $155,000, were used as a fertilizer in Connecticut this year, by tobacco growers alone, the following rules adopted by the Interstate Cotton Seed Crushers Association in May 1907, are of importance:

STANDARD CLASSIFICATION.

"Sec. 1. Choice Cotton Seed Meal must be finely ground, perfectly sound and sweet in odor, yellow, free from excess of lint and hulls, and by analysis must contain at least 8 per cent. of ammonia. (6.59 per cent. nitrogen.)

Sec. 2. Prime Cotton Seed Meal must be finely ground, of sweet odor, reasonably bright in color, yellow, not brown or reddish, and by analysis must contain at least 7½ per cent. of ammonia. (6.2 per cent. nitrogen.)

Sec. 3. Good Cotton Seed Meal must be finely ground, of sweet odor, reasonably bright in color, and by analysis must contain at least 7 per cent. of ammonia. (5.77 per cent. nitrogen.)

Sec. 4. Off Cotton Seed Meal. Any Cotton Seed Meal which is distinctly deficient in any of the requirements of prime quality, either in color, odor, texture or analysis, or all, shall be deemed Off Meal and should be sold by sample.

Sec. 5. Standard Seed Meal not coming up to contract grade shall be a good delivery if within one-half of one per cent. of the ammonia content of the grade sold, or the sale sample, but the settlement price shall be reduced at the rate of one-tenth of the contract price for each one per cent., and proportionately for the fractions, of deficiency in ammonia."

The meaning of the last section, as far as cotton seed meal as a fertilizer goes, is that the meal must be accepted if not more than 0.41 per cent. deficient in nitrogen, but the settlement price shall be reduced at the rate of one-tenth of the contract price for each 0.82 of one per cent. of nitrogen deficiency of nitrogen. For instance, if "Choice" cotton seed meal, selling at $32.00 per ton, is found to contain 6.20 per cent. of nitrogen instead of 6.61 as guaranteed, it must be accepted, but $30.40 per ton must be accepted by the seller in payment.

The following rule regarding sampling should also be noted by those who do this work for themselves or others:

"Rule 20. Meal. Two ounces or more from a sack shall constitute a sample of meal, and must be drawn so as to fairly represent the entire contents of the bag. Twenty samples from each carload, or fifty sacks from each 100 tons, if not shipped in car lots, shall be sufficient to represent a shipment. Separate samples of meal should be well wrapped in heavy paper, sealed and labeled, so as to identify them and the shipment they represent. Samples of meal, if of approximately the same grade and quality, need not be kept separate, but may be commingled, in which case they must be placed in a metal mailing or sample box and carefully marked, showing the number of samples taken, as well as car number and mark."

This rule should be carefully followed in the sampling of car lots of meal if a claim is to be made for deficiency of nitrogen in case it exists.

Under the laws of this state cotton seed meal is classed as a commercial feed and not as a fertilizer. The law regarding commercial feeds (General Statutes, § 4592) requires that every lot

"shall have affixed thereto, in a conspicuous place on the outside thereof, a legible and plainly printed statement, certifying the number of net pounds of feeding stuff contained therein, the name, brand, or trade-mark under which the article is sold, the name and address of the manufacturer or importer, and a statement of the percentage it contains of crude fat and of crude protein, allowing one per cent. of nitrogen to equal six and one-fourth per cent. of protein," etc.

The sale of cotton seed meal or other commercial feed which does not comply with the above requirements is illegal and *renders the person who sells the meal in Connecticut* liable to a fine of $100 for the first offense and $200 for the second.

The attention of dealers within the state is called to the matter now, that they may have it in mind in contracting at the south for deliveries next fall and winter.

GUARANTIES.

Of the 174 samples which are included in the tables, sixty, or more than one-third of the whole number, were below guaranty by more than one-tenth per cent. of nitrogen.

If we make a generous allowance for the unavoidable errors in sampling and anaylsis, there still remain 39 samples in which a rebate might fairly be demanded because of failure to meet the manufacturers' claims.

Twenty-one samples had at least 0.25 per cent. less nitrogen than was guaranteed. Nine others had at least 0.40 per cent. less, 4 others at least 0.6 per cent. less and 5 others at least 0.8 per cent. less nitrogen than was guaranteed. Allowing $3.00 per unit of ammonia for the deficiency, the above figures represent a loss to the purchaser

For 0.25 per cent. nitrogen deficiency,	$0.90	per ton.
0.40 " " " "	1.44	" "
0.60 " " " "	2.16	" "
0.80 " " " "	2.88	" "

The meal is usually shipped direct from the mills to the Connecticut dealer, and the commission merchant, who makes the sale, does not see the meal, but sells it on the makers' guaranty. In selling it however he assumes, or should assume, responsibility for the correctness of the representations, in order that he may protect the Connecticut dealer, who is liable under our state law.

This responsibility has been assumed during the last year by Messrs. Humphreys, Godwin & Co. of Memphis, Tenn. When this station has found cotton seed meal sold by them to contain less than the guaranteed amount of nitrogen and the fact has been brought to their attention, they have reduced the price to the Connecticut dealer by $3.00 per unit *of ammonia* in this deficiency, which is equivalent to 18.1 cents per pound of nitrogen deficient. (A "unit" is one per cent. or 20 pounds per ton. "Units" of nitrogen are calculated to units of ammonia by multiplying by 1.2, and conversely units of ammonia are reduced to units of nitrogen by dividing by 1.2.) Such a guaranty by a responsible party is a very different thing from a guaranty printed on the tag for which no one will hold himself responsible and for which the law can only hold the Connecticut dealer responsible. It is hoped that other commission houses will see the wisdom of following the plan adopted by the firm named.

The station is frequently asked what rebate should be given where meal fails to meet the guaranty. The station has no authority or desire to prescribe adjustments of price between buyer and seller, but has suggested the following example as perhaps indicating a fair method of adjustment.

A meal costing $32.00 per ton, guaranteed 6.5 per cent. of nitrogen, contains only 6.24.

As stated on page 20, the average valuation of phosphoric acid and potash in a ton of meal is $4.42; $32 — $4.42 = $27.58, which we may call the price of the nitrogen in it. The meal is guaranteed to have 6.50 per cent. of nitrogen, or 130 pounds per ton; $27.58 ÷ 130 = 21.2, the cost of a pound of nitrogen in the meal if as guaranteed. But instead of 130 pounds it contains in fact only 6.24 × 20 = 124.8 pounds, a deficiency of 5.2 pounds, which at 21.2 cents per pound equals $1.10, the rebate to be allowed to the buyer.

Composition and Valuation.

Besides nitrogen, cotton seed meal contains relatively small quantities of phosphoric acid and potash.

The average, highest and lowest percentages of the three ingredients found in decorticated meal by the Massachusetts, New Jersey and Connecticut Stations, are summarized below.

		New Jersey 144 analyses.	Mass. 130 analyses.	Conn. 75 analyses.
Nitrogen	Average	7.14	7.16	7.18
	Highest	7.69	—	8.08
	Lowest	6.52	—	6.01
Phosphoric Acid	Average	3.09	2.86	2.94
	Highest	3.75	—	3.69
	Lowest	2.00	—	1.70
Potash	Average	1.82	2.01	1.87
	Highest	2.09	—	2.22
	Lowest	1.49	—	0.99

The general average calculated from these 349 analyses is 2.97 per cent. of phosphoric acid and 1.90 per cent. of potash.

The figure for phosphoric acid is 0.18 per cent. lower than we have assumed and for potash the same that we have assumed for some years in calculating the cost per pound of nitrogen in cotton seed meal.

The average percentages of phosphoric acid and potash in cotton seed meal, assumed to be 3.15 and 1.90 respectively, are valued together at $4.42 per ton. To determine the cost of nitrogen, the above figure is subtracted from the ton price, and the remainder, after multiplying by 100 to reduce it to cents, is divided by the number of pounds of nitrogen in a ton of meal.

Thus if a sample of meal contains 6.94 per cent. of nitrogen (which is equivalent to 138.8 pounds in the ton) and costs $27.50 per ton: 27.50 — 4.42 = 23.08. And 2,308 divided by 138.8 = 16.6, which is the cost of nitrogen per pound in cents.

Inspection of the range of percentages of potash and phosphoric acid will show that the error caused by assuming an average percentage of these two ingredients, instead of determining them in each sample, would not amount in extreme cases to more than half a cent on the calculated cost of nitrogen.

The following determinations, made this year, show the usual range of these percentages in both light and dark meal:

LIGHT COTTON SEED MEAL.

Station No.	18839	18967	19084	19085	19232	AVERAGE
Percentage amounts of						
Phosphoric acid	2.40	3.25	2.95	2.40	2.62	2.72
Potash	2.14	2.25	2.23	2.18	1.98	2.15

DARK COTTON SEED MEAL.

	18832	18954	18972	18752	18854	AVERAGE
Phosphoric Acid	2.11	2.75	2.75	1.81	2.30	2.34
Potash	1.98	2.14	2.14	1.76	1.80	1.96

The percentage of nitrogen in the samples analyzed has ranged from 8.14 to 5.58, the average of all being 6.83, or 0.2 higher than last year. The cost of nitrogen has ranged from 14.9 cents per pound to 24.2 cents, the average being 19.4 cents.

These figures mean that the grower who pays 24.2 cents per pound for nitrogen instead of the average, 19.4 cents, adds from 1/3 to 1/2 a cent a pound to the cost of raising his tobacco crop.

The grower who pays 14.9 cents a pound for his nitrogen, raises his crop nearly a cent a pound cheaper than the one who pays 24.2 cents a pound.

Occasionally samples of meal contain exceptionally high percentages of nitrogen. Thus, eight samples analyzed recently have from 8.02 to 8.14 per cent.

It has been suggested that cotton seed meal of low grade might be "fortified" by mixing with it either sulphate of ammonia, nitrate of soda, or some animal matter to improve its analysis.

The average cost of nitrogen in cotton seed meal is a little over 19 cents. The cost of nitrogen in nitrate is 17.5 cents and in dried blood nearly as much. The margin of profit in the mixing would be very small at most. Nevertheless a considerable number of the samples analyzed this spring have been tested for ammonia and nitrate with negative results, and microsopic examination has never showed the presence of anything foreign to the cotton seed.

It is the samples with low nitrogen content which are adulterated by adding ground hulls to them.

The following additional samples of meal represent lots from Humphreys, Godwin & Co., sold by Olds & Whipple of Hartford to Connecticut purchasers:

Marks.	Percentage of Nitrogen.	Marks.	Percentage of Nitrogen.
Car 65723	6.85	E	7.15
C	6.82	E	7.75
H.M. N. & G.	6.88	Car 41129	7.49
Car 20098	7.88	" 19040	7.41
" 92375	7.75	" 47971	7.93
" 16366	7.80	" 75491	7.85
B	7.14	" 16626	7.88
Car 33984	7.32	" 5870	7.68
F. & H.	7.26	" 13533	7.48
Car 20857	7.33	" 11149	7.10
" 1271	7.47	" 80079	5.36

Since the foregoing analyses were tabulated three other analyses of meal have been made, as follows:

19676. 35 bags from car 10548. Shipped by F. W. Brode, Memphis, Tenn. Sampled and sent by C. V. Chandler, Hartford.

Analyses of Cotton Seed Meal

Station No.	Dealer.	Purchased, Sampled or Sent by	Per cent. of Nitrogen. Found.	Per cent. of Nitrogen. Guaranteed.	Cost per ton.	Nitrogen costs cents per pound.
19156	H. G. & Co., Houston, Texas. Spencer Bros., Suffield	Spencer Bros., Suffield	7.89	6.56	$28.00	14.9
19232	Hunter Bros. Milling Co., St. Louis. Ernest N. Austin, Suffield	Ernest N. Austin, Suffield	7.68	7.20	28.00	15.4
18750	H. G. & Co., Memphis, Tenn. Spencer Bros., Suffield	Bissell, Graves Co., Suffield	8.11	7.20	30.50	16.1
18756	" " " " "	" " "	8.02	7.20	30.50	16.3
19043	F. W. Brode & Co., Memphis, Tenn., Owl Brand	R. B. Clarke, Windsor	7.07	6.50	28.00	16.7
18985	Olds & Whipple, Hartford	Clark Bros., Poquonock	7.03	6.60	28.00	16.8
19203	H. G. & Co., Memphis, Tenn. The Loomis Bros. Co., Granby	L. C. Spring, Granby	7.02	6.50	28.00	16.8
18757	H. G. & Co., Memphis, Tenn. Spencer Bros., Suffield	Bissell, Graves Co., Suffield	7.70	7.20	30.50	16.9
19291	H. G. & Co., Memphis, Tenn. The Loomis Bros. Co., Granby	Wm. R. Messenger, Granby	7.46	6.60	30.00	17.1
19289	H. G. & Co., Memphis, Tenn. The Loomis Bros. Co., Granby	Wm. R. Messenger, Granby	7.50	6.60	30.00	17.1
18735	H. G. & Co., Memphis, Tenn., Spencer Bros., Suffield	Bissell, Graves Co., Suffield	7.62	7.20	30.50	17.1
19206	" " " " "	B. L. Root, Suffield	6.88	6.56	28.00	17.1
18712	Olds & Whipple, Hartford	E. P. Brewer, Silver Lane	7.95	----	32.00	17.3
19231	The Loomis Bros. Co., Granby	Indian Head Plantations, Inc., Granby	6.51	5.78	27.00	17.3
18714	H. G. & Co., Memphis, Tenn. Spencer Bros., Suffield	Bissell, Graves Co., Suffield	7.50	7.20	30.50	17.4
18740	" " " " " "	" " "	7.50	6.80	30.50	17.4
19116	Smith, Northam & Co., Inc., Hartford	Smith, Northam & Co., Inc., Hartford	6.43	6.56	27.00	17.5
19290	H. G. & Co., Memphis, Tenn. The Loomis Bros. Co., Granby	Wm. R. Messenger, Granby	6.46	6.60	27.00	17.5
19204	C. A. Arnold, Broad Brook	A. E. Potwine, East Windsor	6.74	6.50	28.00	17.5
18741	H. G. & Co., Houston, Texas. Spencer Bros., Suffield	Harry C. Warner, Suffield	8.10	7.40	33.00	17.6
18729	H. G. & Co., Memphis, Tenn. Spencer Bros., Suffield	Bissell, Graves Co., Suffield	7.43	7.00	30.50	17.6
18744	H. G. & Co., Houston, Texas. Spencer Bros., Suffield	Joseph L. Myer, Suffield	8.14	7.40	33.00	17.6

Analyses of Cotton Seed Meal.—*Continued.*

Station No.	Dealer.	Purchased, Sampled or Sent by	Per cent of Nitrogen. Found.	Per cent of Nitrogen. Guaranteed.	Cost per ton.	Nitrogen costs cents per pound.
19205	C. H. Dexter & Sons, Windsor Locks	Gantley Bros., Windsor Locks	7.65	----	$31.50	17.7
18742	H. G. & Co., Houston, Texas. Spencer Bros., Suffield	Frank F. Ford, Suffield	8.08	7.40	33.00	17.7
18743	" " " " " "	J. O. Haskins, Suffield	8.08	7.40	33.00	17.7
19176	T. H. Bunch, Little Rock, Ark. A. N. Graves, Windsor Locks	Station agent	6.67	6.50	28.00	17.7
18784	H. G. & Co., Memphis, Tenn. Spencer Bros., Suffield	K. McCabe, Windsor Locks	7.78	7.00	32.00	17.7
18785	H. G. & Co., Houston, Texas. Spencer Bros., Suffield	William J. Hargraves, Suffield	8.03	7.40	33.00	17.8
19306	Olds & Whipple, Hartford	P. S. Brewer, Silver Lane	7.18	6.50	30.00	17.8
19004	H. G. & Co., Memphis, Tenn. Broad Brook L. & C. Co., Broad Brook	Broad Brook Lumber & Coal Co.	7.02	6.50	30.50	17.8
18745	Spencer Bros., Suffield	Edmund Halladay, Suffield	8.04	7.40	33.00	17.8
18854	" " "	Ernest N. Austin, Suffield	7.98	6.60	33.00	17.9
18934	Olds & Whipple, Hartford	The Conn. Tobacco Corp., Tariffville	6.87	----	29.00	18.0
18935	" " "	" " " "	6.84	----	29.00	18.0
19202	H. G. & Co., Memphis, Tenn. Newell St. John, Simsbury	Station agent	7.06	6.50	30.00	18.1
18933	American Cotton Oil Co., New York	James Price, Warehouse Point	6.75	6.50	29.00	18.2
19284	H. G. & Co., Memphis, Tenn. The Loomis Bros. Co., Granby	Wm. R. Messenger, Granby	7.36	7.00	31.50	18.4
18936	H. G. & Co. Spencer Bros., Suffield	H. E. Hastings, West Suffield	7.78	7.20	33.00	18.4
19027	Arthur Sikes, Suffield	E. B. Fall and others, Windsor	7.23	7.00	31.00	18.4
18806	" " "	S. F. Brown and others, Windsor	6.64	6.50	29.00	18.5
18841	H. G. & Co. Memphis, Tenn. Spencer Bros., Suffield	James O. Malley, West Suffield	7.74	7.25	33.00	18.5
18838	" " " " " " "	Stanly Roach, Suffield	7.71	7.25	33.00	18.5
18894	H. G. & Co., Houston, Texas. Spencer Bros., Suffield	James McCabe, Suffield	7.74	7.40	33.00	18.5
18903	American Cotton Oil Co., New York. Spencer Bros., Suffield	B. L. Root, Suffield	6.38	6.18	28.00	18.5
18984	H. G. & Co.	Leslie C. Brainard, Thompsonville	7.18	6.75	31.00	18.5

ANALYSES OF COTTON SEED MEAL.—*Continued.*

Station No.	Dealer.	Purchased, Sampled or Sent by	Per cent. of Nitrogen. Found.	Per cent. of Nitrogen. Guaranteed.	Cost per ton.	Nitrogen costs cents per pound.
19177	S. D. Viets Co., Springfield. A. N. Graves, Windsor Locks	Station agent	6.36	6.50	$28.00	18.5
19288	H. G. & Co., Memphis, Tenn. The Loomis Bros Co., Granby	Wm. R. Messenger, Granby	6.35	6.60	28.00	18.6
19287	H. G. & Co., Memphis, Tenn. The Loomis Bros. Co., Granby	Wm. R. Messenger, Granby	7.01	6.60	30.50	18.6
19399	H. G. & Co.,* Ackley & Burnham, East Hartford	Station agent	6.60	6.59	29.00	18.6
18940	H. G. & Co., Houston, Texas. Spencer Bros., Suffield	B. L. Root, Suffield	7.70	7.25	33.00	18.6
18808	Arthur Sikes, Suffield	A. E. Holcomb & Jacob Lang, Windsor	6.60	6.59	29.00	18.6
18791	H. G. & Co., Houston, Texas. Spencer Bros., Suffield	Geo. N. Thompson, Suffield	7.70	7.40	33.00	18.6
19264	" " " " " " "	Spencer Bros., Suffield	7.41	7.25	32.00	18.6
19283	H. G. & Co., Memphis, Tenn. The Loomis Bros. Co., Granby	Wm. R. Messenger, Granby	7.36	7.00	32.00	18.7
18973	H. G. & Co., Memphis, Tenn. Ernest N. Austin, Suffield	Ernest N. Austin, Suffield	6.27	6.60	27.90	18.7
18989	H. G. & Co., Houston, Texas. Spencer Bros., Suffield	B. L. Root, Suffield	7.63	7.25	33.00	18.7
19326	S. D. Viets Co., Springfield	A. N. Graves, Windsor Locks	6.28	6.50	28.00	18.8
18758	H. G. & Co., Memphis, Tenn. Spencer Bros., Suffield	A. S. Barr, Suffield	7.35	7.00	32.00	18.8
19327	S. D. Viets Co., Springfield	A. N. Graves, Windsor Locks	6.24	6.50	28.00	18.9
19099	H. G. & Co. Spencer Bros., Suffield	B. L. Root, Suffield	7.28	7.21	32.00	18.9
19285	H. G. & Co., Memphis, Tenn. The Loomis Bros. Co., Granby	Wm. R. Messenger, Granby	7.13	7.00	31.50	19.0
19324	S. D. Viets Co., Springfield	A. N. Graves, Windsor Locks	6.20	6.50	28.00	19.0
18783	H. G. & Co., Houston, Texas. Spencer Bros., Suffield	W. H. Peckham, Suffield	7.54	7.25	33.00	19.0
18889	Arthur Sikes, Suffield	Timothy Miskill, Suffield, and others	7.24	7.00	32.00	19.0
18971	H. G. & Co. Ernest N. Austin, Suffield	Ernest N. Austin, Suffield	6.34	6.60	28.50	19.0
19081	G. B. Robinson, Jr., New York. J. R. Norton, Broad Brook	Station agent	6.68	6.59	29.75	19.0

*Statement of dealer.

ANALYSES OF COTTON SEED MEAL.—*Continued.*

Station No.	Dealer.	Purchased, Sampled or Sent by	Per cent. of Nitrogen. Found.	Per cent. of Nitrogen. Guaranteed.	Cost per ton.	Nitrogen costs cents per pound.
19115	Arthur Sikes, Suffield	C. P. Viets, East Granby	7.12	7.00	$31.50	19.0
19286	H. G. & Co., Memphis, Tenn. The Loomis Bros. Co., Granby	Wm. R. Messenger, Granby	7.08	7.00	31.50	19.1
18887	Arthur Sikes, Suffield	B. E. Viets and others, Suffield	7.22	7.00	32.00	19.1
18938	H. G. & Co., Memphis, Tenn. Spencer Bros., Suffield	B. L. Root, Suffield	7.22	7.00	32.00	19.1
18770	Arthur Sikes, Suffield	John A. DuBon, Poquonock	6.96	6.59	31.00	19.1
19083	" " "	Geo. Denlye and others, Suffield	7.23	7.00	32.00	19.1
19329	H. G. & Co., Memphis, Tenn. The Loomis Bros. Co., Granby	Arthur M. Griffin, Granby	7.22	7.00	32.00	19.1
19325	S. D. Viets Co., Springfield	A. N. Graves, Windsor Locks	6.15	6.50	28.00	19.2
19328	" " "	" " " "	6.13	6.50	28.00	19.2
18754	H. G. & Co., Memphis, Tenn. Spencer Bros., Suffield	L. F. Woodworth, Suffield	7.18	7.00	32.00	19.2
18891	American Cotton Oil Co., New York. Spencer Bros., Suffield	James H. Sullivan, Suffield	6.40	6.18	29.00	19.2
18954	H. G. & Co., Memphis, Tenn. Ernest N. Austin, Suffield	Station agent	6.13	6.60	28.00	19.2
18972	H. G. & Co., Memphis, Tenn. Ernest N. Austin, Suffield	Ernest N. Austin, Suffield	6.14	6.60	28.00	19.2
19265	H. G. & Co., Houston, Texas. Spencer Bros., Suffield	B. L. Root, Suffield	7.20	7.25	32.00	19.2
19143	H. G. & Co., Memphis, Tenn. The Loomis Bros. Co., Granby	D. A. Merriam, Granby	7.07	7.00	31.50	19.2
19266	H. G. & Co., Memphis, Tenn. Ira B. Barnard, Bloomfield	Chas. Dwyer, Bloomfield	6.30	6.50	28.75	19.3
18751	H. G. & Co., Memphis, Tenn. Spencer Bros., Suffield	Bissell, Graves Co., Suffield	6.74	7.20	30.50	19.3
18771	Arthur Sikes, Suffield	W. F. White and others, Suffield	7.14	7.00	32.00	19.3
18890	" " "	J. L. Phelps, Southwick, Mass., and others	7.15	7.00	32.00	19.3
18937	H. G. & Co., Houston, Texas. Spencer Bros., Suffield	B. L. Root, Suffield	7.16	7.00	32.00	19.3
18931	Arthur Sikes, Suffield	W. C. Smith, Suffield	7.15	7.00	32.00	19.3

Analyses of Cotton Seed Meal.—*Continued.*

Station No.	Dealer.	Purchased, Sampled or Sent by	Per cent. of Nitrogen. Found.	Per cent. of Nitrogen. Guaranteed.	Cost per ton.	Nitrogen costs cents per pound.
19006	H. G. & Co., Memphis, Tenn. Broad Brook L. & C. Co., Broad Brook	Broad Brook Lumber & Coal Co.	6.38	6.50	$29.00	19.3
19079	H. G. & Co., Houston, Texas. Spencer Bros., Suffield	Geo. F. Holloway, Suffield	7.13	7.25	32.00	19.3
19085	Arthur Sikes, Suffield	P. G. Jones and others, Suffield	7.16	7.00	32.00	19.3
18792	H. G. & Co., Memphis, Tenn. Spencer Bros., Suffield	A. A. Brown, Suffield	6.72	6.50	30.50	19.4
18857	National Fertilizer Co., Bridgeport	J. B. Parker, Poquonock	6.71	6.50	30.50	19.4
18855	H. G. & Co., Memphis, Tenn. E. N. Austin, Suffield	Ernest N. Austin, Suffield	6.20	6.60	28.50	19.4
18904	N. F. Co., Henry Davis, Thompsonville	National Fertilizer Co., Bridgeport	6.74	----	30.50	19.4
18789	H. G. & Co., Memphis, Tenn. Spencer Bros., Suffield	J. Alexander, Suffield	6.70	6.50	30.50	19.5
18775	H. G. & Co., Memphis, Tenn. H. K. Brainard, Thompsonville	Leslie C. Brainard, Thompsonville	7.06	6.75	32.00	19.5
18768	Arthur Sikes, Suffield	D. I. King, Suffield	7.06	7.00	32.00	19.5
18766	" " "	W. C. Knox, Suffield, and others	7.08	7.00	32.00	19.5
18763	H. G. & Co., Memphis, Tenn. Horace K. Brainard, Thompsonville	Leslie C. Brainard, Thompsonville	7.02	6.75	31.75	19.5
18893	H. G. & Co., Memphis, Tenn. Spencer Bros., Suffield	M. Doughney, Windsor Locks	7.07	7.00	32.00	19.5
18892	" " " " " " "	Silas L. Wood, West Suffield	7.06	7.00	32.00	19.5
18941	" " " " " " "	B. L. Root, Suffield	7.08	7.00	32.00	19.5
19084	Arthur Sikes, Suffield	Geo. S. Phelps and others, Suffield	7.06	7.00	32.00	19.5
19281	" " "	E. S. Seymour, Suffield	7.03	7.00	32.00	19.6
18840	H. G. & Co., Memphis, Tenn. Spencer Bros., Suffield	Joseph P. Graham, Suffield	7.30	7.25	33.00	19.6
19169	F. W. Brode & Co., Memphis, Tenn. T. J. Coleman, Warehouse Point	Mrs. J. M. Bahr, Warehouse Point	6.62	6.50	30.50	19.7
19307	The L. C. Daniels Grain Co., Hartford	Aug. Pouleur, Windsor	5.66	6.50	26.69	19.7
18801	T. H. Bunch, Little Rock, Ark. S. D. Viets Co., Springfield	L. C. Spring, Granby	6.58	6.50	30.50	19.8
18888	Arthur Sikes, Suffield	E. S. Seymour, Suffield	6.98	7.00	32.00	19.8
18967	" " "	F. B. Hatheway, Suffield	6.96	7.00	32.00	19.8

Analyses of Cotton Seed Meal.—*Continued.*

Station No.	Dealer.	Purchased, Sampled or Sent by	Per cent. of Nitrogen. Found.	Per cent. of Nitrogen. Guaranteed.	Cost per ton.	Nitrogen costs cents per pound.
19233	Arthur Sikes, Suffield	Geo. A. Peckham and others, Suffield	6.98	7.00	$32.00	19.8
19086	" " "	Geo. Remington and others, Suffield	6.93	7.00	32.00	19.9
19343	A. D. Bridges Sons, Hazardville	The E. Hartford Tobacco Storage Corp'n	6.42	6.50	30.00	19.9
18844	H. G. & Co., H. K. Brainard, Thompsonville	Leslie C. Brainard, Thompsonville	6.89	6.75	32.00	20.0
18753	H. G. & Co., Memphis, Tenn. Spencer Bros., Suffield	Bissell, Graves Co., Suffield	6.50	7.20	30.50	20.1
18798	American Cotton Oil Co., New York. Spencer Bros., Suffield	Christopher Michel, Suffield	6.86	6.50	32.00	20.1
18846	T. H. Bunch, Little Rock, Ark. S. D. Viets Co., Springfield	H. G. Viets, Granby	6.50	6.50	30.50	20.1
18901	F. W. Brode & Co., Memphis, Tenn. National Fertilizer Co., Bridgeport	Oscar E. Pitcher, Suffield	6.30	6.60	29.75	20.1
19080	H. G. & Co., Houston, Texas. Spencer Bros., Suffield	Geo. F. Holloway, Suffield	6.85	7.25	32.00	20.1
18987	H. G. & Co., Memphis, Tenn. Spencer Bros., Suffield	Spencer Bros., Suffield	6.34	6.50	30 00	20.2
19056	Spencer Bros., Suffield	" " "	7.09	7.25	33.00	20.2
19342	Arthur Sikes, Suffield	Thos. Kenney, Suffield, and others	6.79	6.50	32.00	20.3
18939	American Cotton Oil Co., New York. Spencer Bros., Suffield	James Sullivan, Suffield	6.04	6.18	29.00	20.3
18776	Olds & Whipple, Hartford	C. A. Huntington, Windsor	6 16	----	29.51	20.4
18739	" " "	" " "	6.21	----	29 71	20.4
18811	Arthur Sikes, Suffield	W. E. Russell and others, Suffield	6.76	7.00	32.00	20.4
18845	American Cotton Oil Co., New York. Spencer Bros., Suffield	Wm. A. Hamblin, Suffield	6.75	6.50	32.00	20.4
18755	H. G. & Co., Memphis, Tenn. Spencer Bros., Suffield	Robert Brown, Suffield	6.72	7.00	32.00	20.5
18856	American Cotton Oil Co., New York. Olds & Whipple, Hartford	Wm. H. Daly, Warehouse Point	6.59	6.50	31.50	20.5
18884	Arthur Sikes, Suffield	Mrs. Margaret Tobin, Windsor Locks	6.72	7.00	32.00	20.5
18812	" " "	C. K. & H. T. Hale and others, Portland	6.70	7.00	32.00	20.6
18852	" " "	Ernest N. Austin, Suffield	6.68	6.60	32.00	20.6
18902	H. G. & Co., Houston, Texas. Spencer Bros., Suffield	J. E. Hastings, West Suffield	6.94	7.25	33.00	20.6

Analyses of Cotton Seed Meal.—*Continued.*

Station No.	Dealer.	Purchased, Sampled or Sent by	Per cent. of Nitrogen. Found.	Per cent. of Nitrogen. Guaranteed.	Cost per ton.	Nitrogen costs cents per pound.
19007	H. G. & Co., Memphis, Tenn. Broad Brook L. & C. Co., Broad Brook	Broad Brook Lumber & Coal Co.	6.20	6.50	$30.00	20.6
19028	Ackley, Hatch & Marsh, New Milford	A. W. Camp, Danbury	6.44	6.48	31.00	20.6
18736	H. G. & Co. H. K. Brainard, Thompsonville	I. D. Woodworth, Suffield	6.40	6.50	30.90	20.7
18839	Geo. B Robinson, New York. Spencer Bros., Suffield	M. Wysook, Suffield	6.67	6.50	32.00	20.7
18850	American Cotton Oil Co., Pine Bluff, Ark. W. F. Fletcher, Southwick, Mass.	E. M. Griffin, Granby	6.53	6.50	31.50	20.7
18885	Arthur Sikes, Suffield	Henry Fuller, Suffield, and others	6.66	7.00	32.00	20.7
19005	H G. & Co. Broad Brook L. & C. Co., Broad Brook	Broad Brook Lumber & Coal Co.	6.19	6.50	30.00	20.7
18926	H. G. & Co., Memphis, Tenn. C. A. Arnold, Broad Brook	F. A. Hamilton, Warehouse Point	6.15	6.50	30.00	20.8
19282	Arthur Sikes, Suffield	F. J. Pomeroy, Agawam, Mass., and others	6.63	7.00	32.00	20.8
18843	American Cotton Oil Co., New York. Spencer Bros., Suffield	Matthew Leahey, West Suffield	6.63	6.50	32.00	20.8
18900	Arthur Sikes, Suffield	Charles H. Wells, Suffield	6.62	7.00	32.00	20.8
19002	J. Lindsay Wells Co., Memphis, Tenn. Chapin & Co., Boston	Ackley, Hatch & Marsh, New Milford	6.48	6.50	31.50	20.9
18962	American Cotton Oil Co., Pine Bluff, Ark. W. F. Fletcher, Southwick, Mass.	R. W. Griffin, Granby	6.48	6.50	31.50	20.9
18790	American Cotton Oil Co., New York. Spencer Bros., Suffield	James Olram, Suffield	6.60	6.50	32.00	20.9
18767	Arthur Sikes, Suffield	W. C. Sikes and others, Suffield	6.37	6.59	31.00	20.9
18752	H. G. & Co., Memphis, Tenn. Spencer Bros., Suffield	Bissell, Graves Co., Suffield	6.24	7.20	30.50	20.9
19003	H. G. & Co., Memphis, Tenn. Broad Brook L. & C. Co., Broad Brook	Broad Brook Lumber & Coal Co.	6.08	6.50	30.00	21.0
19263	H. G. & Co., Memphis, Tenn. Spencer Bros., Suffield	S. R. Spencer, Suffield	6.07	6.56	30.00	21.1
18910	H. G. & Co., Memphis, Tenn. Broad Brook L. & C. Co., Broad Brook	Harry W. Mohn, Warehouse Point	6.15	6.50	30.50	21.2

Analyses of Cotton Seed Meal.—*Concluded.*

Station No.	Dealer.	Purchased, Sampled or Sent by	Per cent. of Nitrogen. Found.	Per cent. of Nitrogen. Guaranteed.	Cost per ton.	Nitrogen costs cents per pound.
18886	Arthur Sikes, Suffield	Geo. B. Parker and others, Suffield	6.23	6.60	$31.00	21.3
18905	H. G. & Co., Memphis, Tenn., Dixie Brand	Ackley, Hatch & Marsh, New Milford	6.35	6.50	31.50	21.3
18906	Oneonta Milling Co., Buffalo, N. Y.	" " " "	6.36	6.56	31.50	21.3
18988	American Cotton Oil Co., New York. Spencer Bros., Suffield	Spencer Bros., Suffield	6.46	6.50	32.00	21.3
18865	Hunter Bros. Milling Co., St. Louis, Mo. H. A. Bugbee, Willimantic	Chas. T. Remington, Suffield	6.08	6.50	30.50	21.4
18970	Hunter Bros Milling Co., St. Louis, Mo. National Fertilizer Co., Bridgeport	E. N. Austin, Suffield	6.22	6.50	31.00	21.4
18809	Arthur Sikes, Suffield	H. N. Fuller and others, Suffield	6.18	6.59	31.00	21.5
18832	Olds & Whipple, Hartford	John B. Parker, Poquonock	5.60	6.20	28.50	21.5
18842	Geo. B. Robinson, New York. Spencer Bros., Suffield	James Fleming, Suffield	6.64	6.50	33.00	21.5
18853	Spencer Bros., Suffield	Ernest N. Austin, Suffield	6.50	6.50	32.50	21.6
19267	Ira B. Barnard, Bloomfield	Chas. Dwyer, Bloomfield	6.00	6.50	30.50	21.7
18769	Arthur Sikes Suffield	H. D. Sikes and others, Suffield	6.35	6.59	32.00	21.7
18932	National Fertilizer Co., Bridgeport	B. M. Gillette, Suffield	6.12	7.00	31.00	21.7
18957	American Cotton Oil Co., Little Rock, Ark. Spencer Bros., Suffield	Station agent	6.32	6.50	32.00	21.8
18851	Spencer Bros., Suffield	Ernest N. Austin, Suffield	6.26	6.50	32.00	22.0
19022	T. H. Bunch, Little Rock, Ark. C. H. Dexter & Sons, Windsor Locks	P. Cleaveland, Windsor Locks	6.25	6.50	32.00	22.1
19082	Arthur Sikes, Suffield	W. A. Soper and others, Suffield	6.00	6.59	31.00	22.2
19090	J. E. Soper & Co., Boston. C. H. Dexter & Sons, Windsor Locks	Albert Epstein, Windsor Locks	6.36	6.50	32.75	22.3
18807	Arthur Sikes, Suffield	F. M. Thompson, Warehouse Point	5.78	6.59	30.50	22.6
18961	Chas. M. Cox Co., Boston. H. A. Bugbee, Willimantic	Andrew Kingsbury, Rockville	5.83	6.50	31.20	23.0
18810	Arthur Sikes, Suffield	F. M. Thompson, Warehouse Point	5.58	6.59	30.50	23.4
19057	J. Lindsay Wells Co., Memphis, Tenn. N. H. Root, New Milford	Station agent	5.69	6.50	32.00	24.2

19677. 20 bags from car 33672, **19678**, 40 bags from car 14341, both shipped by F. W. Brode & Co., Memphis, Tenn. Sampled and sent by T. P. Kinney, Windsor.

ANALYSES.

	Nitrogen.	Cost per ton.	Nitrogen costs cents per pound.
19676	6.20	$27.50	18.6
19677	6.00	27.00	18.8
19678	6.16	27.50	18.7

CASTOR POMACE.

This is the ground residue of castor beans from which castor-oil has been expressed or extracted. The nitrogen which it contains is readily available to plants, but the pomace is extremely poisonous to animals, which often eat it greedily when the opportunity offers.

Eight samples have been analyzed this year, as follows:—

18730. Sold by Olds & Whipple, Hartford. Sampled and sent by E. P. Brewer, Silver Lane.

18746. Sold by Olds & Whipple, Hartford. Sampled and sent by R. A. McJunkin, Hartford.

18819. Sold by Olds & Whipple, Hartford. Sampled and sent by L. H. Brewer, Hockanum.

19200. Sold by Olds & Whipple, Hartford. Sampled and sent by E. S. Seymour, Suffield.

19402. Sampled from stock of Olds & Whipple, Hartford.

18948. Sold by H. J. Baker & Bro., N. Y. Sampled from stock of Olds & Whipple, Hartford.

19201. Sold by American Agricultural Chemical Co., N. Y. Sampled from stock of S. T. Welden, Simsbury.

19175. Sold by Bowker Fertilizer Co., N. Y. Sampled from stock of John Parker, Poquonock.

ANALYSES OF CASTOR POMACE.

	Sold by Messrs. Olds & Whipple.					Baker & Co.	Am. Ag. Chem. Co.	Bowker.
Station No.	18730	18746	18819	19200	19402	18948	19201	19175
Percentage amounts of								
Nitrogen found	6.18	6.00	5.98	5.58	5.36	5.14	4.74	4.29
Nitrogen guaranteed	....	....	....	....	5.5	4.9	4.12	4.12
Cost per ton	$24.00	24.00	24 00	23.00	24.00	23.50	23.50	24.00
Nitrogen costs cents per pound	**17.4**	**17.9**	**17.9**	**18.3**	**20.0**	**20.4**	**22.1**	**25.0**

The samples of Olds & Whipple's stock were all "grey" pomace, while the others were dark pomace containing considerably less nitrogen though sold at the same price as the gray pomace.

Gray pomace usually contains about 6 per cent. of nitrogen. The lower percentages found in Nos. 18819, 19200 and 19402, taken later in the season, are stated to be due to over-rushing the mill after delay caused by installing new machinery.

The percentages of phosphoric acid and potash in castor pomace average 1.95 and 0.98 respectively. The cost of nitrogen is determined in each case by deducting $2.54—the valuation of the phosphoric acid and potash—from the ton price, and dividing the remainder by the number of pounds of nitrogen in a ton of the pomace.

The cost of nitrogen in castor pomace has ranged from 17.4 to 25 cents per pound, the average of the eight samples being 19.9 cents, half a cent per pound more than in cotton seed meal.

LINSEED MEAL.

This material is occasionally used as a tobacco fertilizer in spite of its relatively high price.

A single sample, 18774, sold by Olds & Whipple of Hartford, sampled and sent by R. C. Hyde, Windsor, contained 5.72 per cent of nitrogen, which, at the ton price quoted, $31.50, cost 27.5 cents per pound.

II. RAW MATERIALS CHIEFLY VALUABLE FOR PHOSPHORIC ACID.

DISSOLVED ROCK PHOSPHATE OR ACID ROCK.

This material, made by treating various mineral phosphates with oil of vitriol, has been practically the only form in which water-soluble phosphoric acid could be bought during the past year.

The following nine analyses show the quality of the dissolved phosphate sold this year in this state:—

19067. Sold by C. M. Shay Fertilizer Co., Groton. Sampled and sent by Henry A. Slater, Manchester.

18977. Sold by Wilcox Fertilizer Works, Mystic. Sampled at the factory.

Analyses of Acid Phosphate.

Station No.	19067	18977	18827	18945	19227	19323	19228	18978	18915
Percentage amounts of									
Water-soluble phosphoric acid	13.18	13.74	10.19	11.04	10.99	7.94	8.34	11.57	12.21
Citrate-soluble phosphoric acid	2.83	2.79	3.09	3.18	1.79	3.56	5.02	2.44	3.03
Citrate-insoluble phosphoric acid	0.45	1.03	2.05	1.02	1.46	1.77	0.46	1.53	0.85
Total phosphoric acid found	16.46	17.56	15.33	15.24	14.24	13.27	13.82	15.54	16.09
Total phosphoric acid guaranteed	....	....	....	....	16.0	....	....	....	....
Sum of water-soluble and citrate-soluble phosphoric acid found	16.01	16.53	13.28	14.22	12.78	11.50	13.36	14.01	15.24
"Available" phosphoric acid guaranteed	14.0	14.0	14.0	14.0	14.0	14.0	14.0	14.0	14.0
Cost per ton	$15.00	17.00	15.00	16.00	17.00	15.00	18.00	....	....
"Available" phosphoric acid costs cents per pound	**4.7**	**5.0**	**5.4**	**5.5**	**6.4**	**6.5**	**6.7**	....	....

18827. Sold by Swift's Lowell Fertilizer Co., Boston. Sampled from stock of Andrew Ure, Highwood.

18945. Sold by American Agricultural Chemical Co., New York. Sampled from stock of Spencer Bros., Suffield.

19227. Sold by Bowker Fertilizer Co., New York City. Sampled from Bowker's Branch, Hartford.

19323. Sold by Swift's Lowell Fertilizer Co., Boston. Sampled from stock of E. E. Burwell, New Haven.

19228. Bought by E. Manchester & Sons, Winsted.

18978. Sold by National Fertilizer Co., Bridgeport. Sampled from stock bought by Connecticut School for Boys, Meriden.

18915. Sold by American Agricultural Chemical Co., New York City. Sampled from stock bought by S. D. Woodruff & Sons, Orange.

It appears from these analyses that acid phosphate at present has no very constant composition, the amount of "available" phosphoric acid in the samples tested ranging from 16.53 to 11.50 per cent.

The prices quoted, $15 to $18, are higher than need be paid, some farmers having bought at considerably lower figures for prompt cash.

The cost of "available" phosphoric acid in the samples examined ranged from 4.7 to 6.7 cents per pound.

It needs to be repeated that "available phosphoric acid" is purely a trade name for the sum of the water-soluble and citrate-soluble phosphoric acid and has no necessary connection with the availability of the phosphoric acid to crops. Water-soluble phosphoric acid is comparatively readily available to plants. When applied to the soil it quickly becomes insoluble in water, but exists for a time at least in forms which are easily decomposed and absorbed by the action of the plant roots. This is not by any means equally true of all forms of citrate-soluble phosphoric acid. Some of them are, probably, about as quickly and perfectly "available," in the agricultural sense, as water-soluble phosphates, while others are, by comparison, quite "unavailable," and there is no means, at present known, for determining this difference in the laboratory.

The method of citrate extraction was devised for, and is strictly applicable only to, the determination of that part of the phosphoric acid in a plain superphosphate ("acid phosphate," or dissolved rock phosphate) which had been at first dissolved by sulphuric acid but by further chemical reactions has become insoluble in water. Such a case is represented by the sample—**19228**—cited above. It was formerly called "backgone" or "reverted" phosphoric acid.

But when this method is applied to such mixed fertilizers as are now in the trade, containing bone, tankage and sometimes iron and aluminum phosphates, citrate-solution dissolves much phosphate which has not been made more soluble by the manufacture than it was originally, and some of which cannot be considered as readily "available" to crops.

BASIC SLAG.

This material, variously called Thomas slag, phosphate slag, and odorless phosphate, is a slag from the steel manufacture containing basic silicates of lime and magnesia with some free lime, much iron and from 15 to 20 per cent. of phosphoric acid. Where it is offered to farmers cheaply enough it is regarded as a valuable fertilizer, on some soils giving as good or even better results than acid phosphate. A single sample, **19398**, sold by the Coe-Mortimer Co., of New York and taken from stock of W. I. Lobdell, Stratford, contained 20.06 per cent. of phosphoric acid.

PRECIPITATED BONE.

18773. Sold by Olds & Whipple of Hartford, sampled and sent by E. P. Brewer, Silver Lane. This sample contained

Percentage amounts of	
Water-soluble phosphoric acid	2.66
Citrate-soluble phosphoric acid	32.06
Citrate-insoluble phosphoric acid	2.10
Total phosphoric acid	36.82

This material should be a very excellent source of quickly available phosphoric acid. It is apparently a manufacturing by-product, neither strongly acid nor alkaline, and the phosphate, being very fine and apparently in freshly precipitated form, should be quickly assimilated by plants.

III. RAW MATERIALS OF HIGH GRADE CONTAINING POTASH.

CARBONATE OF POTASH.

Commercial carbonate of potash has been a popular form of potash fertilizer for tobacco. During the present year, however, only two samples have been sent for analysis, both of them bought of Innis, Speiden Co., 46 Cliff St., New York City.

19260. Sampled and sent by Geo. A. Douglass, Thompsonville.

19305. Sampled and sent by T. J. Noone, Suffield.

ANALYSES.

Station No.	19260	19305
Percentage amounts of		
Potash	65.52	63.55
Cost per ton	$95.00	92.50
Potash costs cents per pound	**7.2**	**7.3**

HIGH GRADE SULPHATE OF POTASH.

(ANALYSES ON PAGES 36 AND 37.)

This chemical should contain about 90 per cent. of pure potassium sulphate (sulphate of potash), or about 49 per cent. of potassium oxide ("potash"), about one per cent. less than is contained in muriate, and it should be nearly free from chlorides. The four samples analyzed were of good quality.

The cost of potash in high grade sulphate has been a little over five cents a pound.

DOUBLE SULPHATE OF POTASH AND MAGNESIA.

(ANALYSES ON PAGES 36 AND 37.)

This material is usually sold as "sulphate of potash" or "manure salt," on a guaranty of "48-50 per cent. sulphate," which is equivalent to 25.9-27.0 per cent. of potassium oxide. Besides some 46-50 per cent. of potassium sulphate, it contains over 30 per cent. of magnesium sulphate, chlorine equivalent to 3 per cent. of common salt, a little sodium and calcium sulphates, with varying quantities of moisture.

The six samples analyzed were all of the usual quality with one exception, which contained somewhat less potash than usual, 25.60 per cent.

The cost of potash per pound, in double sulphate of potash of good quality, has been nearly six cents.

Potash Salts. Percentage Composition and Cost per Pound of Potash.

Station No.	Drawn from stock in possession of	Sampled or sent by	Station No.	Potash soluble in water, found.	Potash guaranteed.	Cost per ton.	Potash costs cents per pound.
	High Grade Sulphate of Potash:						
18950	E. N. Austin, Suffield, from Wilcox Fertilizer Works, Mystic	Station agent	18950	50.68	48.0	$50.00	4.9
19261	C. H. Wells, Suffield, from Rogers Co., Rockfall	C. H. Wells	19261	50.04	----	50.00	5.0
19063	J. G. Schwink, Meriden, from Buffalo Fertilizer Co., Buffalo, N. Y.	Station agent	19063	49.13	50.0	50.00	5.1
18952	Spencer Bros., Suffield, from Amer. Ag. Chem. Co., N. Y.	Station agent	18952	49.68	48.0	53.00	5.3
	Double Sulphate of Potash and Magnesia:						
18923	Sanderson Fertilizer and Chemical Co., New Haven	Station agent	18923	27.60	25.0	30.00	5.4
19262	C. H. Wells, Suffield, from Rogers Co., Rockfall	C. H. Wells	19262	26.48	----	30.00	5.7
18951	E. N. Austin, Suffield, from Wilcox Fertilizer Works, Mystic	Station agent	18951	26.04	25.0	30.00	5.8
18955	Spencer Bros., Suffield, from Amer. Ag. Chem. Co., N. Y.	Station agent	18955	25.60	28.0	30.00	5.9
19098	Spencer Bros., Suffield, from Amer. Ag. Chem. Co., N. Y.	Spencer Bros.	19098	26.76	----	32.00	6.0
18980	Conn. School for Boys, Meriden, from National Fertilizer Co., Bridgeport	Station agent	18980	27.32	----	----	----
	Muriate of Potash:						
19064	J. G. Schwink, Meriden, from Buffalo Fertilizer Co., Buffalo, N. Y.	Station agent	19064	50.08	50.0	44.00	4.4
19062	E. N. Austin, Suffield, from Wilcox Fertilizer Works, Mystic	Station agent	19062	50.76	50.0	45.00	4.4
19182	J. A. Lewis Estate, Willimantic, and E. E. Burwell, New Haven, from Bowker Fertilizer Co., New York	Station agent	19182	49.84	50.0	45.00	4.5
19407	E. E. Burwell, New Haven, from Swift's Lowell Fertilizer Co., Boston	Station agent	19407	49.71	50.0	45.00	4.5
18922	Sanderson Fertilizer and Chemical Co., New Haven	Station agent	18922	50.11	50.0	45.00	4.5
18949	E. N. Austin, Suffield, from Wilcox Fertilizer Works, Mystic	Station agent	18949	49.28	50.0	45.00	4.6
18956	Spencer Bros., Suffield, from Amer. Ag. Chem. Co., N. Y.	Station agent	18956	50.28	50.0	47.00	4.7
18921	S. D. Woodruff & Sons, Orange	Station agent	18921	54.82	----	----	----
18829	Andrew Ure, Highwood, from Swift's Lowell Fertilizer Co., Boston	Station agent	18829	50.87	50.0	----	----
18981	Conn. School for Boys, Meriden, from National Fertilizer Co., Bridgeport	Station agent	18981	45.60	50.5	----	----
	Kainit:						
18982	Conn. School for Boys, Meriden, from National Fertilizer Co., Bridgeport	Station agent	18982	11.68	12.0	----	---

MURIATE OF POTASH.

(ANALYSES ON PAGES 36 AND 37.)

Commercial muriate of potash contains about 80 per cent. of muriate of potash (potassium chloride), 15 per cent. or more of common salt (sodium chloride) and 4 per cent. or more of water.

Of the ten samples analyzed one was of inferior quality, containing only 45.60 per cent. of potash.

Referring to analysis **18949**, the Wilcox Fertilizer Co. wrote that the foreign test showed 51.9 per cent. of potash while our sample showed but 49.28 per cent. and asked for a re-test. Another sample was therefore drawn from Mr. Austin's stock, six weeks later, No. **19062**, which showed 50.76 per cent.

Both samples were drawn with equal care and both analyses were correctly made.

The price per pound of potash in muriate has been about four and one-half cents.

KAINIT.

(ANALYSIS ON PAGES 36 AND 37.)

Kainit is less uniform in composition than the other potash salts. It contains from 11 to 15 per cent. of potash, more than that quantity of soda, and rather less magnesia. These "bases" are combined with chlorine and sulphuric acid. Unless "calcined," it contains more water than either the sulphate or the muriate of potash. It is usually sold on a guaranty of 12 to 15 per cent. of potash, or 23 to 25 per cent. "sulphate of potash." It is not properly called, or claimed to be, a sulphate of potash, since it contains more than enough chlorine to combine with all the potash present, and there are sound reasons for believing that its potash exists chiefly as muriate and, to a much less extent, as sulphate. Its action and effects are unquestionably those of a muriate rather than of a sulphate.

The very favorable action of kainit on grass-land, which is frequently observed, is doubtless due in part to the other salts in it, particularly common salt, and recalls the practice, formerly in vogue, of "salting" meadows.

The single sample of kainit analyzed was below the average quality, containing only 11.68 per cent. of water-soluble potash.

IV. RAW MATERIALS CONTAINING NITROGEN AND PHOSPHORIC ACID.

BONE MANURES.

The terms "Bone Dust," "Ground Bone," "Bone Meal" and "Bone" applied to fertilizers, sometimes signify material made from dry, clean and pure bones; in other cases these terms refer to the result of crushing fresh or moist bones which have been thrown out either raw or after cooking, with more or less meat, tendon and grease, and—if taken from garbage or ash heaps—with ashes or soil adhering; again they denote mixtures of bone, blood, meat and other slaughter-house refuse which have been cooked in steam tanks to recover grease, and are then dried and sometimes sold as "tankage"; or finally, they apply to bone from which a large share of the nitrogenous substance has been extracted in the glue manufacture. When they are in the same state of mechanical subdivison, the nitrogen of all these varieties of bone probably has about the same fertilizing value.

VALUATION OF FERTILIZERS IN GENERAL.

The table of analyses of bone manures contains a column headed "Valuation per ton."

The valuation of a fertilizer, as practiced at this station, consists in calculating the retail trade-value or cash-cost at freight centers (in raw material of good quality) of an amount of nitrogen, phosphoric acid and potash equal to that contained in one ton of the fertilizer.

The trade value per pound of these ingredients is reckoned from the current market prices of the standard articles which furnish them to commerce. The valuation of a fertilizer does not show either its fair price or agricultural value. Nor should it be inferred that the ingredients of a given mixture always have the market value represented by the valuation.

The valuation, properly understood and used, does, however, furnish a rational basis for comparing the commercial values of fertilizer mixtures.

The consumer, in estimating the reasonable price to pay for high-grade fertilizers, should add to the trade-value of the above-named ingredients a suitable margin for the expenses of manufacture and sale, and for the convenience or other advantage incidental to their use.

TRADE-VALUES OF FERTILIZER ELEMENTS FOR 1907.*

The average trade-values or retail costs in market, per pound, of the ordinarily occurring forms of nitrogen, phosphoric acid and potash in

*Adopted at a conference of representatives of the Connecticut, Maine, Massachusetts, New Jersey, Rhode Island and Vermont stations held in March, 1907.

raw materials and chemicals, as found in New England, New York and New Jersey markets during 1906, were as follows:

	Cents per pound.
Nitrogen in nitrates	18½
ammonia salts	17½
Organic nitrogen in dry and fine ground fish, meat and blood, and in mixed fertilizers	20½
in fine† bone and tankage	20½
in coarse† bone and tankage	15
Phosphoric acid, water-soluble	5
citrate-soluble‡	4½
of fine ground bone and tankage	4
of coarse bone and tankage	3
of cotton seed meal, castor pomace and ashes	4
of mixed fertilizers, if insoluble in ammonium citrate‡	2
Potash as high-grade sulphate in forms free from muriate (or chlorides)	5
as muriate	4¼

The foregoing are, as nearly as can be estimated, the prices at which, during the six months preceding March last, the respective ingredients were retailed for cash, in our large markets, in those raw materials which are the regular source of supply. The valuations obtained by use of the above figures will be found to correspond fairly with the average retail prices, at the large markets, of standard raw materials.

Valuation of Bone and Tankage.

To obtain the valuation of ground bone the sample is sifted into two grades, that finer than $\frac{1}{50}$ inch, "fine," and that coarser than $\frac{1}{50}$ inch, "coarse."

The nitrogen value of each grade is separately computed by multiplying the pounds of nitrogen per ton by the per cent. of each grade, multiplying the product by the trade value per pound of nitrogen in that grade, and taking this final product as the result in cents. Summing up the separate values of each grade thus obtained, together with the values of each grade of phosphoric acid, similarly computed, the total is the valuation of the sample.

1. *Bone Manures Sampled by the Station Agent.*

In the table on pages 42 and 43 are tabulated analyses of twenty-three samples.

†In this report "fine," as applied to bone and tankage, signifies smaller than $\frac{1}{50}$ inch; and "coarse," larger than $\frac{1}{50}$ inch.

‡Dissolved from 2 grams of the fertilizer, previously extracted with pure water, by 100 cc. neutral solution of ammonium citrate, sp. gr. 1.09, in thirty minutes, at 65° C., with agitation once in five minutes. Commonly called "reverted" or "backgone" phosphoric acid.

GUARANTIES.

Seven of the twenty-three brands sampled by the station do not fully meet the maker's guaranty, but in two cases only do the goods fail to give a percentage of plant food equivalent in value to the guaranty. These two brands are:

The Berkshire Ground Bone, 19410. Phosphoric acid found, 12.19; guaranteed, 20.0.

The Buffalo Fertilizer Co.'s Bone Meal, 19413. Nitrogen found, 2.4; guaranteed, 2.9. Phosphoric acid found, 19.93; guaranteed, 22.0.

COST AND VALUATION.

The valuation of five samples was more than the cost. The average cost of the twenty-three samples drawn by the station was $30.43 and the average valuation $27.40.

2. *Sampled by Purchasers and Others.*

In the table on pages 42 and 43 are also included analyses of five samples of bone manures drawn by others than the station agent.

SLAUGHTER-HOUSE TANKAGE.

(Analyses on page 45.)

After boiling or steaming meat scrap, bone and other slaughter-house waste, fat rises to the surface and is removed, the soup is run off and the settlings are dried and sold as tankage. Tankage has a very variable composition. In general, it contains more nitrogen and less phosphoric acid than bone.

In the table, page 45, are analyses of sixteen samples of this material from the Connecticut market.

19629 and **18974.** Made by Connecticut Rendering & Fertilizer Corporation, New Haven. **19629.** Sampled from stock of E. E. Burwell, New Haven. **18974.** Sampled at factory.

18927. From slaughter-house of C. H. Davis & Co., Norwich. Sampled and sent by F. W. Barber, Baltic.

18797 and **18909.** Made by Sperry & Barnes, New Haven. Sampled and sent by C. M. Abbe, New Haven.

19207, 19208, 18747, 18748 and **18918.** Stock of S. D. Woodruff & Sons, Orange.

18779. Sent by E. B. Clark, Milford.

Percentage Composition and Valuation of Bone Manures.

Station No.	Name or Brand.	Manufacturer.	Dealer.	Dealer's cash price per ton.	Valuation per ton.	Percentage difference between cost and valuation.	Chemical Analysis. Nitrogen. Found.	Nitrogen. Guaranteed.	Phosphoric Acid. Found.	Phosphoric Acid. Guaranteed.	Mechanical Analysis. Finer than 1-50 inch.	Coarser than 1-50 inch.
19423	Fine Knuckle Bone Flour	Rogers Mfg. Co., Rockfall	Arthur Sikes, Suffield	**$32.00**	$35.18	9.0*	3.95	**3.8**	25.75	**24.0**	83	17
19426	Swift-Sure Bone Meal	M. L. Shoemaker & Co., Phila., Pa.	Spencer Bros., Suffield	36.00	37.31	7.5*	5.54	**4.1**	22.91	**20.0**	65	35
			J. G. Schwink, Meriden	33.00								
				34.50								
19417	Fine Ground Bone	L. T. Frisbie Co., Hartford	Edward White, Rockville	**29.00**	30.57	5.1*	4.80	**3.3**	19.85	**20.0**	46	54
19170	Ground Bone	New England Fertilizer Co., Boston, Mass.	J. A. Lewis Estate, Willimantic	**28.00**	29.23	4.2*	2.62	**2.5**	27.04	**22.0**	62	38
19051	Self-Recommending Fertilizer	Valentine Bohl, Waterbury	A. N. Graves,† Windsor Locks	28.00								
			Manufacturer	**30.00**	30.20	**0.7***	4.37	**3.7**	20.99	**21.0**	50	50
19427	Swift's Lowell Ground Bone	Swift's Lowell Fertilizer Co., Boston, Mass.	E. A. Buck Co., Willimantic	30.00	28.97	0.1	3.00	**2.5**	26.32	**23.0**	48.5	51.5
			J. A. Warner, Tylerville	28.00								
				29.00								
19415	Pure Bone Dust	Peter Cooper's Glue Factory, New York	H. K. Brainard, Thompsonville	**25.00**	24.92	0.3	1.90	**0.9**	25.75	**26.0**	52	48
19681	Pure Ground Bone	Parmenter & Polsey Fertilizer Co., Peabody, Mass.	A. Williams & Co., So. Woodstock	30.00	28.75	0.9	2.62	**2.5**	26.17	**23.0**	64	36
			John H. Atkins, Middletown	-----								
			T. J. Pring & Bro., Wallingford	28.00								
				29.00								
19425	Shay's Ground Bone	C. M. Shay Fertilizer Co., Groton	Manufacturer	**30.00**	29.04	3.3	2.86	**3.3**	27.35	**25.0**	47	53
19419	Bone Meal	Lister's Agricultural Chemical Works, Newark, N. J.	J. C. Wilcoxson, Stratford	30.00	28.34	9.4	2.72	**2.5**	26.56	**23.0**	51	49
			Wm. Sullivan, New Milford	32.00								
				31.00								
19422	Fine Ground Bone	Rogers Mfg. Co., Rockfall	Meeker Coal Co., Norwalk	**32.00**	28.90	10.7	3.70	**3.4**	23.65	**22.0**	41	59
			M. B. Clark & Son, Milford	32.00								
19428	Ground Bone	Wilcox Fertilizer Works, Mystic	Manufacturer	**30.00**	26.77	12.2	2.28	**2.5**	25.48	**22.0**	61	39
			W. A. Howard, Woodstock	30.00								
19408	Fine Ground Bone	American Agricultural Chemical Co., N. Y.	Tanner & Wilcox, East Winsted	**30.00**	26.19	14.5	2.56	**2.5**	23.67	**22.0**	57	43
			G. W. Eaton, Bristol	30.00								
19416	Ground Bone	Geo. L. Dennis, Stafford Springs	Manufacturer	**28.00**	24.11	16.1	4.00	**2.5**	20.03	**20.0**	1	99
19420	Hubbard's Raw Knuckle Bone Flour	Rogers & Hubbard Co., Middletown	F. S. Bidwell & Co., Windsor Locks	38.00	31.48	17.5	3.88	**3.5**	25.41	**24.5**	49	51
			H. W. Andrews, Wallingford	36.00								
				37.00								
19412	Bowker's XX Bone	Bowker Fertilizer Co., N. Y. City	Bowker's Branch, Hartford	**25.00**	20.88	19.7	1.17	**1.0**	23.30	**25.0**	57	43
19421	Hubbard's Strictly Pure Fine Bone	Rogers & Hubbard Co., Middletown	W. O. Goodsell, Bristol	32.00	27.80	22.3	4.34	**2.9**	20.89	**22.0**	25	75
			E. A. Buck Co., Willimantic	35.00								
				34.00								
19411	Bowker's Fresh Ground Bone	Bowker Fertilizer Co., N. Y.	Lightbourn & Pond Co., New Haven	33.00	24.92	26.4	2.50	**2.5**	22.81	**22.0**	51	49
			Bowker's Branch, Hartford	30.00								
				31.50								
19413	Bone Meal	Buffalo Fertilizer Co., Buffalo, N. Y.	L. A. Fenton, Norwich Town	**30.00**	23.53	27.5	2.40	**2.9**	19.93	**22.0**	66	34
19414	XXX Ground Bone	Coe-Mortimer Co., New York, N. Y.	Bishop & Lynes, Norwalk	30.00								
			A. L. Burdick, Westbrook	**32.00**	24.95	28.3	3.00	**3.0**	21.54	**20.0**	39.5	60.5
19424	Sanderson's Fine Ground Bone	Sanderson Fertilizer & Chemical Co., New Haven	Manufacturer	**30.00**	23.21	29.3	2.85	**2.5**	20.05	**20.0**	36.5	63.5
			R. H. Hall, East Hampton	30.00								
19409	Armour's Bone Meal	Armour Fertilizer Works, Baltimore, Md.	F. T. Blish Hardware Co., South Manchester	**35.00**	26.85	30.4	2.58	**2.5**	24.18	**24.0**	60	40
19410	Fine Ground Bone	Berkshire Fertilizer Co., Bridgeport	H. T. Childs, Woodstock	**28.00**	18.04	55.2	2.50	**2.5**	12.19	**20.0**	62	38
	Sampled by purchasers and others.	*Manufacturer or Dealer.*	*Sampled or sent by*									
18863	Self-Recommending Fertilizer	Valentine Bohl, Waterbury	Dennis Megin, Bethany	**25.00**	30.87	19.0*	4.59	**3.7**	20.95	**21.0**	49	51
18802	Bone	W. M. Davidge, Morristown, N. J.	Andrew Kingsbury, R. D. Rockville	**27.00**	27.32	1.2*	3.76	----	20.67	----	44	56
19058	Ground Bone	Swift's Lowell Fertilizer Co., Boston, Mass.	James Price, Warehouse Point	**28.00**	28.00	-----	2.46	**2.5**	26.39	**23.0**	60	40
19418	Ground Bone	Ernest L. James, Warrenville	Ernest L. James, Warrenville	**29.00**	24.14	20.1	3.86	**3.5**	20.78	**20.0**	1	99
18882	Bone	Connecticut Hospital for the Insane, Middletown	Connecticut Hospital for the Insane, Middletown	-----	28.62	-----	2.66	----	26.80	----	55	45

* Valuation exceeds cost. † Purchaser.

19230. Sent by E. Manchester & Sons, Winsted.

19061. Made by Springfield Rendering Co., Springfield, Mass. From stock of H. K. Brainard, Thompsonville.

18826. Made by Swift's Lowell Fertilizer Co., Boston. Sampled from stock of Andrew Ure, Highwood.

18979. Sold by National Fertilizer Co., Bridgeport. Sampled from lot bought by Connecticut School for Boys, Meriden.

19091. Car lot sold by Buffalo Fertilizer Co., to G. A. Hopson, Wallingford.

These figures show the wide variations in the composition of tankage. Nitrogen ranges from 4.90 to 10.01 and phosphoric acid from 4.53 to 15.74 per cent.

DRY GROUND FISH.

(ANALYSES ON PAGE 47.)

This is a by-product from the manufacture of fish oil, a process which removes from the fish little that is of value as a fertilizer. The fresh fish are cooked by steam, pressed to remove the oil, and dried either in the air, or more commonly, in the large factories, by steam. The scrap is sometimes sprinkled with diluted oil of vitriol, to check putrefaction, whereby the bones are softened and to some extent dissolved. Ten samples have been examined, as follows:—

19172. Sold by American Agricultural Chemical Co., New York. Sampled from stock of A. N. Graves, Windsor Locks.

19173. Sold by Parmenter & Polsey, Peabody, Mass. Sampled from stock of J. R. Norton, Broad Brook.

19405. Made by Russia Cement Co., Gloucester, Mass. Sampled from stock of J. B. Parker, Poquonock, and J. and H. Woodford, Avon.

18947. Made by Wilcox Fertilizer Works, Mystic. Sampled from stock of S. D. Viets, Springfield, Mass., by James Price, Warehouse Point.

19321. Sold by Bowker Fertilizer Co., New York City. Sampled from stock of Bowker's Branch, Hartford, J. A. Lewis Estate, Willimantic, and Warren & Hardin, Glastonbury.

19171. Made by Wilcox Fertilizer Works, Mystic. Sampled from stock of Ackley & Burnham, East Hartford, and E. N. Austin, Suffield.

18946. Made by Wilcox Fertilizer Works. Sampled from stock of Spencer Bros., Suffield.

ANALYSES OF TANKAGE.

	Conn. Rend'g Co.		Davis.	Sperry & Barnes.	
Station No.	19629	18974	18927	18797	18909
MECHANICAL ANALYSES.					
Finer than $\frac{1}{50}$ inch	30	33	54	33	49
Coarser than $\frac{1}{50}$ inch	70	67	46	67	51
	100	100	100	100	100
CHEMICAL ANALYSES.					
Percentage amounts of					
Nitrogen	4.90	5.04	7.16	10.01	9.80
Phosphoric acid	14.56	15.74	13.91	4.53	6.46
Cost per ton	$30.00	20.00	....	....	....
Valuation	25.93	27.43	35.58	36.60	39.20

	Various lots bought by S. D. Woodruff & Sons.					Clark.	Man-chester.	Sp'gfield Rend. Co.	Swift's Lowell.	National Fert. Co.	Buffalo Fert. Co.
Station No.	19207	19208	18747	18748	18918	18779	19230	19061	18826	18979	19091
MECHANICAL ANALYSES.											
Finer than $\frac{1}{50}$ inch	30	28	37	38	35	47	36	59	40	42	37
Coarser than $\frac{1}{50}$ inch	70	72	63	62	65	53	64	41	60	58	63
	100	100	100	100	100	100	100	100	100	100	100
CHEMICAL ANALYSES.											
Percentage amounts of											
Nitrogen	5.46	6.16	7.13	6.91	7.12	6.60	7.04	6.61	5.36	5.90	5.65
Phosphoric acid	11.55	8.03	13.34	13.59	13.24	13.37	13.20	14.28	14.21	11.13	14.56
Cost per ton	....	....	....	....	....	....	....	....	....	....	....
Valuation	25.80	25.65	33.29	32.81	32.98	32.50	32.78	34.38	28.10	28.04	29.07

19320. Chittenden's Dry Ground Fish. Sold by National Fertilizer Co., Bridgeport. Sampled from stock of G. D. Mosher, Milford.

18975. Sold by the American Agricultural Chemical Co., New York City. Sampled from stock of F. S. Bidwell & Co., Windsor Locks.

18925. Sold by Sanderson Fertilizer & Chemical Co., New Haven. Sampled from the factory.

Guaranties.

Three of the ten samples failed to meet the maker's guaranty, but only one, Parmenter & Polsey's, 19173, failed to furnish an amount of plant food equivalent in money value to the amount guaranteed.

The other two, while deficient in one ingredient, fully covered the money value of this deficiency by supplying correspondingly more of the other ingredient than was guaranteed.

Analyses and Valuations.

The percentages of nitrogen in dry fish this year were quite up to the average, ranging from 7.92 to 9.90. Phosphoric acid ranged from 5.28 to 14.70 per cent.

In six of the ten samples valuation exceeded cost. Dry fish has been an economical fertilizer to buy and use this year, nitrogen and phosphoric acid costing considerably less in this form than in bone and their percentages, being much more uniform in the different samples than the percentages in tankage.

NITROGENOUS SUPERPHOSPHATES AND GUANOS.

Here are included those mixed fertilizers containing nitrogen, phosphoric acid and, in most cases, potash, which are not designed by their manufacturers for use on any special crop.

"Special Manures" are noticed further on.

1. Samples Drawn by the Station Agent.

In the table, pages 56 to 73, are given analyses of one hundred and four samples belonging to this class, arranged according to the percentage difference between cost and valuation.

Analyses requiring Special Notice.

19194. Woodruff's Home Mixture, given in the table, pages 56 and 57, represents the large stock found by our agent in the warehouse in May.

PERCENTAGE COMPOSITION AND VALUATION OF DRY FISH.

	Am. Ag. Chem. Co.	Parmenter & Polsey.	Russia Cement Co.	Wilcox Fertilizer Works.	Bowker Fertilizer Co.	Wilcox Fertilizer Works.		National Fertilizer Co.	Am. Ag. Chem. Co.	Sanderson Fertz. and Chem. Co.
Station No.	**19172**	**19173**	**19405**	**18947**	**19321**	**19171**	**18946**	**19320**	**18975**	**18925**
Percentage amounts of—										
Nitrogen as ammonia	0.17	0.32	0.10	0.22	....	0.16	0.16	....	....	0.48
" organic	8.68	9.58	7.92	8.62	8.57	8.74	8.86	8.50	8.58	7.44
Total nitrogen found	8.85	9.90	8.02	8.84	8.57	8.90	9.02	8.50	8.58	7.92
" guaranteed	**8.2**	**10.0**	**8.0**	**8.5**	**8.2**	**8.5**	**8.5**	**8.2**	**8.3**	**8.0**
Phosphoric acid, water-soluble	0.67	0.77	0.64	0.62	0.48	0.64	0.59	0.61	0.59	1.12
" " citrate-soluble	4.88	3.95	10.22	4.34	5.06	4.48	4.01	5.10	3.97	4.02
" " citrate-insoluble	1.10	0.56	3.84	1.83	1.37	1.38	1.54	1.58	2.09	1.24
Total phosphoric acid found	6.65	5.28	14.70	6.79	6.91	6.50	6.14	7.29	6.65	6.38
" " guaranteed	**7.0**	**12.0**	**11.0**	**6.0**	**6.0**	**6.0**	**6.0**	**6.0**	**7.0**	**6.0**
Cost per ton	$37.00	40.00	41.00	38.50	39.50	40.50	42.00	42.00	42.00	40.00
Valuation per ton	$41.69	44.95	44.20	41.37	40.72	41.61	41.71	40.68	40.18	37.42
Percentage difference between cost and valuation	**11.3***	**11.0***	**7.2***	**6.9***	**3.0***	**2.7***	**0.7**	**3.2**	**4.5**	**6.9**

*Valuation exceeds cost.

A small lot, sampled March 28th, was made up with sulphate of ammonia in place of nitrate, and a sample of this had the following composition:

	18914
Nitrogen	2.90
Phosphoric acid	10.03
Potash	8.92
Valuation per ton	$27.64

The manufacturers stated regarding the analysis of **19037**, Rogers Mfg. Co.'s All Round Fertilizer, pages 68 and 69, which showed less potash than was guaranteed, that they felt sure the analysis did not fairly represent the average composition of the fertilizer and asked that another sample be drawn and analyzed. This was done, as appears from analysis No. **19191**, pages 64 and 65, which shows nearly one per cent. more of potash than the first sample. **19338**, The Coe-Mortimer Co's. Peruvian Market Garden Manure, sampled from stock of J. E. Holmes, Stratford, and Andrew Kingsbury, Coventry, contained 5.00 per cent. of nitrogen, 9.90 of phosphoric acid and 7.41 of potash. The manufacturer protested that this analysis, which shows wide discrepancies between composition and guaranty, did not at all represent the quality of this brand. It also appeared that each sample was drawn from only a single bag, as that was all the stock available at the time. Later another sample of this brand was drawn and analyzed, the results being given on pages 68 and 69, No. **19651**. **19336**, The Coe-Mortimer Co.'s Red Brand Excelsior Guano, sampled from stock of W. H. Burr, Fairfield, contained 1.82 per cent. of nitrogen, 10.64 of phosphoric acid and 6.07 of potash, and had a valuation of $21.97. The manufacturer protested that this could not represent the average quality of this brand and asked that a new sample be drawn. This was done and the results of analysis are given in the table, pages 64 and 65, No. **19650**.

The Buffalo Fertilizer Co. protested that their mixtures were made so as to fully meet their guaranties and that the failure of most of them to do this in this state was inexplicable to them, except through errors of sampling or analysis. This protest applies to their Garden Truck, **19372**, Top Dresser, **19121**, and Farmers Choice, **19035**.

The first analysis of Top Dresser, **19121**, appears on pages 72 and 73 of the table. The director of the station drew a second sample, after receiving the manufacturer's protest, the analysis of which, **19395**, is given on pages 66 and 67 of the table.

While containing considerably more nitrogen than the first sample, it still falls far short of the guaranty.

The director also drew samples of Garden Truck, **19394**, and Farmers Choice, **19392**, which were partially analyzed with the results given below, with the previous analyses of the same brands for comparison.

	Garden Truck			Farmers' Choice		
	19372	19394	Guaranty	19035	19392	Guaranty
Nitrogen	3.14	3.14	**3.25**	0.75	0.82	**0.82**
Total phosphoric acid	8.55	8.24	8.0	7.61	7.48	**9.0**
Potash	7.14	7.13	7.0	4.66	4.92	**5.0**

The agreement of the two samples in each case is fairly good, the second sample of Farmers Choice containing somewhat more potash than the first.

GUARANTIES.

Of the one hundred and four analyses of nitrogenous superphosphates given in the table, made on samples drawn by the station agent, thirty-two, nearly one-third of the whole number, failed to meet the manufacturers' guaranty in some particular by more than one-tenth of one per cent. Ten were deficient in nitrogen alone, seven in phosphoric acid and six in potash. Eight are deficient in respect of two ingredients and one in respect of the three. In most cases the deficiency is slight and accompanied with a considerable excess of another ingredient, so that it may be fairly said that a fair commercial equivalent has been returned for the deficiency of one ingredient.

Nine brands, however, are so deficient that they not only fail to meet the letter of the maker's guaranty but also its spirit, in that they do not furnish an amount of plant food equivalent to what they are claimed and sold to furnish. This shortage ranges from about 35 cents to $8.88, the latter figure being one-quarter of the ton price.

These nine brands are the following:—

19372. Buffalo Fertilizer Co.'s Garden Truck. Nitrogen found, 3.14 per cent.; guaranteed, 3.3. Phosphoric acid found, 8.55; guaranteed, 9.0. See pages 62 and 63.

19395. Buffalo Fertilizer Co.'s Top-Dresser. Nitrogen found, 4.80 per cent.; guaranteed, 5.7. Phosphoric acid found, 5.96; guaranteed, 7.0. See pages 66 and 67.

19121. Buffalo Fertilizer Co.'s Top-Dresser. Nitrogen found, 3.11 per cent.; guaranteed, 5.7. See pages 72 and 73.

19035. Buffalo Fertilizer Co.'s Farmers Choice. Nitrogen found, 0.75 per cent.; guaranteed, 0.8. Phosphoric acid found, 7.61; guaranteed, 9.0. Potash found, 4.66; guaranteed, 5.0. See pages 72 and 73.

19296. Coe-Mortimer Co.'s Peruvian Vegetable Grower. Potash found, 6.44 per cent.; guaranteed, 8.0. See pages 62 and 63.

19650. Coe-Mortimer Co.'s Red Brand Excelsior. Nitrogen found, 3.12 per cent.; guaranteed, 3.3. Potash found, 5.64; guaranteed, 6.0. See pages 64 and 65.

19124. Coe-Mortimer Co.'s Gold Brand Excelsior. Phosphoric acid found, 9.49 per cent.; guaranteed, 10.0. Potash found, 5.69; guaranteed, 6.0. See pages 66 and 67.

19651. Coe-Mortimer Co.'s Peruvian Market Garden Fertilizer. Nitrogen found, 5.7 per cent.; guaranteed, 6.5. Phosphoric acid found, 8.94; guaranteed, 9.3. Potash found, 8.70; guaranteed, 9.8. See pages 68 and 69.

19111. Sanderson Fertilizer and Chem. Co.'s Special with 10 per cent. of Potash. Nitrogen found, 2.23 per cent.; guaranteed, 2.5. Phosphoric acid found, 7.57; guaranteed, 8.0. See pages 68 and 69.

Of these the Coe-Mortimer Co.'s Red Brand Excelsior and the Buffalo Fertilizer Co.'s Garden Truck and Farmers Choice showed similar deficiencies last year.

As appears on page 48, other analyses of Coe-Mortimer's Peruvian Market Garden Manure and Red Brand Excelsior Guano made at the station this year also showed glaring deficiencies in one or more ingredients.

The cause of these deficiencies is not connected either with the method of sampling or the accuracy of the analytical work, but is the fault of the makers of the mixtures.

Cost and Valuation.

Cost.

The method used to ascertain the retail cash cost price of the superphosphates and of commercial fertilizers in general is as follows:

The sampling agent inquires and notes the price at the time each sample is drawn. The analysis is reported as soon as made to each dealer from whom a sample was taken, as well as to the manufacturer of the article, in order to give opportunity for explanation or correction as regards the price or the analysis itself. When the data thus gathered show a wide range of prices, further correspondence is required and the manufacturers are also consulted. In general an average or nearly average price forms the basis of comparison between cost and valuation. The price thus employed is printed in the following tables in full-face type.

Valuation.

The valuation of a mixed fertilizer, as practiced at this station, consists in calculating the retail trade-value or cash-cost at freight centers (in raw material of good quality) of an amount of nitrogen, phosphoric acid and potash equal to that contained in one ton of the fertilizer.

The schedule of trade-values is given on page 40. The organic nitrogen in mixed fertilizers is reckoned at the price of nitrogen in raw material of the best quality, 20½ cents per pound.

Citrate-insoluble phosphoric acid is rated at 2 cents per pound. Potash is rated at 4¼ cents, if sufficient chlorine is present in the fertilizer to combine with it to make muriate. If there is more potash present than will combine with the chlorine, then this excess of potash is reckoned at 5 cents per pound, except in certain special cases, to be noted later, where carbonate of potash has been used in the mixture.

In most cases the valuation of the ingredients in superphosphates and specials falls below the retail price of these goods. The difference between the two figures represents the manufacturers' charges for converting raw materials into manufactured articles and selling them. The charges are for grinding and mixing, bagging or barreling, storage and transportation, commission to agents and dealers, long credits, interest on investments, bad debts and, finally, profits.

To Obtain the Valuation of a Fertilizer we multiply the pounds per ton of nitrogen, etc., by the trade-value per pound. We thus get the values per ton of the several ingredients, and adding them together we obtain the total valuation per ton.

Percentage Difference given in the table shows the percentage excess of the cost price over the average retail cost, at freight centers, of the nitrogen, phosphoric acid and potash contained in the fertilizer and furnishes the best means we have for expressing the comparative commercial value of the different brands.

This information helps the purchaser to determine whether it is better economy to buy the commercial mixed fertilizers, of which so many are now offered for sale, or to purchase and mix for himself the raw materials.

The average cost per ton of the one hundred and four nitrogenous superphosphates is $32.04, the average valuation $23.80, and the percentage difference 34.6.

Last year the corresponding averages were, cost $31.00, valuation $21.00, percentage difference 47.6.

The average composition and cost of nitrogenous superphosphates for the last four years have been as follows:

	Nitrogen.	Total Phosphoric Acid.	Potash.	Cost per ton.	Percentage Difference.
1904	2.68	10.02	4.31	$31.01	50.1
1905	2.56	10.02	4.59	30.79	45.5
1906	2.50	9.99	4.66	31.00	47.6
1907	2.81	9.66	5.04	32.04	34.6

It appears from these calculations that in 1907 nitrogenous superphosphates contained, on the average, considerably more nitrogen and potash than in the three preceding years and less phosphoric acid. The average cost has been one dollar per ton more, but the higher valuation has more than made up for it.

Forms of Organic Nitrogen.

Considerable work has been done in the microscopic and chemical examination of mixed fertilizers, with reference to the detection and identification of the forms of nitrogen used in them, but our results are not yet in shape for publication.

Economy of Purchase.

An examination of the analyses of nitrogenous superphosphates shows a very wide range of composition and prices; the latter ranging from $23.75 to $51.00 per ton. The range of composition is equally wide and so is the range of guaranties. Nearly all contain three valuable fertilizing ingredients and it is a task requiring some study and calculation to find out which of them furnish plant food at the cheapest rate.

Setting aside for the moment the system of valuations used by this station, another method, and one which seems beyond criticism, is the following: taking the cost of each brand, and the amounts of nitrogen, phosphoric acid and potash in each—figures about which there can be no dispute—to calculate how many pounds of these three things one can buy for $30 in each fertilizer.

This we have done, not for each fertilizer, but for each group of about a dozen fertilizers, in the tables under discussion. The results of this computation are the following:

Purchasable for Thirty Dollars.

	Nitrogen, pounds.	Phosphoric Acid, pounds.	Potash, pounds.
In the first 15 samples in the table	73	188	122
" next 12 " " "	59	183	124
" " 11 " " "	63	169	94
" " 13 " " "	51	163	115
" " 10 " " "	47	200	83
" " 13 " " "	55	159	68
" " 9 " " "	42	185	77
" " 13 " " "	30	208	68
" " 9 " " "	29	194	61

The great differences in the price paid for plant food in the various brands now in market are clearly shown in this table.

Thus, by careful study of the analyses, the farmer can select factory-mixed fertilizers which will give him for $30, 73 pounds of nitrogen, 188 of phosphoric acid and 122 of potash. With less care in selection he is likely to get 45 to 50 pounds of nitrogen, 180 to 200 pounds of phosphoric acid and 80 to 100 pounds of potash for the same money.

He may also get, and particularly if he is looking for "cheap" fertilizers, only 30 pounds of nitrogen, 190 of phosphoric acid and 60 of potash for his outlay of $30.00.

In the last case he pays about twice as much for his plant food as in the first case. Yet in no case is he defrauded by the manufacturer if the goods are as guaranteed. He simply pays for his carelessness or lack of sense in doing business.

The seller is not to be blamed for charging a very high price for his goods if, without fraud, he can find people simple enough to pay it.

Low-priced fertilizers are not by any means uneconomical to buy *in all cases*. In the table there are certain brands which are sold quite below the average price of $32.00 and yet supply plant food at relatively low rates. On the other hand, the twenty or more fertilizers which furnish the smallest quantities of plant food for the money all sell at low prices, from four to six dollars at least under the average price of superphosphates.

As the groups of fertilizers are arranged in the table above, each supplies less value in plant food for a given outlay than any group preceding it, and supplies more value in plant food than any which follows it. That is, they are arranged in the strict order of the economy of this purchase.

But this order of arrangement is the same as in the tables of analyses on pages 56 to 73, where the order is that of the "percentage difference" based on the station's system of valuation. The station valuations, when compared with the selling prices, as is done by the statements of percentage difference, do, therefore, in a fairly accurate manner show the probable relative value of the fertilizers.

To this it has been objected that these comparisons and valuations assume that the nitrogen of the different mixed fertilizers is all in quickly available forms; that it is quite possible for the manufacturer without detection to put in inferior or worthless forms of nitrogen which are very cheap and will raise his valuation and it is freely asserted that this is sometimes done. Of course the only perfect protection against such imposition is the purchase of raw materials, which can be more easily examined as to the quality of their nitrogen, and the home mixture of fertilizers.

But assuming that some mixed fertilizers contain inferior forms of nitrogen, it is fair to suppose that the low grade and low-priced goods will be more likely to contain such a mixture than the more costly brands.

2. *Sampled by Purchasers and Others.*

On pages 74 and 75 are tabulated eight analyses of samples of nitrogenous superphosphates which were sent to the station for analysis by interested persons. The station is not responsible for the sampling of these articles.

A sample of E. B. Clark & Co.'s Special Manure, drawn from a single bag by A. N. Beard, Milford, contained nitrogen 2.52, phosphoric acid 10.91, potash 8.23 and agreed with the manufacturer's guaranty.

Two samples of fertilizers made in England especially for florists' use were sent for analysis by Thos. W. Head, Groton, Conn.

19275. Clay's Fertilizer for chrysanthemums and general flowering stock, imported in bags and tins, for sale at seed stores for $7.00 per hundred weight.

19276. Thompson's Vine Manure imported in bags and sold for $6.75 per hundred pounds.

	Clay's Fertilizer.	Thompson's Vine Manure.
	19275	19276
Nitrogen as ammonia	1.81	1.77
Nitrogen, organic	3.09	2.42
Nitrogen, total	4.90	4.19
Water-soluble phosphoric acid	0.08	5.46
Citrate-soluble " "	1.50	4.54
Citrate-insoluble " "	7.11	2.31
Total phosphoric acid	8.69	12.31
Water-soluble potash	0.18	7.31
Valuation per ton	$23.43	$32.80

19276 apparently contained horn shavings. Nitrogenous superphosphates or specials can be bought here for from $30 to $35 which contain as much available plant food as these fertilizers which sell at preposterous prices.

Nitrogenous Superphosphates.

Station No.	Name or Brand.	Manufacturer.	Dealer.	Dealer's cash price per ton.	Valuation per ton.
	Sampled by Station Agent:				
19009	Home Mixture. High Grade Special	Olds & Whipple, Hartford	Herman Ude,* Suffield	$28.00	$33.59
19194†	Woodruff's Home Mixture	S. D. Woodruff & Sons, Orange	Manufacturer	28.00	30.50
19252	Manchester's Formula	E. Manchester & Sons, Winsted	G. W. Morgan,* East Haddam	30.00	32.08
			Manufacturer	30.00	
19250	Brainard's High Grade	H. K. Brainard, Thompsonville	Manufacturer	30.00	29.83
19151	Mapes' Top Dresser Improved, Full Strength	Mapes F. & P. G. Co., New York City	Mapes' Branch, Hartford	51.00	47.36
			W. C. Bulkley, Forestville	51.00	
19050	Bone, Fish & Potash	E. R. Kelsey, Branford	E. A. Ives,* Cheshire	26.00	24.03
18995	4-8-7	(Made for) E. B. Clark Co., Milford	C. R. Treat, Orange	30.00	27.55
19186	C.V.O.Co.'s Complete H. G. Fertilizer	Conn. Valley Orchard Co., Berlin	Manufacturer	28.00	25.27
19322	Mapes' Dissolved Bone	Mapes F. & P. G. Co., New York City	Thompson Bros., East Haddam	31.00	28.23
			Mapes' Branch, Hartford	32.00	
				31.50	
19072	Boardman's Complete for Potatoes and General Crops	F. E. Boardman, Middletown	Manufacturer	33.00	28.39
19107	Chittenden's XXX Fish and Potash	Nation'l Fertilizer Co., Bridgeport	A. H. Cashen, Meriden	24.00	20.29
			G. W. Eaton, Plainville	23.00	
			J. & H. Woodford, Avon	24.00	
				23.75	
19333	Long Island Special	Berkshire Fertilizer Co., Bridgeport	H. T. Childs, Woodstock	34.00	28.82
18913	Clark's Special Mixture for general use	(Made for) E. B. Clark Co., Milford	E. B. Clark Co., Milford	30.00	25.17
19314	Quinnipiac Market Garden Manure	American Agricultural Chemical Co., N. Y.	C. Buckingham, Southport	34.00	28.41
19380	Wilcox's H. G. Fish and Potash	Wilcox Fertilizer Works, Mystic	Manufacturer	----	24.17
			W. A. Howard, Woodstock	29.00	
19345	10% Manure	No. Western Fertilizer Co., Chicago, Ill.	R. H. Nesbit, Hamden	33.50	27.92
19106	Chittenden's Formula A	Nation'l Fertilizer Co., Bridgeport	G.W. Eaton, Plainville	----	25.75
			D. L. Clark, Milford	30.00	
			J. & H. Woodford, Avon	32.00	
				31.00	

* Purchaser. † See note on page 46.

Analyses and Valuations.

Station No.	Percentage difference between cost and valuation.	Nitrogen.					Phosphoric Acid.							Potash.		
					Total Nitrogen.					Total.		So-called "Available."		Found.		
		As Nitrates.	As Ammonia.	Organic.	Found.	Guaranteed.	Water-soluble.	Citrate-soluble.	Citrate-insoluble.	Found.	Guaranteed.	Found.	Guaranteed.	As Muriate.	Total.	Guaranteed.
19009	‡16.6	1.50	---	2.86	4.36	4.1	----	7.51	0.47	7.98	----	7.98	7.0	11.01	11.01	10.0
19194	‡ 8.2	2.53	---	1.74	4.27	3.3	4.05	2.93	0.94	7.92	8.0	6.98	----	8.17	8.17	8.0
19252	‡ 6.5	0.38	---	3.66	4.04	3.7	3.31	5.92	1.75	10.98	9.0	9.23	7.0	7.43	7.43	7.5
19250	0.6	----	---	3.86	3.86	3.5	0.14	8.54	2.68	11.36	10.8	8.68	----	6.00	6.00	6.0
19151	7.7	8.84	1.00	0.10	9.94	9.9	0.45	6.52	0.87	7.84	8.0	6.97	----	1.20	4.25	4.0
19050	8.2	----	0.79	2.39	3.18	2.5	2.10	5.24	0.77	8.11	5.0	7.34	4.0	0.62	4.42	4.0
18995	8.9	1.47	---	1.89	3.36	3.3	4.46	3.01	1.18	8.65	8.0	7.47	----	7.91	7.91	7.0
19186	10.8	0.74	---	1.87	2.61	2.5	7.84	2.54	0.61	10.99	11.0	10.38	8.0	2.72	4.90	4.0
19322	11.6	----	0.30	2.99	3.29	2.1	4.77	10.90	0.86	16.53	----	15.67	12.0	----	----	----
19072	16.2	----	1.09	1.82	2.91	2.9	5.41	2.42	1.13	8.96	6.0	7.83	----	10.67	10.67	10.0
19107	17.1	0.21	0.18	2.23	2.62	2.5	4.19	2.16	1.62	7.97	7.0	6.35	5.0	3.48	3.48	3.0
19333	18.0	----	1.32	2.61	3.93	2.3	5.28	2.96	1.16	9.40	8.0	8.24	6.0	6.00	6.00	7.0
18913	19.2	0.51	---	1.72	2.23	2.5	4.66	3.26	2.42	10.34	----	7.92	9.0	9.02	9.02	8.0
19314	19.7	----	1.43	1.96	3.39	3.3	7.55	1.81	1.05	10.41	9.0	9.36	6.0	6.78	6.78	7.0
19380	20.0	----	---	3.28	3.28	3.3	4.67	1.90	0.44	7.01	6.0	6.57	5.0	4.89	4.89	4.0
19345	20.0	----	1.93	1.29	3.22	3.3	4.86	2.48	0.90	8.24	7.0	7.34	6.0	9.91	9.91	10.0
19106	20.4	0.86	0.56	1.73	3.15	3.3	5.36	2.28	1.32	8.96	9.0	7.64	6.0	6.57	6.57	6.0

‡ Valuation exceeds cost.

Nitrogenous Superphosphates.

Station No.	Name or Brand.	Manufacturer.	Dealer.	Dealer's cash price per ton.	Valuation per ton.
	Sampled by Station Agent:				
19344	No. Western Empire Special	No. Western Fertiliz'g Co., Chicago, Ill.	C. Buckingham, Southport	**$33.00**	$27.14
19125	American Farmers' Market Garden Special	Armour Fertilizer Works, Baltimore, Md.	O. H. Meeker, Danbury	**35.00**	28.71
			W. B. Martin, Rockville	34.00	
			F. T. Blish Hdw. Co., South Manchester	36.50	
19157	Chittenden's Formula B	Nation'l Fertilizer Co., Bridgeport	G. D. Mosher, Milford	30.00	24.65
			J. N. Lasbury, Broad Brook	30.00	
			George Fairchilds, Westport	31.00	
				30.25	
19298	Mapes' Average Soil Complete Manure	Mapes F. & P. G. Co., New York City	Mapes' Branch, Hartford	36.00	29.65
			Southington Lumber & Feed Co., Southington	37.00	
				36.50	
19048	Swift-Sure Superphosphate for general use	M. L. Shoemaker & Co., Phila., Pa.	A. N. Clark, Milford	35.00	28.59
			Olds & Whipple, Hartford	35.00	
			F. S. Bidwell & Co., Windsor Locks	36.00	
				35.25	
19330	A. A. C. Co.'s Southport XX Special	Am'can Agric. Chem. Co., New York City	E. H. Austin, Gaylordsville	**36.50**	29.55
19220	Wilcox's Complete Bone Superphosphate	Wilcox Fertilizer Works, Mystic	Manufacturer	**29.00**	23.44
			W. A. Howard, Woodstock	29.00	
			W. R. McDonald, Cromwell	28.00	
19302	Hubbard's Market Garden Phosphate	The Rogers & Hubbard Co., Middletown	H. H. McKnight, Ellington	**38.00**	30.44
			T. S. Loomis, Windsor	38.00	
19136	Armour's Blood, Bone and Potash	Armour Fertilizer Works, Baltimore, Md.	W. F. Stocking, Milford	40.00	31.37
			Farmers' Supply and Roof. Co., Bridgeport	38.00	
			Geo. Labonne, Jr., Jewett City	40.00	
				39.25	
19366	A. A. Brand	Parmenter & Polsey, Peabody, Mass.	J. R. Norton, Broad Brook	**39.50**	31.58
			R. E. Hyde, Ellington	----	

Analyses and Valuations—*Continued.*

Station No.	Percentage difference between cost and valuation.	Nitrogen.					Phosphoric Acid.							Potash.		
					Total Nitrogen.					Total.		So-called "Available."		Found.		
		As Nitrates.	As Ammonia.	Organic.	Found.	Guaranteed.	Water-soluble.	Citrate-soluble.	Citrate-insoluble.	Found.	Guaranteed.	Found.	Guaranteed.	As Muriate.	Total.	Guaranteed.
19344	21.6	----	1.71	1.73	3.44	**3.3**	5.55	1.93	0.96	8.44	**8.0**	7.48	**7.0**	7.52	7.52	**7.0**
19125	21.9	----	1.34	1.76	3.10	**3.3**	8.00	1.61	0.48	10.09	**9.0**	9.61	**8.0**	8.42	8.42	**7.0**
19157	22.7	0.90	0.79	1.47	3.16	**3.3**	5.20	1.83	0.81	7.84	**10.0**	7.03	**6.0**	6.29	6.29	**6.0**
19298	23.1	3.45	---	0.86	4.31	**4.1**	1.38	6.25	0.66	8.29	**8.0**	7.63	**7.0**	1.22	6.26	**5.0**
19048	23.3	0.81	---	2.04	2.85	**2.9**	7.68	4.76	1.65	14.09	----	12.44	**9.0**	0.60	4.70	**4.5**
19330	23.5	0.15	1.68	2.29	4.12	**4.1**	5.14	2.43	1.18	8.75	**8.0**	7.57	**7.0**	6.97	6.97	**7.0**
19220	23.7	----	0.51	1.91	2.42	**2.1**	6.51	4.17	1.12	11.80	**9.0**	10.68	**8.0**	3.66	3.66	**3.0**
19302	24.8	2.42	---	1.02	3.44	**3.5**	4.46	4.25	0.50	9.21	**8.5**	8.71	**7.5**	10.38	10.38	**10.0**
19136	25.1	0.61	1.05	2.42	4.08	**4.1**	7.09	1.95	0.39	9.43	**10.0**	9.04	**8.0**	4.64	7.20	**7.0**
19366	25.1	0.76	---	3.13	3.89	**4.1**	5.47	2.39	0.66	8.52	**8.0**	7.86	**7.0**	1.46	8.28	**8.0**

Nitrogenous Superphosphates.

Station No.	Name or Brand.	Manufacturer.	Dealer.	Dealer's cash price per ton.	Valuation per ton.
	Sampled by Station Agent:				
19032	Sanderson's Formula A	Sanderson Fertilizer and Chemical Co., New Haven	Manufacturer	$35.00	$27.95
			A. I. Martin, Wallingford	35.00	
			Morse & Landon, Guilford	35.00	
			G. W. Eaton, Plainville	35.00	
19113	Am'n Farmers' Fish and Potash Mixture	Armour Fertilizer Works, Baltimore, Md.	S. V. Osborn, Branford	24.00	19.71
			Brower & Malone, Norwalk	25.00	
			W. B. Martin, Rockville	25.00	
				24.75	
19337	Peruvian Guano, Chincha Grade	Coe-Mortimer Co., New York City	P. Callahan, Stratford	----	37.42
			John Du Bon, Poquonock	44.00	
			Ackley & Burnham, East Hartford	50.00	
				47.00	
19045	North Western Market Garden Phosphate	North Western Fertilizing Co., Chicago, Ill.	C. Buckingham, Southport	32.00	24.50
			G. W. Eaton, Bristol	30.00	
				31.00	
19377	Swift's Lowell Market Garden Manure	Swift's Lowell Fertilizer Co., Boston	Weed & Turner, New Canaan	38.00	29.22
			G. S. Jennings, Southport	36.00	
				37.00	
19140	Clark's 10% Brand	(Made for) E. B. Clark Co., Milford	M. W. Stowe, Milford	**35.00**	27.57
19273	Peruvian Guano, Lobos Grade	Coe-Mortimer Co., New York City	E. E. Burwell, New Haven	37.00	28.37
			W. I. Lobdell, Stratford	35.00	
				36.00	
19187	Mapes' Vegetable Manure, or Complete for Light Soils	Mapes F. & P. G. Co., New York City	Mapes' Branch, Hartford	**42.00**	33.06
			J. P. Barstow, Norwich	42.00	
19310	Darling's Blood, Bone and Potash	Am'n Agric. Chemical Co., New York City	Wm. Bartman, East Haddam	**38.00**	29.87
19299	Chittenden's Fish and Potash	Nation'l Fertilizer Co., Bridgeport	G. A. Williams, Silver Lane	33.00	24.33
			J. A. Glasnapp, Cheshire	30.00	
				31.50	
19346	North Western Superphosphate	No. Western Fertilizing Co., Chicago, Ill.	G. W. Eaton, Bristol	**30.00**	22.71

Analyses and Valuations—*Continued.*

Station No.	Percentage difference between cost and valuation.	Nitrogen.					Phosphoric Acid.							Potash.		
					Total Nitrogen.					Total		So-called "Available."		Found.		
		As Nitrates.	As Ammonia.	Organic.	Found.	Guaranteed.	Water-soluble.	Citrate-soluble.	Citrate-insoluble.	Found.	Guaranteed.	Found.	Guaranteed.	As Muriate.	Total.	Guaranteed.
19032	25.2	0.20	0.79	2.56	3.55	**3.3**	4.91	2.47	2.85	10.23	**9.0**	7.38	**6.0**	6.67	6.67	**6.0**
19113	25.6	----	---	2.45	2.45	**2.1**	5.29	2.28	1.17	8.74	**7.0**	8.74	**6.0**	2.18	2.18	**2.0**
19337	25.6	0.32	3.66	3.12	7.10	**7.1**	2.56	5.06	1.60	9.22	**8.5**	7.62	**6.5**	0.13	2.91	**2.0**
19045	26.5	0.06	0.76	1.75	2.57	**2.5**	7.25	1.74	1.21	10.20	**9.0**	8.99	**8.0**	6.05	6.05	**6.0**
19377	26.6	0.74	---	3.17	3.91	**4.1**	3.82	4.17	2.22	10.21	**8.0**	7.99	**7.0**	5.90	5.90	**6.0**
19140	26.9	1.35	---	1.83	3.18	**3.3**	3.36	3.36	0.84	7.56	**6.0**	6.72	----	9.82	9.82	**10.0**
19273	26.9	1.06	1.16	0.78	3.00	**2.9**	0.99	9.31	5.15	15.45	**15.0**	10.30	**9.0**	1.74	6.02	**4.8**
19187	27.1	3.98	0.32	0.94	5.24	**4.9**	1.14	6.47	1.24	8.85	**8.0**	7.61	**6.0**	1.25	6.09	**6.0**
19310	27.2	----	1.77	2.17	3.94	**4.1**	5.71	1.87	1.16	8.74	**8.0**	7.58	**7.0**	8.14	8.14	**7.0**
19299	29.5	----	---	3.09	3.09	**3.0**	5.44	1.89	1.31	8.64	**6.0**	7.33	----	4.70	4.70	**4.0**
19346	32.1	----	0.83	1.85	2.68	**2.5**	7.92	2.17	1.37	11.46	**11.0**	10.09	**9.0**	2.11	2.11	**2.0**

NITROGENOUS SUPERPHOSPHATES.

Station No.	Name or Brand.	Manufacturer.	Dealer.	Dealer's cash price per ton.	Valuation per ton.
	Sampled by Station Agent:				
19054	Berkshire Complete Fertilizer	Berkshire Fertilizer Co., Bridgeport	P. Schwartz, New London	$34.00	$25.57
			Wm. Williamson, Stratford	34.00	
			Hotchkiss & Templeton, Waterbury	34.00	
19038	O. & W's. Special Phosphate	Olds & Whipple, Hartford	Manufacturer	**35.00**	26.28
19349	Chittenden's Complete Fertilizer	Nation'l Fertilizer Co., Bridgeport	G. A. Williams, Silver Lane	**37.00**	27.68
19312	Packers' Union Gardeners' Complete Manure	Am'n Agric. Chemical Co., New York City	J. W. Gardner, Cromwell	37.00	27.97
			R. M. Fenn, Middlebury	38.00	
			--	**37.50**	
19272	Complete with 10% Potash	Am'n Agric. Chemical Co., New York City	D. L. Clark, Milford	38.00	28.98
			Tanner & Wilcox, East Winsted	40.00	
			--	**39.00**	
19319	W. & C's. Americus High Grade Special	Am'n Agric. Chemical Co., New York City	W. H. H. Chappell, R. F. D., Oakdale	**37.00**	27.50
19379	Wilcox's Special Superphosphate	Wilcox Fertilizer Works, Mystic	Manufacturer	26.00	18.92
			A. C. Tillinghast, Plainfield	25.00	
			--	**25.50**	
19114	Armour's All Soluble	Armour Fertilizer Works, Baltimore, Md.	Lightbourn & Pond, New Haven	33.00	24.29
			Farmers' Supply Co., Bridgeport	33.00	
			O. H. Meeker, Danbury	32.00	
			--	**32.75**	
19154	Hubbard's Soluble Corn and General Crops	The Rogers & Hubbard Co., Middletown	H. W. Andrews, Wallingford	**36.00**	26.67
			R. H. Hall, East Hampton	36.00	
19296*	Peruvian Vegetable Grower	Coe-Mortimer Co., New York City	M. W. Stowe, Milford	37.50	28.68
			J. W. Gardner, Cromwell	40.00	
			--	**38.75**	
19372†	Garden Truck	Buffalo Fertilizer Co., Buffalo, N. Y.	Bishop & Lynes, Norwalk	**36.00**	26.61
19353	Lister's Pure Bone Superphosphate of Lime	Lister's Agricultural Chemical Works, Newark, N. J.	A. I. Martin, Wallingford	**32.00**	23.43
19163	Darling's Dissolved Bone and Potash	Am'n Agric. Chemical Co., New York City	C. B. Wier, Southington	35.00	25.99
			B. F. Eddy, East Woodstock	36.00	
			--	**35.50**	

* See note on page 50. † See notes on pages 48 and 49.

ANALYSES AND VALUATIONS—*Continued.*

Station No.	Percentage difference between cost and valuation.	Nitrogen.			Total Nitrogen.		Phosphoric Acid.			Total.		So-called "Available."		Potash.		
		As Nitrates.	As Ammonia.	Organic.	Found.	Guaranteed.	Water-soluble.	Citrate-soluble.	Citrate-insoluble.	Found.	Guaranteed.	Found.	Guaranteed.	Found. As Muriate.	Found. Total.	Guaranteed.
19054	33.0	----	1.65	1.25	2.90	**2.5**	6.56	2.24	0.97	9.77	**10.0**	8.80	**8.0**	6.69	6.69	**6.0**
19038	33.2	----	1.13	3.37	4.50	**4.1**	0.16	5.14	1.33	6.63	----	5.30	**4.0**	0.68	3.28	**3.5**
19349	33.7	0.41	0.78	2.15	3.34	**3.3**	5.86	3.56	1.13	10.55	**10.0**	9.42	**8.0**	6.00	6.00	**6.0**
19312	34.1	----	0.68	1.88	2.56	**2.5**	5.97	1.65	0.76	8.38	**7.0**	7.62	**6.0**	2.05	10.43	**10.0**
19272	34.5	----	1.58	1.78	3.36	**3.3**	5.17	1.38	1.47	8.02	**7.0**	6.55	**6.0**	10.77	10.77	**10.0**
19319	34.5	1.53	---	1.70	3.23	**3.3**	4.61	3.32	1.90	9.83	**9.0**	7.93	**8.0**	7.66	7.66	**7.0**
19379	34.8	---	---	1.34	1.34	**1.0**	6.59	4.47	1.95	13.01	**9.0**	11.06	**8.0**	2.40	2.40	**1.5**
19114	34.8	0.60	0.81	1.69	3.10	**2.9**	6.29	2.11	0.68	9.08	**10.0**	8.40	**8.0**	4.52	4.52	**4.0**
19154	35.0	1.23	---	1.51	2.74	**2.5**	2.22	5.47	1.74	9.43	**8.0**	7.69	**6.0**	9.52	9.52	**8.0**
19296	35.1	0.64	1.52	1.40	3.56	**3.5**	3.58	5.03	2.14	10.75	**11.0**	8.61	**7.5**	1.08	6.44	**8.8**
19372	35.3	0.18	1.73	1.23	3.14	**3.3**	5.15	2.47	0.93	8.55	**9.0**	7.62	**8.0**	0.29	7.14	**7.0**
19353	36.6	0.11	0.94	1.73	2.78	**2.5**	5.84	4.51	2.19	12.54	**11.0**	10.35	**9.0**	2.19	2.19	**2.0**
19163	36.6	----	1.13	1.45	2.58	**2.5**	5.60	1.46	0.79	7.85	**7.0**	7.06	**6.0**	10.41	10.41	**10.0**

Nitrogenous Superphosphates.

Station No.	Name or Brand.	Manufacturer.	Dealer.	Dealer's cash price per ton.	Valuation per ton.
	Sampled by Station Agent:				
19141	Plymouth Rock Brand Fertilizer	Parmenter & Polsey, Peabody, Mass.	J. P. Norton, Broad Brook	**$32.00**	$23.32
			A. Williams & Co., South Woodstock	32.00	
			R. E. Hyde, Ellington	----	
19191*	All Round Fertilizer	Rogers Mfg. Co., Rockfall	H. L. Drake, Windsor Locks	26.00	19.62
			Manufacturer	28.00	
			--	**27.00**	
19222	Wilcox's Fish and Potash	Wilcox Fertilizer Works, Mystic	Olds & Whipple, Hartford	29.00	20.50
			Spencer Bros., Suffield	27.00	
			W. R. McDonald, Cromwell	29.00	
			--	**28.50**	
19650†	Red Brand Excelsior Guano	Coe-Mortimer Co., New York City	L. A. Gowdy, R. F. D., Hazardville	**37.00**	26.62
19238	Quinnipiac Phosphate	Am'n Agric. Chemical Co., New York City	G. M. Williams Co., New London	34.00	23.35
			C. C. Pierce, Putnam	31.00	
			--	**32.50**	
19300	Chittenden's Market Garden	Nation'l Fertilizer Co., Bridgeport	A. H. Cashen, Meriden	**35.00**	25.05
			G. D. Mosher, Milford	35.00	
19127	New England Superphosphate	New England Fertilizer Co., Boston	Hitchcock Hardware Co., Watertown	35.00	23.48
			D. W. Ives, Wallingford	32.00	
			A. D. Zabriski, R.F.D. Norwich	32.00	
			--	**33.00**	
19242	Bowker's Market Garden Fertilizer	Bowker Fertilizer Co., New York City	Bowker's Branch, Hartford	36.00	25.24
			J. P. Barstow, Norwich	35.00	
			--	**35.50**	
19254	Essex XXX Fish and Potash	Russia Cement Co., Gloucester, Mass.	Spencer Bros., Suffield	32.00	22.86
			J. B. Parker, Poquonock	33.00	
			--	**32.50**	
19075	Church's Fish and Potash	Am'n Agric. Chemical Co., New York City	F. S. Bidwell & Co., Windsor Locks	27.00	17.74
			J. H. Paddock, Wallingford	24.00	
			Geo. Beaumont, Wallingford	25.00	
			--	**25.30**	
19351	Lister's Ammoniated Dissolved Bone	Lister's Agric. Chemical Wks., Newark, N. J.	J. A. Foster, Staffordville	**29.00**	20.28

* See note on page 48. † See note on pages 48 and 50.

Analyses and Valuations—*Continued.*

Station No.	Percentage difference between cost and valuation.	Nitrogen.					Phosphoric Acid.							Potash.		
		As Nitrates.	As Ammonia.	Organic.	Total Nitrogen. Found.	Total Nitrogen. Guaranteed.	Water-soluble.	Citrate-soluble.	Citrate-insoluble.	Total. Found.	Total. Guaranteed.	So-called "Available." Found.	So-called "Available." Guaranteed.	Found. As Muriate.	Found. Total.	Guaranteed.
19141	37.2	----	---	2.38	2.38	**2.5**	4.67	4.63	2.47	11.77	**9.0**	9.30	**8.0**	4.39	4.39	**4.0**
19191	37.6	0.04	0.42	1.43	1.89	**1.7**	4.82	4.57	2.12	11.51	**10.0**	9.39	**8.0**	2.78	2.78	**2.0**
19222	39.0	----	0.22	2.43	2.65	**2.5**	2.78	3.12	2.10	8.00	**6.0**	5.90	**5.0**	3.93	3.93	**3.0**
19650	39.0	----	1.82	1.30	3.12	**3.3**	6.78	3.11	1.38	11.27	**10.0**	9.89	**9.0**	5.64	5.64	**6.0**
19238	39.2	0.86	---	1.94	2.80	**2.5**	6.91	2.86	2.09	11.86	**11.0**	9.77	**9.0**	2.23	2.23	**2.0**
19300	39.7	----	1.00	1.62	2.62	**2.5**	6.21	3.07	1.86	11.14	**9.0**	9.28	**8.0**	6.12	6.12	**6.0**
19127	40.6	----	---	2.50	2.50	**2.5**	4.94	4.04	2.30	11.28	**10.0**	8.98	**8.0**	4.39	4.39	**4.0**
19242	40.7	----	0.88	1.74	2.62	**2.5**	5.54	1.52	0.83	7.89	**7.0**	7.06	**6.0**	9.17	9.17	**10.0**
19254	42.2	0.44	---	1.96	2.40	**2.1**	3.33	5.79	4.76	13.88	**12.0**	9.12	**9.0**	3.24	3.24	**2.3**
19075	42.6	----	---	2.16	2.16	**2.1**	4.91	1.80	1.12	7.83	**7.0**	6.71	**6.0**	2.23	2.23	**2.0**
19351	43.0	----	---	2.40	2.40	**2.1**	5.09	3.57	1.84	10.50	**9.0**	8.66	**8.0**	1.65	1.65	**1.5**

Nitrogenous Superphosphates.

Station No.	Name or Brand.	Manufacturer.	Dealer.	Dealer's cash price per ton.	Valuation per ton.
	Sampled by Station Agent:				
19245	Atlantic Coast Bone, Fish and Potash	Sanderson Fertilizer & Chemical Co., New Haven	Manufacturer	$26.00	$17.82
			Morse & Landon, Guilford	25.00	
			--	**25.50**	
19304	Swift's Lowell Animal Brand	Swift's Lowell Fertilizer Co., Boston	C. W. Lines Co., New Britain	35.00	23.60
			Spencer Bros., Suffield	33.00	
			--	**34.00**	
19124*	E. F. Coe's Gold Brand Excelsior Guano	Coe-Mortimer Co., New York City	W. D. Wanzer, Lanesville	32.00	23.46
			M. W. Stowe, Milford	33.00	
			Wm. E. Warner & Bro., Westville	38.00	
			--	**34.00**	
19355	Bowker's Hill & Drill Phosphate	Bowker Fertilizer Co., New York City	J. P. Barstow, Norwich	**35.00**	24.13
19077	Bradley's Farmers' New Method Fertilizer	Am'n Agric. Chemical Co., New York City	Avery Bros., Norwich Town	31.00	20.65
			C. M. Beach, New Milford	31.00	
			Wilson & Burr, Middletown	28.00	
			--	**30.00**	
19269	East India A. A. Ammoniated Superphosphate	American Agricultural Chemical Co., New York City	M. P. McKenna, Stratford	**32.00**	22.03
			F. J. Hartz, R. F. D., South Manchester	32.00	
19395†	Top Dresser	Buffalo Fertilizer Co., Buffalo, N. Y.	Edward White, Rockville	----	27.34
			--	**39.75**	
19251	Success Phosphate	Lister's Agricultural Chemical Works, Newark, N. J.	J. A. Foster, Staffordville	27.00	18.73
			D. C. Burnham, Moodus	27.00	
			C. H. Sage, East Canaan	28.00	
			--	**27.25**	
19363	Fish and Potash	Rogers Mfg. Co., Rockfall	Geo. Meachin, Stratford	**30.00**	20.58
			N. H. Root, New Milford	30.00	
19110	Mapes' Top Dresser Improved, Half Strength	Mapes F. & P. G. Co., New York City	Mapes' Branch, Hartford	35.00	23.55
			Southington Lumber & Feed Co., Southington	35.00	
			Wilson & Burr, Middletown	33.00	
			--	**34.50**	

* See note on page 50. † See note on page 49.

Analyses and Valuations—*Continued.*

Station No.	Percentage difference between cost and valuation.	Nitrogen.					Phosphoric Acid.							Potash.		
		As Nitrates.	As Ammonia.	Organic.	Total Nitrogen. Found.	Total Nitrogen. Guaranteed.	Water-soluble.	Citrate-soluble.	Citrate-insoluble.	Total. Found.	Total. Guaranteed.	So-called "Available." Found.	So-called "Available." Guaranteed.	Found. As Muriate.	Found. Total.	Guaranteed.
19245	43.1	----	---	2.02	2.02	**1.7**	2.51	2.61	1.88	7.00	**6.0**	5.12	**4.0**	4.62	4.62	**4.0**
19304	44.1	----	---	2.60	2.60	**2.5**	4.62	4.32	2.43	11.37	**10.0**	8.94	**8.0**	4.07	4.07	**4.0**
19124	44.9	0.11	0.87	1.55	2.53	**2.5**	3.78	4.60	1.11	9.49	**10.0**	8.38	**8.0**	2.74	5.69	**6.0**
19355	45.0	----	0.28	2.98	3.26	**2.5**	6.64	2.40	1.00	10.04	**10.0**	9.04	**9.0**	2.03	2.03	**2.0**
19077	45.3	0.30	---	1.90	2.20	**1.7**	5.95	2.53	1.93	10.41	**9.0**	8.48	**8.0**	3.24	3.24	**3.0**
19269	45.3	----	1.02	1.64	2.66	**2.5**	8.06	1.34	1.12	10.52	**10.0**	9.40	**9.0**	2.38	2.38	**2.0**
19395	45.4	2.31	1.78	0.71	4.80	**5.7**	3.20	2.12	0.64	5.96	**7.0**	5.32	**6.0**	5.04	5.04	**5.0**
19251	45.5	0.03	---	1.49	1.52	**1.2**	6.94	3.46	1.14	11.54	**11.0**	10.40	**9.0**	2.35	2.35	**2.0**
19363	45.8	0.23	1.18	1.62	3.03	**3.3**	3.01	2.17	1.28	6.46	**5.0**	5.18	**4.0**	4.11	4.11	**3.8**
19110	46.5	4.38	0.40	0.17	4.95	**4.9**	0.33	2.85	0.76	3.94	**4.0**	3.18	----	0.70	2.14	**2.0**

NITROGENOUS SUPERPHOSPHATES.

Station No.	Name or Brand.	Manufacturer.	Dealer.	Dealer's cash price per ton.	Valuation per ton.
	Sampled by Station Agent:				
19651†	Peruvian Market Garden Fertilizer	Coe-Mortimer Co., New York City	H. N. Tiemann, Newtown	$55.00	$37.53
19161	Darling's Farm Favorite	Am'n Agric. Chemical Co., New York City	A. D. Zabriski, R. F. D., Norwich	29.00	20.02
			B. F. Eddy, East Woodstock	30.00	
				29.50	
19037*	All Round Fertilizer	Rogers Mfg. Co., Rockfall	Geo. Meachin, Stratford	28.00	18.83
			R. E. Davis, Guilford	27.00	
			M. B. Clark & Son, Milford	28.00	
				27.75	
18828	Swift's Lowell Animal Brand	Swift's Lowell Fertilizer Co., Boston	Andrew Ure, Highwood	----	23.05
				34.00	
19111‡	Sanderson's Special with 10% Potash	Sanderson Fertilizer & Chemical Co., New Haven	Manufacturer	38.00	24.26
			G. W. Eaton, Plainville	35.00	
			R. H. Hall, East Hampton	35.00	
				36.00	
19144	Hubbard's Complete Phosphate	The Rogers & Hubbard Co., Middletown	H. W. Andrews, Wallingford	**26.00**	17.51
			E. T. Clark, Milford	26.00	
			John Bransfield, Portland	26.00	
19020	Bradley's Superphosphate	Am'n Agric. Chemical Co., New York City	Spencer Bros., Suffield	**34.00**	22.28
			F. S. Bidwell & Co., Windsor Locks	34.00	
			J. B. Parker, Poquonock	34.00	
19034	Bowker's Fisherman's Brand Fish and Potash	Bowker Fertilizer Co., New York City	W. T. McKenzie, Yalesville	29.00	17.97
			P. Schwartz, New London	26.00	
			G. F. Walter, Guilford	27.00	
				27.50	
19055	Armour's Ammoniated Bone with Potash	Armour Fertilizer Works, Baltimore, Md.	Brower & Malone, Norwalk	30.00	19.54
			W. F. Stocking, Milford	31.00	
			Farmers' Supply Co., Bridgeport	30.00	
				30.25	
19318	Williams & Clark's Ammoniated Bone Superphosphate	American Agricultural Chemical Co., New York City	R. H. Hall, East Hampton	34.00	22.04
			D. B. Wilson Co., Waterbury	35.00	
				34.50	

* See note on page 48. † See notes on pages 48 and 50. ‡ See note on page 50.

ANALYSES AND VALUATIONS—*Continued.*

Station No.	Percentage difference between cost and valuation.	Nitrogen. As Nitrates.	As Ammonia.	Organic.	Total Nitrogen. Found.	Total Nitrogen. Guaranteed.	Phosphoric Acid. Water-soluble.	Citrate-soluble.	Citrate-insoluble.	Total. Found.	Total. Guaranteed.	So-called "Available." Found.	So-called "Available." Guaranteed.	Potash. Found. As Muriate.	Found. Total.	Guaranteed.
19651	46.5	1.86	2.20	1.64	5.70	**6.5**	3.74	3.81	1.39	8.94	**9.3**	7.55	**7.5**	1.34	8.70	**9.8**
19161	47.3	0.17	0.62	1.49	2.28	**2.1**	5.78	2.27	1.39	9.44	**9.0**	8.05	**8.0**	3.21	3.21	**3.0**
19037	47.4	0.54	0.56	1.02	2.12	**1.7**	6.03	2.85	1.66	10.54	**10.0**	8.88	**8.0**	1.68	1.68	**2.0**
18828	47.5	----	---	2.44	2.44	**2.5**	5.54	3.54	2.18	11.26	**10.0**	9.08	**8.0**	4.06	4.06	**4.0**
19111	48.4	----	---	2.23	2.23	**2.5**	4.18	1.76	1.63	7.57	**8.0**	5.94	**5.0**	10.25	10.25	**10.0**
19144	48.5	0.11	---	1.11	1.22	**1.0**	5.86	3.06	0.37	9.29	**9.0**	8.92	**8.0**	4.46	4.46	**3.5**
19020	52.6	0.21	0.61	1.76	2.58	**2.5**	7.82	2.10	1.30	11.22	**11.0**	9.92	**9.0**	2.25	2.25	**2.0**
19034	53.0	----	0.75	1.68	2.43	**2.5**	3.15	1.60	0.97	5.72	**5.0**	4.75	**4.0**	4.08	4.08	**4.0**
19055	54.8	----	1.31	1.35	2.66	**2.5**	5.28	1.96	0.87	8.11	**7.0**	7.24	**6.0**	2.38	2.38	**2.0**
19318	56.5	0.35	0.40	1.75	2.50	**2.5**	7.84	2.06	1.46	11.36	**11.0**	9.90	**9.0**	2.22	2.22	**2.0**

Nitrogenous Superphosphates.

Station No.	Name or Brand.	Manufacturer.	Dealer.	Dealer's cash price per ton.	Valuation per ton.
	Sampled by Station Agent:				
19270	Great Eastern General Fertilizer	Am'n Agric. Chemical Co., New York City	T. E. Green, Plainfield	$26.00	$17.05
			J. H. Elliott, Campville	28.00	
				27.00	
19335	H. G. Ammoniated Bone Superphosphate	Coe-Mortimer Co., New York City	A. L. Burdick, Westbrook	**30.00**	18.43
			W. D. Wanzer, Lanesville	28.00	
			J. P. Barstow, Norwich	32.00	
19153	Mapes' Complete, A Brand	Mapes F. & P. G. Co., New York City	Birdsey & Raven, Meriden	**37.00**	22.53
			Southington Lumber & Feed Co., Southington	37.00	
19295	Bowker's Middlesex Special	Bowker Fertilizer Co., New York City	W. T. McKenzie, Yalesville	29.00	18.12
			S. C. Ingersoll, Stamford	35.00	
				30.00	
19244	Buffalo Fish Guano	Buffalo Fertilizer Co., Buffalo, N. Y.	Lightbourn & Pond Co., New Haven	**24.00**	14.33
			S. V. Osborn, Branford	24.00	
19376	Swift's Lowell Dissolved Bone and Potash	Swift's Lowell Fertilizer Co., Boston	F. S. Bidwell & Co., Windsor Locks	30.00	18.19
			Weed & Turner, New Canaan	31.00	
				30.50	
19122	Packers' Union Universal Fertilizer	Am'n Agric. Chemical Co., New York City	G. W. Eaton, Bristol	30.00	16.63
			F. L. Mackey, Ellington	**28.00**	
			G. A. Forsyth, R.F.D., Waterford	26.00	
19248	Read's Standard Superphosphate	Am'n Agric. Chemical Co., New York City	Carlos Bradley, Ellington	28.00	17.17
			G. K. Goodwin, East Canaan	30.00	
				29.00	
19131	Bradley's Eclipse Phosphate	Am'n Agric. Chemical Co., New York City	Platt Bros., Milford	----	16.49
			C. H. Rounds, North Sterling	**28.00**	
			F. M. Cole, Putnam	28.00	
19039	Eldredge's Spl. Fish & Potash Fertilizer	(Made for) T. H. Eldredge, Norwich	Ackley & Burnham, East Hartford	**30.00**	17.63
19397	Chittenden's Sol. Bone and Potash	Nation'l Fertilizer Co., Bridgeport	F. W. Konold, Collinsville	**23.00**	13.49

Analyses and Valuations—*Continued.*

Station No.	Percentage difference between cost and valuation.	Nitrogen.					Phosphoric Acid.							Potash.		
		As Nitrates.	As Ammonia.	Organic.	Total Nitrogen.		Water-soluble.	Citrate-soluble.	Citrate-insoluble.	Total.		So-called "Available."		Found.		Guaranteed.
					Found.	Guaranteed.				Found.	Guaranteed.	Found.	Guaranteed.	As Muriate.	Total.	
19270	58.4	----	---	1.16	1.16	**0.8**	4.85	3.24	2.17	10.26	**9.0**	8.09	**8.0**	4.29	4.29	**4.0**
19335	62.8	----	0.59	1.35	1.94	**1.9**	5.01	3.80	1.23	10.04	**11.0**	8.81	**9.0**	2.24	2.24	**2.3**
19153	64.2	1.22	0.42	0.99	2.63	**2.5**	1.44	8.06	2.73	12.23	**12.0**	9.50	**10.0**	3.19	3.19	**2.5**
19295	65.6	0.81	0.30	1.05	2.16	**2.1**	3.08	1.22	0.84	5.14	**6.0**	4.30	**4.0**	6.17	6.17	**6.0**
19244	67.5	----	0.40	0.86	1.26	**0.8**	2.80	3.85	0.97	7.62	**10.0**	6.65	**9.0**	3.22	3.22	**2.0**
19376	67.7	----	---	1.66	1.66	**1.7**	7.17	2.22	1.04	10.43	**10.0**	9.39	**9.0**	2.11	2.11	**2.0**
19122	68.4	0.04	0.20	0.92	1.16	**0.8**	4.59	3.23	2.24	10.06	**9.0**	7.82	**8.0**	4.25	4.25	**4.0**
19248	68.9	----	0.12	1.12	1.24	**0.8**	4.80	3.48	2.27	10.55	**9.0**	8.28	**8.0**	3.90	3.90	**4.0**
19131	69.8	0.03	---	1.24	1.27	**1.0**	4.22	3.96	2.37	10.55	**9.0**	8.18	**8.0**	3.02	3.02	**2.0**
19039	70.1	----	0.13	1.59	1.72	**1.7**	3.04	3.27	2.39	8.70	**6.0**	6.31	**5.0**	4.37	4.37	**4.0**
19397	70.5	----	---	---	----	---	8.48	2.77	2.20	13.45	**12.0**	11.25	**11.0**	1.93	1.93	**2.0**

Nitrogenous Superphosphates.

Station No.	Name or Brand.	Manufacturer.	Dealer.	Dealer's cash price per ton.	Valuation per ton.
	Sampled by Station Agent:				
19271	Quinnipiac Climax Phosphate	Am'n Agric. Chemical Co., New York City	J. M. Burke, South Manchester	$29.00	$16.80
			H. A. Doyle & Co., Burnside	29.00	
19159	Bradley's Niagara Phosphate	Am'n Agric. Chemical Co., New York City	Wilson & Burr, Middletown	22.50	14.35
			F. M. Cole, Putnam	29.00	
				25.00	
19354	Bowker's Sure Crop Phosphate	Bowker Fertilizer Co., New York City	P. Schwartz, New London	**28.00**	16.00
19040	Eldredge's Special Superphosphate	(Made for) T. H. Eldredge, Norwich	Ackley & Burnham, East Hartford	**28.00**	15.96
19121*	Top Dresser	Buffalo Fertilizer Co., Buffalo, N. Y.	C. W. Lines Co., New Britain	35.00	22.62
			Ansonia Flour & Grain Co., Ansonia	41.00	
			J. P. Barstow, Norwich	43.00	
				39.75	
19166	Gloucester Fish and Potash	Bowker Fertilizer Co., New York City	Lightbourn & Pond Co., New Haven	24.00	14.12
			W. T. McKenzie, Yalesville	26.00	
				25.00	
19167	Bowker's Farm and Garden Phosphate	Bowker Fertilizer Co., New York City	W. T. McKenzie, Yalesville	32.00	16.92
			P. Schwartz, New London	29.00	
				30.50	
19309	Darling's General Fertilizer	Am'n Agric. Chemical Co., New York City	W. H. Hewins, R. D., New Hartford	**28.00**	15.37
19137	Berkshire Ammoniated Bone Phosphate	Berkshire Fertilizer Co., Bridgeport	Hotchkiss & Templeton, Waterbury	29.00	15.45
			Jacob Glover & Son, Staffordville	28.00	
			Johnson Bros., Jewett City	28.00	
				28.25	
19359	Essex A1 Superphosphate	Russia Cement Co., Gloucester, Mass.	W. J. Cox, East Hartford	**28.00**	15.10
19035*	Farmers' Choice	Buffalo Fertilizer Co., Buffalo, N. Y.	C. W. Lines Co., New Britain	30.00	13.44
			Lightbourn & Pond Co., New Haven	29.00	
			Ansonia Flour & Feed Co., Ansonia	24.00	
				27.75	

* See notes on pages 48 and 49.

Analyses and Valuations—*Continued.*

Station No.	Percentage difference between cost and valuation.	Nitrogen.					Phosphoric Acid.							Potash.		
					Total Nitrogen.					Total.		So-called "Available."		Found.		
		As Nitrates.	As Ammonia.	Organic.	Found.	Guaranteed.	Water-soluble.	Citrate-soluble.	Citrate-insoluble.	Found.	Guaranteed.	Found.	Guaranteed.	As Muriate.	Total.	Guaranteed.
19271	72.6	0.03	---	1.24	1.27	**1.0**	4.40	3.63	2.37	10.40	**9.0**	8.03	**8.0**	3.52	3.52	**2.0**
19159	74.2	0.06	---	1.20	1.26	**0.8**	4.00	3.47	2.46	9.93	**8.0**	7.47	**7.0**	1.31	1.31	**1.0**
19354	75.0	----	---	1.10	1.10	**0.8**	6.59	2.17	1.28	10.04	**10.0**	8.76	**9.0**	2.87	2.87	**2.0**
19040	75.4	----	---	1.13	1.13	**1.0**	4.43	4.21	3.01	11.65	**8.0**	8.64	**5.0**	2.25	2.25	**2.0**
19121	75.7	0.82	1.53	0.76	3.11	**5.7**	3.64	2.61	1.05	7.30	**7.0**	6.25	**6.0**	5.53	5.53	**5.0**
19166	77.1	0.06	0.31	0.80	1.17	**0.8**	5.84	1.83	1.36	9.03	**9.0**	7.67	**8.0**	1.76	1.76	**1.0**
19167	80.3	----	0.55	1.16	1.71	**1.7**	6.30	1.70	1.40	9.40	**9.0**	8.00	**8.0**	2.16	2.16	**2.0**
19309	82.2	0.08	0.36	0.74	1.18	**1.2**	5.82	1.88	1.54	9.24	**7.0**	7.70	**6.0**	3.12	3.12	**3.0**
19137	82.8	----	---	1.20	1.20	**0.8**	6.40	2.42	0.69	9.51	**10.0**	8.82	**8.0**	1.97	1.97	**2.0**
19359	85.4	----	---	1.13	1.13	**1.0**	1.25	4.95	6.41	12.61	**9.0**	6.20	**7.0**	2.59	2.59	**2.0**
19035	106.5	----	0.12	0.63	0.75	**0.8**	2.43	3.94	1.24	7.61	**9.0**	6.37	**8.0**	4.66	4.66	**5.0**

NITROGENOUS SUPERPHOSPHATES.

Station No.	Name or Brand.	Manufacturer.	Dealer.	Dealer's cash price per ton.	Valuation per ton.
	Sampled by purchasers and others.		*Sent by*		
18833	Bone, Fish and Potash	E. R. Kelsey, Branford	Manufacturer	$26.00	$26.01
18780	Mixed Goods, C. 3-9-8	(Made for) E. B. Clark Co., Milford	E. B. Clark Co., Milford	30.00	26.97
19223	High Grade Fertilizer	(Made for) Conn. Valley Orchard Co., Berlin	J. L. Watrous, R.F.D., Kensington	28.00	24.98
19368	Bone Phosphate	Ernest L. James, Warrenville	Manufacturer	30.00	26.76
18781	A 5-7-7	(Made for) E. B. Clark Co., Milford	E. B. Clark Co., Milford	34.00	30.03
18965	Market Garden Special	Armour Fertilizer Works, Baltimore, Md.	S. C. Goddard & Co., Branford	35.00	28.50
19041	Special Mixture	Sanderson Fertilizer & Chemical Co., New Haven	O. G. Beard, Shelton	38.00	28.51
18966	Ammoniated Bone and Potash	Armour Fertilizer Works, Baltimore, Md.	S. C. Goddard & Co., Branford	32.00	18.28

SPECIAL MANURES.

Here are included such mixed fertilizers, chiefly nitrogenous superphosphates containing potash, as are claimed by their manufacturers to be specially adapted to the needs of particular crops. Those which are claimed to contain potash in form of carbonate, tobacco specials, are separately considered on pages 102 to 107.

1. *Samples Drawn by Station Agent.*

In the table on pages 78 to 101 are 119 analyses of samples of this kind.

Analyses Requiring Special Notice.

18996, Wilcox's High Grade Tobacco Special, the analysis of which is given on pages 78 and 79, is stated by the manufacturer to contain both high-grade sulphate of potash and the double sul-

ANALYSES AND VALUATIONS—*Concluded.*

Station No.	Percentage difference between cost and valuation.	Nitrogen.					Phosphoric Acid.							Potash.		
		As Nitrates.	As Ammonia.	Organic.	Total Nitrogen.		Water-soluble.	Citrate-soluble.	Citrate-insoluble.	Total.		So-called "Available."		Found.		Guaranteed.
					Found.	Guaranteed.				Found.	Guaranteed.	Found.	Guaranteed.	As Muriate.	Total.	
18833	0.0	....	0.81	2.69	3.50	**2.5**	2.05	5.31	0.79	8.15	**5.0**	7.36	**4.0**	0.96	5.13	**4.0**
18780	11.2	0.90	0.10	1.95	2.95	**2.5**	5.04	3.33	1.16	9.53	**9.0**	8.37	....	7.99	7.99	**8.0**
19223	12.1	0.70	...	1.74	2.44	**2.5**	8.46	2.17	0.41	11.04	....	10.63	**9.0**	3.04	5.15	**4.0**
19368	12.1	....	...	2.46	2.46	**2.0**	2.56	9.28	4.10	15.94	**13.0**	11.84	**10.0**	4.85	4.85	**3.5**
18781	13.2	1.58	...	2.88	4.46	**4.1**	1.90	3.65	1.42	6.97	**7.0**	5.55	....	7.78	7.78	**7.0**
18965	22.8	1.36	0.20	1.47	3.03	**3.3**	7.86	2.25	0.43	10.54	**10.0**	10.11	**8.0**	7.86	7.86	**7.0**
19041	33.3	....	1.16	2.09	3.25	...	5.57	2.11	2.03	9.71	....	7.68	....	8.94	8.94	**10.0**
18966	75.0	....	0.70	1.64	2.34	**2.5**	4.83	2.11	1.21	8.15	**7.0**	6.94	**6.0**	2.24	2.24	**2.0**

phate, as well as carbonate of potash. The analysis shows no potash "calculated as carbonate," because the sulphuric acid introduced in the double sulphate is more than enough to combine with all the potash introduced as carbonate. The method of calculation is explained on page 103.

Regarding **19369**, Coe-Mortimer Co.'s Peruvian Tobacco Special, the analysis of which appears on pages 88 and 89, the manufacturers state that this brand should have nearly 2 per cent. of nitrate-nitrogen, instead of 0.94 as reported, and at least 9.50 per cent. of potash, instead of 8.34 per cent. as reported. The manufacturer protested that this analysis did not represent the average quality of this brand and requested that other samples be drawn and analyzed. Having assured ourselves that there was no error in the analysis of **19369**, another sample, **19649**, of the same brand was drawn and analyzed with the results given on pages 84 and 85. This second analysis shows 6.15 per cent. of nitrogen, where the first showed 5.47, and 9.90 per cent. of potash, where the first showed 8.34 per cent.

Regarding **19014**, Swift's Lowell Potato Phosphate, of which the analysis is given on pages 92 and 93, the manufacturers wrote that the goods shipped this spring should fully meet the guaranty of 2.46 per cent. of nitrogen and asked that other samples be drawn and analyzed. This was done and the analysis **19274**, given on pages 80 and 81, shows about one-half per cent. more of both nitrogen and potash than the first sample.

The same firm also expressed disappointment at the somewhat low potash content in No. **19145**, Potato Manure, an analysis of which appears on pages 96 and 97. It was not possible to get a second sample of this brand for analysis.

Owing to the dissatisfaction of the Buffalo Fertilizer Co. with the analysis of their Vegetable and Potato Fertilizer, **19149**, pages 94 and 95, a second sample, **19393**, was drawn by the director from stock of Edward White, Rockville, and partially analyzed.

It contained 0.23 per cent. more of nitrogen, 0.39 per cent. more of phosphoric acid and 0.42 per cent. less of potash than the other sample. Both samples were below the guaranty in all particulars.

In the same way a second sample was drawn of the Buffalo Fertilizer Co.'s Ideal Wheat and Corn from stock of Bishop & Lynes, Norwalk, the analysis of which, **19019**, is given on pages 96 and 97. The analysis of this second sample, **19391**, showed .08 per cent. less nitrogen, 0.22 less phosphoric acid and nearly 2.0 per cent. less potash than the first sample.

GUARANTIES.

Of the 119 samples whose analyses are given in the table, 39, just one-third of the whole number, failed to fully meet their guaranty. Seven failed in respect of nitrogen alone; 12 in respect of phosphoric acid, and 11 in respect of potash.

Eight were deficient in respect of two ingredients and one in all three.

In most cases these discrepancies are not large and a deficiency in one is accompanied with an excess of another.

Eight of these special manures however are so deficient that they do not render a full equivalent of the quantities of plant food which they are claimed to contain by the manufacturer.

The deficiency ranges in value from a fraction of a dollar to more than five dollars per ton.

The defective brands to which attention is called are the following:

19149. Buffalo Fertilizer Co.'s Vegetable and Potato Fertilizer (see note, page 76). Nitrogen found 2.14, guaranteed 2.48. Total phosphoric acid found 7.89, guaranteed 9.0. Available phosphoric acid found 6.73, guaranteed 8.0. Potash found 6.73, guaranteed 7.0.

19019. Buffalo Fertilizer Co.'s Ideal Wheat and Corn (see note, page 76). Nitrogen found 1.52, guaranteed 1.64. Total phosphoric acid found 7.59, guaranteed 10.0. "Available" phosphoric acid 6.48, guaranteed 9.0.

19139. Buffalo Fertilizer Co.'s Celery and Potato Special. Total phosphoric acid found 7.57, guaranteed 8.0. "Available" phosphoric acid found 6.26, guaranteed 8.0. Potash found 7.96, guaranteed 10.0.

18831. Buffalo Fertilizer Co.'s Vegetable and Potato Manure (see note, page 76). Nitrogen found 1.60, guaranteed 2.45. Total phosphoric acid found 5.82, guaranteed 9.0. "Available" phosphoric acid found 5.17, guaranteed 8.0.

19367. National Fertilizer Co.'s H. G. Special Tobacco Fertilizer. Nitrogen found 5.39, guaranteed 5.7. Potash found 9.51, guaranteed 10.0.

19188. Ohio Farmers Fertilizer Co.'s Potato and Tobacco Special. Nitrogen found 1.09, guaranteed 1.6. Potash found 3.10, guaranteed 4.0.

19378. Swift's Lowell Co.'s Special Vegetable Manure. Nitrogen found 3.06, guaranteed 3.3. Potash found 6.23, guaranteed 7.0.

Cost and Valuation.

The method of ascertaining the retail cash cost price of the special manures and of computing the valuation is the same as described on pages 50 and 51.

The average cost per ton of the one hundred and eighteen manures, the cost and valuation of which are given in the tables, was $34.48 per ton, the average valuation $25.42, and the percentage difference 35.8.

In 1906 the corresponding figures were: Cost $34.28; valuation $23.70; percentage difference 44.6.

The average composition and cost of special manures for the last five years, excluding those guaranteed to contain potash as carbonate, have been as follows:

Percentage Composition.

Year.	Nitrogen.	Total phosphoric acid.	Potash.	Cost per ton.	Percentage difference.
1904	2.92	8.56	5.92	$33.93	45.0
1905	2.93	10.38	6.13	33.99	41.8
1906	2.99	9.98	5.92	34.28	44.6
1907	3.09	9.63	5.92	34.48	35.8

Even a superficial examination of the tables of analyses shows a very wide range of prices and of content of plant food in these one hundred and nineteen brands. (Continued on page 102.)

Special Manures.

Station No.	Name or Brand.	Manufacturer.	Dealer.	Dealer's cash price per ton.	Valuation per ton.
	Sampled by Station Agent:				
18997	Shay's Potato Manure	C. M. Shay Fertilizer Co., Groton	Manufacturer	**$30.00**	$30.03
19332	Armour's Fruit and Root Crop Special	Armour Fertilizer Works, Baltimore, Md.	August Grulick, Meriden	**25.00**	24.55
18998	Shay's Corn Manure	C. M. Shay Fertilizer Co., Groton	Manufacturer	**26.00**	24.97
19362	High Grade Grass and Grain	Rogers Mfg. Co., Rockfall	R. E. Davis, Guilford	39.00	37.09
			Manufacturer	40.00	
				39.50	
19311	East India Potato Manure	American Agricultur'l Chemical Co., N. Y.	F. J. Hartz, R. F. D., South Manchester	**32.00**	29.81
18999	Shay's Grass Fertilizer	C. M. Shay Fertilizer Co., Groton	Manufacturer	**35.00**	32.00
19243	Buffalo Tobacco Producer	Buffalo Fertilizer Co., Buffalo, N. Y.	H. H. McKnight, Ellington	**36.00**	32.51
			John H. Atkins, Middletown	36.00	
19189	H. G. Soluble Tobacco Manure	Rogers Mfg. Co., Rockfall	N. H. Root, New Milford	45.00	39.67
			Arthur Sikes, Suffield	44.00	
			H. L. Drake, Windsor Locks	44.00	
				44.25	
19070	Hubbard's Oats and Top Dressing	Rogers & Hubbard Co., Middletown	H. W. Andrews, Wallingford	**52.00**	46.29
			R. H. Hall, East Hampton	53.00	
			H. H. McKnight, Ellington	51.00	
19360	Essex Special Tobacco Manure	Russia Cement Co., Gloucester, Mass.	J. B. Parker, Poquonock	45.00	39.25
			J. & H. Woodford, Avon	44.00	
				44.50	
19364	H. G. Complete Corn and Onion Manure	Rogers Mfg. Co., Rockfall	R. E. Davis, Guilford	34.00	30.77
			N. H. Root, New Milford	36.00	
				35.00	
18996*	H. G. Tobacco Special	Wilcox Fertilizer Works, Mystic	E. N. Austin, Suffield	**36.00**	31.32
19218	H. G. Oats and Top Dressing	Rogers Mfg. Co., Rockfall	R. E. Davis, Guilford	44.00	38.47
			Manufacturer	44.00	
			E. T. Griggs, Cromwell	45.00	
				44.25	

* See note on p. 74.

Analyses and Valuations.

Station No.	Percentage difference between cost and valuation.	Nitrogen.					Phosphoric Acid.							Potash.		
					Total Nitrogen.					Total.		So-called "Available."		Found.		
		As Nitrates.	As Ammonia.	Organic.	Found.	Guaranteed.	Water-soluble.	Citrate-soluble.	Citrate-insoluble.	Found.	Guaranteed.	Found.	Guaranteed.	As Muriate.	Total.	Guaranteed.
18997	*0.1	0.05	---	3.88	3.93	**4.0**	2.62	4.66	1.54	8.82	**8.0**	7.28	----	7.65	7.65	**6.0**
19332	1.8	---	---	2.69	2.69	**1.7**	7.50	1.73	0.29	9.52	**10.0**	9.23	**8.0**	5.10	5.10	**5.0**
18998	4.1	---	---	3.55	3.55	**2.5**	2.98	4.06	1.35	8.39	**8.0**	7.04	----	3.81	3.81	**4.0**
19362	6.5	0.13	---	3.07	3.20	**3.0**	0.02	11.76	7.54	19.32	**16.0**	11.78	----	12.23	12.23	**12.5**
19311	7.4	---	2.26	1.53	3.79	**3.3**	5.37	1.00	0.21	6.58	**7.0**	6.37	**6.0**	10.92	10.92	**10.0**
18999	9.4	0.65	---	3.49	4.14	**4.0**	4.38	4.92	2.01	11.31	**10.0**	9.30	----	5.80	6.54	**6.0**
19243	10.7	---	1.20	3.91	5.11	**4.5**	0.10	5.47	2.12	7.69	**6.0**	5.57	**5.0**	0.47	6.48	**5.5**
19189	10.9	0.47	1.26	3.64	5.37	**5.0**	1.41	5.94	1.50	8.85	**8.0**	7.35	**6.0**	0.41	11.30	**11.0**
19070	12.3	7.64	---	0.72	8.36	**8.5**	0.05	5.94	2.15	8.14	**8.0**	5.99	**3.9**	10.36	10.36	**8.0**
19360	13.4	1.93	---	2.70	4.63	**4.5**	3.74	2.82	3.55	10.11	**8.5**	6.56	----	0.74	13.45	**2.0**
19364	13.7	---	1.90	2.31	4.21	**3.6**	3.82	3.72	1.61	9.15	**8.0**	7.54	**6.0**	8.05	8.05	**7.0**
18996	14.9	0.98	---	2.62	3.60	**3.0**	---	8.68	3.91	12.59	**7.0**	8.68	**5.0**	0.52	7.66	**7.0**
19218	15.0	1.17	3.28	1.99	6.44	**6.3**	2.06	5.78	1.54	9.38	**9.0**	7.84	**7.0**	7.79	7.79	**7.5**

* Valuation exceeds cost.

Special Manures.

Station No.	Name or Brand.	Manufacturer.	Dealer.	Dealer's cash price per ton.	Valuation per ton.
	Sampled by Station Agent:				
19303	Hubbard's Grass and Grain Fertilizer	Rogers & Hubbard Co., Middletown	W. O. Goodsell, Bristol	$40.00	$34.59
			John Bransfield, Portland	41.00	
				40.50	
19274*	Swift's Lowell Potato Phosphate	Swift's Lowell Fertilizer Co., Boston, Mass.	G. S. Jennings, Southport	**30.00**	25.61
19017	Essex Complete Manure for Potatoes, Roots & Vegetables	Russia Cement Co., Gloucester, Mass.	W. J. Cox, East Hartford	39.00	34.16
			Spencer Bros., Suffield	41.00	
			J. B. Parker, Poquonock	41.00	
				40.30	
19069	Hubbard's Soluble Potato Manure	The Rogers & Hubbard Co., Middletown	Edgar T. Clark, Milford	42.00	34.48
			A. E. Kilbourn, East Hartford	42.00	
			H. H. McKnight, Ellington	39.00	
				41.00	
19046	Essex Grass and Top Dressing	Russia Cement Co., Gloucester, Mass.	W. J. Cox, East Hartford	43.00	36.45
			J. B. Parker, Poquonock	44.00	
				43.50	
19365	Hubbard's Soluble Tobacco Manure	The Rogers & Hubbard Co., Middletown	H. W. Andrews, Wallingford	46.00	38.94
			A. E. Kilbourn, East Hartford	47.00	
				46.50	
19381	Wilcox's Potato, Onion & Vegetable Manure	Wilcox Fertilizer Works, Mystic	E. N. Austin, Suffield	34.00	29.72
			Olds & Whipple, Hartford	37.00	
				35.50	
19385	Mapes' Seeding Down Manure	Mapes F. & P. G. Co., New York	Mapes' Branch, Hartford	**41.00**	34.23
19190	High Grade Tobacco Grower	Rogers Mfg. Co., Rockfall	G. W. Lucke, Granby	**39.00**	32.48
			L. H. Seymour, East Granby	39.00	
19367†	Chittenden's H. G. Special Tobacco Fertilizer	National Fertilizer Co., Bridgeport	J. N. Lasbury, Broad Brook	**44.00**	36.23
19348	Chittenden's Connecticut Valley Tobacco Starter	National Fertilizer Co., Bridgeport	L. O. Pomeroy, Suffield	**47.00**	38.61

* See note on page 76. † See note on page 77.

Analyses and Valuations—*Continued.*

Station No.	Percentage difference between cost and valuation.	Nitrogen. As Nitrates.	Nitrogen. As Ammonia.	Nitrogen. Organic.	Total Nitrogen. Found.	Total Nitrogen. Guaranteed.	Phosphoric Acid. Water-soluble.	Phosphoric Acid. Citrate-soluble.	Phosphoric Acid. Citrate-insoluble.	Total. Found.	Total. Guaranteed.	So-called "Available." Found.	So-called "Available." Guaranteed.	Potash. Found. As Muriate.	Potash. Found. Total.	Potash. Guaranteed.
19303	17.1	0.03	0.18	2.84	3.05	**2.2**	0.22	9.53	4.83	14.58	**16.0**	9.75	**6.6**	13.50	13.50	**12.0**
19274	17.1	---	---	2.58	2.58	**2.5**	5.10	3.98	1.95	11.03	**9.0**	9.08	**8.0**	6.55	6.55	**6.0**
19017	18.0	0.80	---	3.14	3.94	**3.7**	4.75	3.63	4.63	13.01	**9.0**	8.38	**7.0**	0.96	8.60	**8.5**
19069	18.9	2.63	0.25	1.99	4.87	**5.0**	0.82	8.51	3.62	12.95	**10.0**	9.33	**7.0**	1.69	6.03	**5.0**
19046	19.3	3.00	---	2.04	5.04	**5.0**	5.07	4.91	3.45	13.43	**10.0**	9.98	**8.0**	7.20	7.20	**8.0**
19365	19.4	2.35	0.22	2.15	4.72	**5.0**	0.69	9.15	2.49	12.33	**10.0**	9.84	**7.0**	0.92	10.86	**10.0**
19381	19.4	0.58	1.10	1.98	3.66	**3.3**	6.58	2.52	0.88	9.98	**8.0**	9.10	**7.0**	4.00	7.00	**6.0**
19385	19.8	2.51	0.20	0.47	3.18	**2.5**	0.11	11.96	5.94	18.01	**18.0**	12.07	----	10.66	10.66	**10.0**
19190	20.1	1.56	0.48	3.22	5.26	**5.0**	1.84	3.64	0.72	6.20	**5.0**	5.48	**4.0**	1.06	6.58	**6.0**
19367	21.4	--	2.50	2.89	5.39	**5.7**	4.54	1.69	0.81	7.04	**7.0**	6.23	**5.0**	1.75	9.51	**10.0**
19348	21.7	---	6.21	2.75	8.96	**8.2**	0.11	2.88	0.77	3.76	**3.0**	2.99	----	0.01	2.58	**2.5**

Special Manures.

Station No.	Name or Brand.	Manufacturer.	Dealer.	Dealer's cash price per ton.	Valuation per ton.
	Sampled by Station Agent:				
19361	Soluble Tobacco and Potato	Rogers Mfg. Co., Rockfall	R. E. Davis, Guilford	$39.00	$32.31
			Arthur Sikes, Suffield	40.00	
				39.50	
19301	O. & W. High Grade Potato Manure	Olds & Whipple, Hartford	Manufacturer	37.00	30.24
19068	O. & W. Home Mixture for Grass	Olds & Whipple, Hartford	Manufacturer	34.00	27.72
18994	Home Mixture for Corn and Potatoes	Olds & Whipple, Hartford	Manufacturer	32.00	25.77
19297	Potato Manure	Lister's Agricultural Chemical Works, Newark, N. J.	D. C. Burnham, Moodus	36.00	28.80
			J. C. Wilcoxson, Stratford	36.00	
19257	Wilcox's Grass Fertilizer	Wilcox Fertilizer Works, Mystic	Spencer Bros., Suffield	37.00	29.15
			E. N. Austin, Suffield	36.00	
				36.50	
19370	Stockbridge Tobacco Manure	Bowker Fertilizer Co., New York	J. J. Gilligan,* Windsor	47.00	37.54
19012	Essex Complete Manure for Corn, Grain and Grass	Russia Cement Co., Gloucester, Mass.	W. J. Cox, East Hartford	39.00	31.09
			J. B. Parker, Poquonock	39.00	
			W. O. Goodsell, Bristol	39.00	
19375	Swift-Sure Guano for Truck, Corn and Onions	M. L. Shoemaker & Co., Phila., Pa.	A. N. Clark, Milford	30.00	23.81
19339	Sanderson's Formula B	Sanderson Fertilizer & Chemical Co., New Haven	Jacob W. Bantle, Naubuc	34.00	26.71
			J. O. Griswold, Glastonbury	34.00	
			A. E. Phelps, Naubuc	34.00	
19374	Swift-Sure Superphosphate for Potatoes	M. L. Shoemaker & Co., Phila., Pa.	Loomis Bros. Co., Granby	36.00	28.29
19294	Berkshire Tobacco Special	Berkshire Fertilizer Co., Bridgeport	W. D. Wanzer, Lanesville	35.00	27.21
			James H. Stuart, Gaylordsville	34.50	
				34.75	
19256	Swift's Special Grass Mixture	Swift's Lowell Fertilizer Co., Boston, Mass.	Tanner & Wilcox, East Winsted	38.00	29.74
19013	Armour's High Grade Potato Fertilizer	Armour Fertilizer Works, Baltimore, Md.	Lightbourn & Pond Co., New Haven	33.00	26.20
			Brower & Malone, Norwalk	34.00	
				33.50	

* Purchaser.

Analyses and Valuations—*Continued.*

Station No.	Percentage difference between cost and valuation.	Nitrogen.					Phosphoric Acid.							Potash.		
					Total Nitrogen.					Total.		So called "Available."		Found.		
		As Nitrates.	As Ammonia.	Organic.	Found.	Guaranteed.	Water-soluble.	Citrate-soluble.	Citrate-insoluble.	Found.	Guaranteed.	Found.	Guaranteed.	As Muriate.	Total.	Guaranteed.
19361	22.3	---	1.20	2.63	3.83	3.5	2.46	5.24	1.51	9.21	9.0	7.70	7.0	0.58	9.64	8.8
19301	22.4	---	---	3.72	3.72	3.3	0.27	6.45	0.96	7.68	----	6.72	6.0	10.03	10.03	10.0
19068	22.7	0.48	---	3.39	3.87	3.3	0.03	6.55	1.25	7.83	----	6.58	6.0	6.60	6.60	6.0
18994	24.2	---	0.44	3.19	3.63	3.3	0.21	6.48	1.10	7.79	----	6.69	6.0	5.49	5.49	6.0
19297	25.0	1.00	0.34	2.02	3.36	3.3	6.24	3.02	0.76	10.02	9.0	9.26	8.0	7.49	7.49	7.0
19257	25.2	1.92	0.40	1.72	4.04	4.1	3.90	4.43	1.47	9.80	7.0	8.33	6.0	6.02	6.02	5.0
19370	25.2	1.16	0.13	4.43	5.72	5.8	2.86	1.57	0.61	5.04	6.0	4.43	4.0	1.25	10.31	10.0
19012	25.4	0.74	---	2.42	3.16	3.3	5.74	4.24	1.41	11.39	9.5	9.98	----	9.78	9.78	9.5
19375	26.0	0.68	---	1.44	2.12	1.7	5.78	4.13	1.97	11.88	----	9.91	8.0	6.00	6.00	5.0
19339	27.3	0.03	---	3.11	3.14	3.3	2.40	4.04	5.06	11.50	10.0	6.44	6.0	1.85	6.07	6.0
19374	27.3	0.88	---	1.86	2.74	2.7	7.26	2.64	0.62	10.52	----	9.90	8.0	8.84	8.84	7.0
19294	27.7	---	2.17	2.19	4.36	4.1	2.43	2.78	0.70	5.91	4.0	5.21	3.0	0.90	5.55	5.0
19256	27.8	0.71	---	3.29	4.00	4.1	3.79	4.46	2.01	10.26	8.0	8.25	7.0	5.90	5.90	6.0
19013	27.9	---	0.18	1.63	1.81	1.7	7.39	2.36	0.61	10.36	10.0	9.75	8.0	10.11	10.66	10.0

Special Manures.

Station No.	Name or Brand.	Manufacturer.	Dealer.	Dealer's cash price per ton.	Valuation per ton.
	Sampled by Station Agent:				
19193	Sanderson's Formula B for Tobacco	Sanderson Fertilizer and Chemical Co., New Haven	Manufacturer	$35.00	$26.53
			G. B. Ferris, New Milford	32.50	
			Loomis Bros. Co., Granby	35.00	
				34.25	
19649*	Peruvian Tobacco Fertilizer, Peruvian Guano Base	Coe-Mortimer Co., New York	L. A. Gowdy, R.F.D., Hazardville	**50.00**	38.70
19219	Tobacco Starter	Rogers Mfg. Co., Rockfall	Arthur Sikes, Suffield	34.00	27.01
			Manufacturer	**35.00**	
			E. T. Griggs, Cromwell	36.00	
19138	Berkshire Grass Special	Berkshire Fertilizer Co., Bridgeport	Hotchkiss & Templeton, Waterbury	40.00	26.89
			Jacob Glover & Son, Staffordville	38.00	
			H. T. Childs, Woodstock	32.00	
				35.00	
19192	Sanderson's Top Dressing for Grass and Grain	Sanderson Fertilizer & Chemical Co., New Haven	Manufacturer	38.00	28.93
			Loomis Bros. Co., Granby	37.00	
			R. H. Hall, East Hampton	38.00	
				37.75	
19241	Stockbridge Grass Top Dressing	Bowker Fertilizer Co., New York	Lightbourn & Pond Co., New Haven	40.00	29.79
			Bowker's Branch, Hartford	38.00	
				39.00	
19030	Mapes' Economical Potato Manure	Mapes F. & P. G. Co., New York	A. N. Clark, Milford	36.00	27.82
			Mapes' Branch, Hartford	36.00	
			Morse & Landon, Guilford	38.00	
				36.50	
19253	Chittenden's Complete Tobacco Fertilizer	National Fertilizer Co., Bridgeport	G. A. Williams, Silver Lane	**37.00**	28.07
			L. O. Pomeroy, Suffield	37.00	
19158	Mapes' Tobacco Starter, Improved	Mapes F. & P. G. Co., New York	Mapes' Branch, Hartford	36.00	27.63
			F. S. Bidwell & Co., Windsor Locks	37.00	
			F. M. Loomis, Windsor storehouse	----	
				36.50	

* See note on page 75.

Analyses and Valuations—*Continued.*

Station No.	Percentage difference between cost and valuation.	Nitrogen. As Nitrates.	Nitrogen. As Ammonia.	Nitrogen. Organic.	Total Nitrogen. Found.	Total Nitrogen. Guaranteed.	Phosphoric Acid. Water-soluble.	Phosphoric Acid. Citrate-soluble.	Phosphoric Acid. Citrate-insoluble.	Phosphoric Acid. Total. Found.	Phosphoric Acid. Total. Guaranteed.	So-called "Available." Found.	So-called "Available." Guaranteed.	Potash. Found. As Muriate.	Potash. Found. Total.	Potash. Guaranteed.
19193	29.1	0.30	0.85	2.51	3.66	**3.3**	3.84	3.06	2.23	9.13	**10.0**	6.90	**6.0**	1.79	4.94	**6.0**
19649	29.2	1.04	2.82	2.29	6.15	**6.0**	0.00	5.81	1.71	7.52	**7.0**	5.81	**6.0**	1.45	9.90	**9.5**
19219	29.6	0.75	0.53	2.95	4.23	**3.8**	0.50	5.49	3.50	9.49	**5.0**	5.99	**4.0**	0.47	3.50	**3.0**
19138	30.2	2.37	0.63	1.90	4.90	**5.0**	3.76	2.05	0.83	6.64	**5.0**	5.81	**4.0**	2.57	2.57	**2.0**
19192	30.5	0.69	1.22	2.13	4.04	**4.0**	5.17	2.14	0.60	7.91	**7.0**	7.31	**7.0**	7.10	7.10	**7.0**
19241	30.9	1.05	0.86	2.95	4.86	**4.9**	2.99	2.18	0.83	6.00	**6.0**	5.17	**4.0**	6.48	6.48	**6.0**
19030	31.2	2.55	0.18	0.83	3.56	**3.3**	0.94	4.89	1.31	7.14	**6.0**	5.83	**4.0**	1.25	8.68	**8.0**
19253	31.8	---	1.15	2.49	3.64	**3.3**	7.38	1.32	1.06	9.76	**10.0**	8.70	**8.0**	0.98	4.99	**5.0**
19158	32.1	3.64	---	1.14	4.78	**4.1**	0.42	7.10	1.72	9.24	**8.0**	7.52	**6.0**	0.94	2.13	**1.0**

Special Manures.

Station No.	Name or Brand.	Manufacturer.	Dealer.	Dealer's cash price per ton.	Valuation per ton.
	Sampled by Station Agent:				
19118	Corn King	Armour Fertilizer Works, Baltimore, Md.	S. V. Osborn, Branford	$32.00	$23.01
			O. H. Meeker, Danbury	30.00	
			W. B. Martin, Rockville	30.00	
				30.50	
19109	Hubbard's Potato Phosphate	The Rogers & Hubbard Co., Middletown	H. W. Andrews, Wallingford	32.00	22.96
			Edgar T. Clark, Milford	30.00	
			H. H. McKnight, Ellington	30.00	
				30.50	
19308	Bradley's Complete Top Dressing for Grass and Grain	American Agricultur'l Chemical Co., N. Y.	G. L. Dennis, Stafford Springs	**37.00**	27.82
19240	Stockbridge Special Corn Manure	Bowker Fertilizer Co., New York	A. R. Manning, Yantic	40.00	29.23
			Bowker's Branch, Hartford	38.00	
				39.00	
19015	Mapes' Potato Manure	Mapes F. & P. G. Co., New York	Mapes' Branch, Hartford	39.00	29.50
			A. N. Clark, Milford	40.00	
				39.50	
19031	Chittenden's Potato Phosphate	National Fertilizer Co., Bridgeport	G. A. Williams, Silver Lane	33.00	23.71
			G. W. Eaton, Plainville	33.00	
			D. L. Clark, Milford	29.00	
				31.75	
19352	Lister's Special Corn and Potato Fertilizer	Lister's Agricultural Chemical Works, Newark, N. J.	J. A. Foster, Staffordville	**29.00**	21.62
19247	Read's Vegetable and Vine Fertilizer	American Agricultur'l Chemical Co., N. Y.	G. K. Goodwin, East Canaan	**32.00**	23.82
19221	Wilcox's Potato Fertilizer	Wilcox Fertilizer Works, Mystic	Spencer Bros., Suffield	29.00	21.21
			Manufacturer	**28.50**	
			W. R. McDonald *	28.00	
19076	Bradley's Complete Manure for Potatoes and Vegetables	American Agricultur'l Chemical Co., N. Y.	Avery Bros., Norwich Town	38.00	28.04
			C. M. Beach, New Milford	38.00	
			G. L. Dennis. Stafford Springs	37.00	
				37.75	

* Cromwell.

Analyses and Valuations—*Continued.*

Station No.	Percentage difference between cost and valuation.	Nitrogen.					Phosphoric Acid.							Potash.		
					Total Nitrogen.					Total.		So-called "Available."		Found.		
		As Nitrates.	As Ammonia.	Organic.	Found.	Guaranteed.	Water-soluble.	Citrate-soluble.	Citrate-insoluble.	Found.	Guaranteed.	Found.	Guaranteed.	As Muriate.	Total.	Guaranteed.
19118	32.6	0.34	0.72	1.36	2.42	**2.5**	7.66	2.00	0.41	10.07	**9.0**	9.66	**8.0**	4.74	4.74	**4.0**
19109	32.8	0.98	---	0.95	1.93	**2.0**	6.59	4.37	0.63	11.59	**10.0**	10.96	**9.0**	5.48	5.48	**5.0**
19308	33.0	5.35	---	---	5.35	**5.0**	2.45	3.11	1.12	6.68	**6.0**	5.56	**5.0**	2.73	2.73	**2.5**
19240	33.4	0.03	1.83	1.56	3.42	**3.3**	7.57	2.70	1.03	11.30	**11.0**	10.27	**10.0**	6.94	6.94	**7.0**
19015	33.9	2.69	0.15	0.78	3.62	**3.7**	1.71	7.26	1.56	10.53	**8.0**	8.97	**8.0**	0.98	7.11	**6.0**
19031	33.9	0.20	0.14	1.89	2.23	**2.1**	6.62	2.26	1.55	10.43	**10.0**	8.88	**8.0**	6.42	6.42	**6.0**
19352	34.1	---	---	2.10	2.10	**1.7**	5.76	4.47	1.50	11.73	**9.0**	10.23	**8.0**	3.09	3.09	**3.0**
19247	34.3	---	0.12	2.20	2.32	**2.1**	6.86	1.97	1.12	9.95	**9.0**	8.83	**8.0**	6.23	6.23	**6.0**
19221	34.4	---	0.62	1.67	2.29	**2.1**	3.06	3.81	2.56	9.43	**7.0**	6.87	**6.0**	5.50	5.50	**4.5**
19076	34.6	0.90	0.60	1.80	3.30	**3.3**	6.11	2.81	1.49	10.41	**9.0**	8.92	**8.0**	7.05	7.05	**7.0**

Special Manures.

Station No.	Name or Brand.	Manufacturer.	Dealer.	Dealer's cash price per ton.	Valuation per ton.
	Sampled by Station Agent:				
19033	Complete Potato and Vegetable Fertilizer	Rogers Mfg. Co., Rockfall	Meeker Coal Co., Norwalk	**$32.00**	$23.76
			R. E. Davis, Guilford	31.00	
			M. B. Clark & Son, Milford	33.00	
19142	Special Potato	Parmenter & Polsey Fertilizer Co., Peabody, Mass.	J. R. Norton, Broad Brook	36.50	27.52
			A. Williams & Co., So. Woodstock	38.00	
			R. E. Hyde, Ellington	----	
				37.25	
19237	Quinnipiac Potato Manure	American Agricultur'l Chemical Co., N. Y.	C. Buckingham, Southport	30.00	22.46
			C. C. Pierce, Putnam	31.00	
				30.50	
19108	Stockbridge Potato & Vegetable Manure	Bowker Fertilizer Co., New York	E. B. Clark Co., Milford	36.00	28.49
			Lightbourn & Pond Co., New Haven	40.00	
			A. R. Manning, Yantic	40.00	
				38.75	
19162	Darling's Potato Manure	American Agricultur'l Chemical Co., N. Y.	A. D. Zabriski, R. F. D., Norwich	31.00	23.38
			B. F. Eddy, East Woodstock	33.00	
				32.00	
19347	New England H. G. Potato Fertilizer	New England Fertilizer Co., Boston, Mass.	B. F. Eddy, East Woodstock	**36.00**	26.20
19217	Tobacco Starter and Grower	American Agricultur'l Chemical Co., N. Y.	C. M. Beach, New Milford	36.00	25.95
			S. J. Stevens, Glastonbury	35.00	
			Wm. Bartman, East Haddam	36.00	
				35.75	
19164	Packers' Union Potato Manure	American Agricultur'l Chemical Co., N. Y.	F. L. Mackey, Ellington	33.00	23.15
			G. A. Forsyth, R. F. D., Waterford	31.00	
				32.00	
19331	Grain Grower	Armour Fertilizer Works, Baltimore, Md.	George La Bonne, Jr., Jewett City†	**27.00**	19.47
19369*	Coe's Peruvian Tobacco Fertilizer	Coe-Mortimer Co., New York	John DuBon, Poquonock	**50.00**	
			Ackley & Burnham, East Hartford	50.00	35.83

* See note on page 75. † Purchaser.

Analyses and Valuations—*Continued.*

Station No.	Percentage difference between cost and valuation.	Nitrogen: As Nitrates.	Nitrogen: As Ammonia.	Nitrogen: Organic.	Total Nitrogen: Found.	Total Nitrogen: Guaranteed.	Phosphoric Acid: Water-soluble.	Phosphoric Acid: Citrate-soluble.	Phosphoric Acid: Citrate-insoluble.	Total: Found.	Total: Guaranteed.	So-called "Available": Found.	So-called "Available": Guaranteed.	Potash Found: As Muriate.	Potash Found: Total.	Potash: Guaranteed.
19033	34.7	0.66	0.81	0.99	2.46	**2.3**	5.61	3.33	1.49	10.43	**10.0**	8.94	**8.0**	6.13	6.13	**5.0**
19142	35.4	---	0.73	2.48	3.21	**3.3**	6.03	2.36	0.69	9.08	**9.0**	8.39	**8.0**	7.48	7.48	**7.0**
19237	35.8	0.46	0.38	1.74	2.58	**2.5**	5.63	2.10	1.11	8.84	**7.0**	7.73	**6.0**	5.11	5.11	**5.0**
19108	36.0	---	1.28	2.05	3.33	**3.3**	4.88	1.62	0.83	7.33	**7.0**	6.50	**6.0**	10.50	10.50	**10.0**
19162	36.9	0.82	---	1.90	2.72	**2.5**	4.01	2.90	1.37	8.28	**7.0**	6.91	**6.0**	6.34	6.34	**5.0**
19347	37.4	---	---	2.54	2.54	**2.5**	5.14	4.54	2.88	12.56	**9.0**	9.68	**8.0**	6.36	6.36	**6.0**
19217	37.8	---	1.80	1.74	3.54	**3.3**	7.04	1.43	0.82	9.29	**9.0**	8.47	**8.0**	0.76	3.97	**4.0**
19164	38.2	0.64	---	1.59	2.23	**2.1**	6.43	2.58	1.66	10.67	**10.0**	9.01	**8.0**	5.70	5.70	**6.0**
19331	38.7	0.97	---	1.29	2.26	**1.7**	5.97	2.39	0.66	9.02	**10.0**	8.36	**8.0**	2.60	2.60	**2.0**
19369	39.5	0.94	2.25	2.28	5.47	**6.0**	0.81	5.65	2.81	9.27	**7.0**	6.46	**6.0**	1.61	8.34	**9.5**

Special Manures.

Station No.	Name or Brand.	Manufacturer.	Dealer.	Dealer's cash price per ton.	Valuation per ton.
	Sampled by Station Agent:				
19133	Quinnipiac Potato Phosphate	American Agricultur'l Chemical Co., N. Y.	G. M. Williams Co., New London	$30.00	$20.68
			C. Buckingham, Southport	27.00	
			Young Bros. Co.*	30.00	
				29.00	
19268	Crocker's Ammoniated Corn Phosphate	American Agricultur'l Chemical Co., N. Y.	F. M. Loomis, North Granby	----	20.59
			L. L. Loomis, Granby	**29.00**	
19117	Bowker's Early Potato Manure	Bowker Fertilizer Co., New York	Lightbourn & Pond Co., New Haven	38.00	26.87
			W. T. McKenzie, Yalesville	**38.00**	
19165	American Farmers' Complete Potato	Armour Fertilizer Works, Baltimore, Md.	W. B. Martin, Rockville	30.00	21.57
			S. V. Osborn, Branford	31.00	
				30.50	
19147	Bowker's Tobacco Starter	Bowker Fertilizer Co., New York	Warner & Hardin, Glastonbury	33.00	22.67
			F. R. Green, New Milford	32.00	
				32.50	
19016	Essex Tobacco Starter	Russia Cement Co., Gloucester, Mass.	W. J. Cox, East Hartford	34.00	23.85
			Spencer Bros., Suffield	35.00	
			J. B. Parker, Poquonock	34.00	
				34.25	
19036	Bradley's Potato Manure	American Agricultur'l Chemical Co., N. Y.	Spencer Bros., Suffield	34.00	23.38
			F. S. Bidwell & Co., Windsor Locks	34.00	
			Avery Bros., Norwich Town	33.00	
				33.75	
19236	Quinnipiac Corn Manure	American Agricultur'l Chemical Co., N. Y.	J. M. Burke, South Manchester	32.00	20.98
			C. C. Pierce, Putnam	29.00	
				30.50	
19074	Great Eastern Vegetable, Vine & Tobacco	American Agricultur'l Chemical Co., N. Y.	S. A. Post, Westbrook	**34.00**	23.18
			Elmer Keeler, Danbury	35.00	
			R. H. Hall, East Hampton	33.00	
19378†	Swift's Lowell Special Vegetable Manure	Swift's Lowell Fertilizer Co., Boston, Mass.	Spencer Bros., Suffield	**39.00**	26.55

* Danielson. † See note on page 77.

Analyses and Valuations—*Continued.*

		Nitrogen.					Phosphoric Acid.							Potash.		
					Total Nitrogen.					Total.		So-called "Available."		Found.		
Station No.	Percentage difference between cost and valuation.	As Nitrates.	As Ammonia.	Organic.	Found.	Guaranteed.	Water-soluble.	Citrate-soluble.	Citrate-insoluble.	Found.	Guaranteed.	Found.	Guaranteed.	As Muriate.	Total.	Guaranteed.
19133	40.2	0.31	0.28	1.66	2.25	**2.1**	6.08	2.67	1.45	10.20	**10.0**	8.75	**8.0**	3.15	3.15	**3.0**
19268	40.8	---	0.18	2.09	2.27	**2.1**	6.02	3.58	1.63	11.23	**9.0**	9.60	**8.0**	1.77	1.77	**1.5**
19117	41.4	0.33	0.73	2.16	3.22	**3.3**	5.60	2.68	1.23	9.51	**8.0**	8.28	**7.0**	6.74	6.74	**7.0**
19165	41.4	0.03	0.35	1.40	1.78	**1.7**	6.66	2.11	0.58	9.35	**8.0**	8.77	**7.0**	6.70	6.70	**6.0**
19147	43.4	---	0.50	2.00	2.50	**2.5**	5.60	3.55	1.40	10.55	**10.0**	9.15	**8.0**	1.75	3.62	**3.0**
19016	43.6	1.49	---	1.01	2.50	**2.5**	5.50	4.45	4.62	14.57	**12.0**	9.95	**9.0**	0.49	2.91	**2.5**
19036	44.4	0.20	0.50	2.02	2.72	**2.5**	5.15	2.24	1.40	8.79	**7.0**	7.39	**6.0**	5.74	5.74	**5.0**
19236	45.4	0.56	0.12	1.74	2.42	**2.1**	6.64	2.45	1.66	10.75	**10.0**	9.09	**8.0**	2.18	2.18	**1.5**
19074	46.7	0.49	---	1.62	2.11	**2.1**	6.72	2.22	1.40	10.34	**9.0**	8.94	**8.0**	6.41	6.41	**6.0**
19378	46.8	---	0.65	2.41	3.06	**3.3**	6.40	2.66	0.75	9.81	**9.0**	9.06	**8.0**	6.23	6.23	**7.0**

Special Manures.

Station No.	Name or Brand.	Manufacturer.	Dealer.	Dealer's cash price per ton.	Valuation per ton.
	Sampled by Station Agent:				
19188*	Potato and Tobacco Special	Ohio Farmers' Fertilizer Co., Columbus, Ohio	R. A. Sherman, Oneco	**$26.00**	$17.65
19018	Essex Market Garden and Potato Manure	Russia Cement Co., Gloucester, Mass.	W. J. Cox, East Hartford	34.00	23.48
			F. S. Bidwell & Co., Windsor Locks	36.00	
			J. B. Parker, Poquonock		
				35.00	
19014†	Swift's Lowell Potato Phosphate	Swift's Lowell Fertilizer Co., Boston, Mass.	C. W. Lines Co., New Britain	35.00	23.29
			Spencer Bros., Suffield	35.00	
			Weed & Turner, New Canaan	36.00	
				35.30	
19313	Packers' Union Animal Corn Fertilizer	American Agricultur'l Chemical Co., N. Y.	G. A. Forsyth, Waterford	32.00	22.08
			R. M. Fenn, Middlebury	35.00	
				33.50	
19078	Mapes' Corn Manure	Mapes F. & P. G. Co., New York	Mapes' Branch, Hartford	35.00	23.66
			Southington Lumber & Feed Co., Southington	37.00	
			W. C. Bulkley, Forestville	37.00	
				36.00	
19160	Crocker's Potato, Hop and Tobacco Fertilizer	American Agricultur'l Chemical Co., N. Y.	F. M. Loomis, Granby	**31.00**	20.19
			W. G. Wrisley, Windsor Storehouse	----	
19053	Northwestern 10 per cent. Potato Fertilizer	Northwestern Fertilizer Co., Chicago, Ill.	J. B. Parker, Poquonock	35.00	24.07
			C. M. Beach, New Milford	38.00	
			D. B. Wilson Co., Waterbury	38.00	
				37.00	
19132	Great Eastern Northern Corn Special	American Agricultur'l Chemical Co., N. Y.	S. A. Post, Westbrook	34.00	21.73
			R. H. Hall, East Hampton	33.00	
			A. Williams & Co., South Woodstock	----	
				33.50	
19049	Bradley's Potato Fertilizer	American Agricultur'l Chemical Co., N. Y.	J. B. Parker, Poquonock	33.00	20.56
			H. K. Brainard, Thompsonville	33.00	
			D. L. Clark, Milford	29.00	
				31.75	

* See note on page 77. † See note on page 76.

Analyses and Valuations—*Continued.*

Station No.	Percentage difference between cost and valuation.	Nitrogen. As Nitrates.	As Ammonia.	Organic.	Total Nitrogen. Found.	Guaranteed.	Phosphoric Acid. Water-soluble.	Citrate-soluble.	Citrate-insoluble.	Total. Found.	Guaranteed.	So-called "Available." Found.	Guaranteed.	Potash. Found. As Muriate.	Total.	Guaranteed.
19188	47.3	0.19	---	0.90	1.09	**1.6**	4.75	5.60	2.08	12.43	**10.0**	10.35	**8.0**	3.10	3.10	**4.0**
19018	49.1	0.46	---	1.71	2.17	**2.0**	4.16	4.95	4.25	13.36	**10.0**	9.11	----	5.24	5.24	**5.0**
19014	51.6	---	---	2.16	2.16	**2.5**	4.80	4.19	1.94	10.93	**9.0**	8.99	**8.0**	5.98	5.98	**6.0**
19313	51.7	0.35	---	2.06	2.41	**2.5**	6.98	3.03	1.52	11.53	**11.0**	10.01	**9.0**	2.37	2.37	**2.0**
19078	52.2	1.46	0.29	0.76	2.51	**2.5**	1.17	6.90	2.61	10.68	**10.0**	8.07	**8.0**	6.71	6.71	**6.0**
19160	53.5	0.18	0.54	1.47	2.19	**2.1**	6.39	2.27	1.33	9.99	**9.0**	8.66	**8.0**	3.11	3.11	**3.0**
19053	53.7	---	0.83	0.87	1.70	**1.7**	6.61	1.99	1.34	9.94	**9.0**	8.60	**8.0**	10.18	10.18	**10.0**
19132	54.2	0.75	---	1.67	2.42	**2.5**	6.88	2.63	1.66	11.17	**11.0**	9.51	**9.0**	2.58	2.58	**2.0**
19049	54.4	0.12	0.40	1.68	2.20	**2.1**	6.70	1.88	1.44	10.02	**9.0**	8.58	**8.0**	3.36	3.36	**3.0**

Special Manures.

Station No.	Name or Brand.	Manufacturer.	Dealer.	Dealer's cash price per ton.	Valuation per ton.
	Sampled by Station Agent:				
19149*	Buffalo Vegetable and Potato Fertilizer	Buffalo Fertilizer Co., Buffalo, N. Y.	C. W. Lines Co., New Britain	$35.00	$20.88
			F. C. Benjamin & Co., Danbury	30.00	
				32.50	
19123	Williams and Clark's Corn Phosphate	American Agricultur'l Chemical Co., N. Y.	Platt Bros., Milford	----	20.25
			George Beaumont, Wallingford	32.00	
			W. H. H. Chappel, Chesterfield	31.40	
				31.75	
19150	Coe's Celebrated Potato Fertilizer	Coe-Mortimer Co., New York	A. L. Burdick, Westbrook	30.00	18.49
			M. W. Stowe, Milford	28.00	
				29.00	
19071	Bowker's Potato and Vegetable Fertilizer	Bowker Fertilizer Co., New York	A. R. Manning, Yantic	36.00	21.97
			F. R. Green, New Milford	32.00	
			W. F. Andross, East Hartford	36.00	
				34.75	
19134	Williams and Clark's Potato Manure	American Agricultur'l Chemical Co., N. Y.	R. H. Hall, East Hampton	**32.00**	20.10
			J. G. Schwink, Meriden	----	
			Carlos Bradley, Ellington	32.00	
19249	Wheeler's Potato Manure	American Agricultur'l Chemical Co., N. Y.	W. Smith & Son., Canterbury	31.00	19.94
			R. I. Sanford, Oxford	32.00	
			J. R. Morgan, Bethel	32.00	
				31.75	
19152	Mapes' Fruit and Vine Manure	Mapes F. & P. G. Co., New York	Birdsey & Raven, Meriden	42.00	25.72
			Mapes' Branch, Hartford	40.00	
				41.00	
19073	Williams & Clark's Potato Phosphate	American Agricultur'l Chemical Co., N. Y.	Platt Bros., Milford	----	21.17
			D. B. Wilson Co., Waterbury	35.00	
			George Beaumont, Wallingford	34.00	
				34.50	
19255	Sanderson's Corn Superphosphate	Sanderson Fertilizer & Chemical Co., New Haven	H. P. Battey, New Britain	28.00	17.74
			C. D. Torrey, Putnam	30.00	
				29.00	

* See notes on pages 76 and 77.

Analyses and Valuations—*Continued.*

Station No.	Percentage difference between cost and valuation.	Nitrogen.					Phosphoric Acid.							Potash.		
					Total Nitrogen.					Total.		So-called "Available."		Found.		
		As Nitrates.	As Ammonia.	Organic.	Found.	Guaranteed.	Water-soluble.	Citrate-soluble.	Citrate-insoluble.	Found.	Guaranteed.	Found.	Guaranteed.	As Muriate.	Total.	Guaranteed.
19149	55.7	0.44	0.54	1.16	2.14	**2.5**	3.58	3.15	1.16	7.89	**9.0**	6.73	**8.0**	6.73	6.73	**7.0**
19123	56.8	0.13	0.34	1.91	2.38	**2.1**	6.40	2.39	1.64	10.43	**9.0**	8.79	**8.0**	1.81	1.81	**1.5**
19150	56.8	---	0.26	1.47	1.73	**1.7**	4.34	3.91	1.29	9.54	**10.0**	8.25	**8.0**	3.73	3.73	**4.0**
19071	58.2	0.31	0.90	1.37	2.58	**2.5**	6.49	1.72	1.15	9.36	**9.0**	8.21	**8.0**	4.18	4.18	**4.0**
19134	59.2	0.28	0.33	1.50	2.11	**2.1**	5.94	2.67	1.57	10.18	**9.0**	8.61	**8.0**	3.27	3.27	**3.0**
19249	59.2	---	0.72	1.40	2.12	**2.1**	6.45	2.12	1.29	9.86	**9.0**	8.57	**8.0**	3.29	3.29	**3.0**
19152	59.4	1.33	0.24	0.61	2.18	**1.7**	0.90	6.07	1.51	8.48	**7.0**	6.97	**5.0**	1.26	10.69	**10.0**
19073	63.0	---	0.27	2.09	2.36	**2.5**	4.80	2.11	0.88	7.79	**7.0**	6.91	**6.0**	5.41	5.41	**5.0**
19255	63.5	---	---	1.78	1.78	**1.6**	5.33	2.49	2.22	10.04	**10.0**	7.82	**7.0**	2.33	2.33	**2.0**

SPECIAL MANURES.

Station No.	Name or Brand.	Manufacturer.	Dealer.	Dealer's cash price per ton.	Valuation per ton.
	Sampled by Station Agent:				
19146	Bradley's Corn Phosphate	American Agricultur'l Chemical Co., N. Y.	F. S. Bidwell & Co., Windsor Locks	**$32.00**	$19.56
			Scofield & Miller, Stamford	32.00	
19019*	Buffalo Ideal Wheat and Corn	Buffalo Fertilizer Co., Buffalo, N. Y.	C. W. Lines Co., New Britain	32.00	18.01
			Ansonia Flour & Grain Co., Ansonia	28.00	
			Bishop & Lynes, Norwalk	28.50	
				29.50	
19135	Berkshire Potato and Vegetable Phosphate	Berkshire Fertilizer Co., Bridgeport	Patty Schwartz, New London	34.00	18.87
			Hotchkiss & Templeton, Waterbury	32.00	
			Johnson Bros., Jewett City	30.00	
				31.00	
19139†	Buffalo Celery and Potato Special	Buffalo Fertilizer Co., Buffalo, N. Y.	C. W. Lines Co., New Britain	35.00	19.57
			Ansonia Flour & Grain Co., Ansonia	32.00	
			H. H. McKnight, Ellington	30.00	
				32.25	
19126	New England Potato Fertilizer	New England Fertilizer Co., Boston, Mass.	Hitchcock Hardware Co., Watertown	33.00	18.79
			Rockville Milling Co., Rockville	30.00	
			A. R. Manning, Yantic	30.00	
				31.00	
19235	American Agl. Chem. Co.'s Grass & Lawn Top Dressing	American Agricultur'l Chemical Co., New York	G. M. Williams Co., New London	38.00	22.32
			F. M. Cole, Putnam	37.00	
				37.50	
19350	Lister's Special Tobacco Fertilizer	Lister's Agricultural Chemical Works, Newark, N. J.	William Sullivan, New Milford	**36.00**	21.28
19052	Sanderson's Potato Manure	Sanderson Fertilizer & Chemical Co., New Haven	Manufacturer	30.00	18.13
			G. W. Eaton, Plainville	33.00	
			E. A. Ives, Cheshire	29.00	
				30.75	
19145‡	Swift's Lowell Potato Manure	Swift's Lowell Fertilizer Co., Boston	C. W. Lines Co., New Britain	33.00	18.67
			F. S. Bidwell & Co., Windsor Locks	**32.00**	
			J. O. Fox & Co., Putnam	31.00	

* See notes on pages 76 and 77. † See note on page 77. ‡ See note on page 76.

ANALYSES AND VALUATIONS—*Continued.*

Station No.	Percentage difference between cost and valuation.	Nitrogen.					Phosphoric Acid.							Potash.		
					Total Nitrogen.					Total.		So-called "Available."		Found.		
		As Nitrates.	As Ammonia.	Organic.	Found.	Guaranteed.	Water-soluble.	Citrate-soluble.	Citrate-insoluble.	Found.	Guaranteed.	Found.	Guaranteed.	As Muriate.	Total.	Guaranteed.
19146	63.6	---	0.37	1.91	2.28	**2.1**	6.14	2.59	1.24	9.97	**9.0**	8.73	**8.0**	1.72	1.72	**1.5**
19019	63.8	---	0.61	0.91	1.52	**1.6**	3.10	3.38	1.11	7.59	**10.0**	6.48	**9.0**	6.54	6.54	**5.0**
19135	64.3	---	0.40	1.54	1.94	**1.7**	4.99	3.25	0.81	8.05	**8.0**	7.24	**6.0**	4.49	4.49	**4.0**
19139	64.8	0.22	0.53	0.89	1.64	**1.6**	3.23	3.03	1.31	7.57	**8.0**	6.26	**8.0**	7.96	7.96	**10.0**
19126	65.0	---	---	1.79	1.79	**1.6**	4.51	3.23	1.51	9.25	**8.0**	7.74	**7.0**	4.03	4.03	**4.0**
19235	68.0	3.78	---	0.08	3.86	**3.9**	2.02	3.64	1.25	6.91	**7.0**	5.66	**6.0**	2.59	2.59	**2.0**
19350	69.1	0.58	---	1.56	2.14	**2.1**	6.51	3.35	1.41	11.27	**10.0**	9.86	**8.0**	1.91	2.93	**3.0**
19052	69.6	0.04	---	1.56	1.60	**1.7**	3.70	2.14	1.20	7.04	**8.0**	5.84	**5.0**	6.44	6.44	**6.0**
19145	71.4	---	---	1.90	1.90	**1.6**	5.01	3.07	0.89	8.97	**8.0**	8.08	**7.0**	3.24	3.24	**4.0**

Special Manures.

Station No.	Name or Brand.	Manufacturer.	Dealer.	Dealer's cash price per ton.	Valuation per ton.
	Sampled by Station Agent:				
18831*	Buffalo Vegetable and Potato Manure	Buffalo Fertilizer Co., Buffalo, N. Y.	W. I. Munson,† Highwood	$30.50	$17.70
19105	Swift's Lowell Bone Fertilizer for Corn and Grain	Swift's Lowell Fertilizer Co., Boston	C. W. Lines Co., New Britain	32.00	18.19
			F. S. Bidwell & Co., Windsor Locks	31.00	
			Weed & Turner, New Canaan	32.00	
				31.75	
19044	Mapes' Cereal Brand	Mapes F. & P. G. Co., New York	A. N. Clark, Milford	**29.00**	16.50
			Mapes' Branch, Hartford	29.00	
19317	Wheeler's Corn Fertilizer	American Agricultur'l Chemical Co., N. Y.	J. N. Morgan, Bethel	**32.00**	18.00
19396	Am. Agl. Chem. Co.'s Grass and Oats Fertilizer	American Agricultur'l Chemical Co., New York	Thomas Richmond, New Milford	23.50	13.60
			Elmer Keeler, Danbury	----	
			J.H. Elliott, Campville	26.00	
				24.75	
19112	Bowker's Potato and Vegetable Phosphate	Bowker Fertilizer Co., New York	Patty Schwartz, New London	31.50	17.62
			S. C. Ingersoll, Stamford	32.00	
			W. F. Andross, East Hartford	33.00	
				32.25	
19680	P. & P. Potato Fertilizer	Parmenter & Polsey, Peabody, Mass.	A. Williams & Co , South Woodstock	----	
			T. J. Pring & Bro., Wallingford	**34.00**	18.43
19315	Read's Practical Potato Special	American Agricultur'l Chemical Co., New York	A. I. Martin, Wallingford	**30.00**	16.18
			C. W. Fulton, West Hartford	30.00	
19119	Swift's Lowell Empress Brand for Corn and Potatoes	Swift's Lowell Fertilizer Co., Boston	Southington Lumber and Feed Co., Southington	28.00	15.26
			Weed & Turner, New Canaan	29.00	
				28.50	
19334	Coe's New Englander Corn and Potato Fertilizer	Coe-Mortimer Co., New York	Wm E. Warner & Bro., Westville	29.00	14.71
			W. Smith & Son, Canterbury	**28.00**	
			F. U. Wadhams, Torrington	27.00	

* See note on page 77. † Purchaser.

Analyses and Valuations—*Continued.*

Station No.	Percentage difference between cost and valuation.	Nitrogen.					Phosphoric Acid.							Potash.		
		As Nitrates.	As Ammonia.	Organic.	Total Nitrogen.		Water-soluble.	Citrate-soluble.	Citrate-insoluble.	Total.		So-called "Available."		Found.		Guaranteed.
					Found.	Guaranteed.				Found.	Guaranteed.	Found.	Guaranteed.	As Muriate.	Total.	
18831	72.3	---	---	1.60	1.60	**2.5**	2.77	2.40	0.65	5.82	**9.0**	5.17	**8.0**	7.0	7.0	**7.0**
19105	74.5	---	---	1.74	1.74	**1.6**	5.77	2.38	1.16	9.31	**9.0**	8.15	**8.0**	3.16	3.16	**3.0**
19044	75.8	0.57	0.46	0.90	1.93	**1.7**	0.86	5.21	2.14	8.21	**8.0**	6.07	**6.0**	3.15	3.15	**3.0**
19317	77.8	---	---	1.80	1.80	**1.7**	6.94	1.85	1.01	9.80	**9.0**	8.79	**8.0**	1.89	1.89	**2.0**
19396	82.0	---	---	---	----	---	8.58	2.62	1.86	13.06	**12.0**	11.20	**11.0**	2.26	2.26	**2.0**
19112	83.0	---	0.36	1.22	1.58	**1.7**	6.88	2.35	0.94	10.17	**10.0**	9.23	**9.0**	2.33	2.33	**2.0**
19680	84.5	---	---	1.72	1.72	**1.7**	2.78	3.40	1.52	7.70	**7.0**	6.18	----	5.80	5.80	**6.0**
19315	85.4	---	---	1.06	1.06	**0.8**	3.44	1.43	0.69	5.56	**5.0**	4.87	**4.0**	8.02	8.02	**8.0**
19119	86.8	---	---	1.38	1.38	**1.2**	4.82	2.52	2.33	9.67	**8.0**	7.34	**7.0**	1.86	1.86	**2.0**
19334	90.3	0.09	---	1.00	1.09	**0.9**	4.08	3.22	0.94	8.24	**9.0**	7.30	**7.5**	3.44	3.44	**3.0**

SPECIAL MANURES.

Station No.	Name or Brand.	Manufacturer.	Dealer.	Dealer's cash price per ton.	Valuation per ton.
	Sampled by Station Agent:				
19128	New England Corn & Grain	New England Fertilizer Co., Boston, Mass.	Hitchcock Hardware Co., Watertown Rockville Milling Co., Rockville A. R. Manning, Yantic	$28.50 29.00 28.00	$14.91
19120	Bowker's Corn Phosphate	Bowker Fertilizer Co., New York	W. T. McKenzie, Yalesville A. R. Manning, Yantic J. P. Barstow, Norwich	33.00 34.00 34.00 **33.75**	17.52
19316	Wheeler's Bermuda Onion Grower	American Agricultur'l Chemical Co, N. Y.	R. I. Sanford, Oxford	**31.00**	16.00
19148	Bowker's Lawn and Garden Dressing	Bowker Fertilizer Co., New York	Lightbourn & Pond Co., New Haven Bowker's Branch, Hartford	55.00 **45.00**	23.08
19239	Wheeler's Havana Tobacco Grower	American Agricultur l Chemical Co., New York	F. M. Loomis, North Granby W. G. Wrisley, Winds'r	---- ----	29.22
	Sampled by purchasers and others:		*Sent by*		
19382	Olds & Whipple's Corn and Potato Fertilizer	Olds & Whipple, Hartford	Wm. H. Brewer, Silver Lane	32.00	29.16
18859	Rogers' H. G. Soluble Tobacco	Rogers Mfg. Co., Rockfall	D. A. Merriam, Granby	45.00	40.95
18991	Buffalo Tobacco Producer	Buffalo Fertilizer Co., Buffalo, N. Y.	H. H. McKnight, Ellington	36.00	31.17
18860	Rogers' H. G. Oats & Top Dressing	Rogers Mfg. Co., Rockfall	D. A. Merriam, Granby	45.00	38.95
18834	Sanderson's Formula B for Tobacco	Sanderson Fertilizer & Chemical Co., New Haven	Jesse M. Bahr, Warehouse Point	34.00	26.17
19225	Chittenden's Complete Tobacco Grower	National Fertilizer Co., Bridgeport	E. N. Austin, Suffield	37.00	28.17
19103	Tobacco Starter and Grower	American Agricultur'l Chemical Co., New York	Spencer Bros., Suffield	36.00	26.92
18992	Buffalo High Grade Fertilizer	Buffalo Fertilizer Co., Buffalo, N. Y.	H. H. McKnight, Ellington	34.50	25.08
18993	Buffalo Potato Special	Buffalo Fertilizer Co., Buffalo, N. Y.	H. H. McKnight, Ellington	30.50	20.35

ANALYSES AND VALUATIONS—*Concluded.*

Station No.	Percentage difference between cost and valuation.	Nitrogen.					Phosphoric Acid.							Potash.		
		As Nitrates.	As Ammonia.	Organic.	Total Nitrogen. Found.	Total Nitrogen. Guaranteed.	Water-soluble.	Citrate-soluble.	Citrate-insoluble.	Total. Found.	Total. Guaranteed.	So-called "Available." Found.	So-called "Available." Guaranteed	Found. As Muriate.	Found. Total.	Guaranteed.
19128	91.1	0.13	---	1.20	1.33	**1.2**	4.54	2.81	2.04	9.39	**8.0**	7.35	**7.0**	1.90	1.90	**2.0**
19120	92.6	---	0.42	1.38	1.80	**1.7**	6.08	2.17	1.36	9.61	**9.0**	8.25	**8.0**	2.14	2.14	**2.0**
19316	93.8	---	---	0.96	0.96	**0.8**	6.88	1.79	1.28	9.95	**9.0**	8.67	**8.0**	3.60	3.60	**4.0**
19148	95.0	0.56	0.74	1.98	3.28	**3.0**	3.46	2.05	0.78	6.29	**8.0**	5.51	**4.0**	5.50	5.50	**5.0**
19239	----	---	0.60	2.44	3.04	**2.5**	5.86	1.22	0.76	7.84	**7.0**	7.08	**6.0**	0.98	10.01	**10.0**
19382	9.7	0.37	---	3.41	3.78	**3.3**	0.32	6.18	2.88	9.38	----	6.50	**6.0**	1.20	6.96	**6.0**
18859	9.9	---	2.62	2.86	5.48	**5.0**	1.58	7.03	1.11	9.72	**8.0**	8.61	**6.0**	0.68	11.80	**11.0**
18991	15.5	---	1.05	4.12	5.17	**4.5**	0.10	4.91	2.12	7.13	**6.0**	5.01	**5.0**	0.15	5.25	**5.5**
18860	15.5	4.05	---	2.05	6.10	**6.3**	1.94	6.39	1.70	10.03	**9.0**	8.33	**7.0**	8.45	8.45	**7.5**
18834	29.9	0.69	0.14	2.53	3.36	**3.3**	2.51	3.84	2.99	9.34	**10.0**	6.35	**6.0**	1.88	5.87	**6.0**
19225	31.3	---	1.00	2.57	3.57	**3.3**	7.63	1.44	1.39	10.46	**7.0**	9.07	----	0.82	4.76	**6.0**
19103	33.7	---	---	3.35	3.35	**3.3**	7.60	1.35	0.86	9.81	**9.0**	8.95	**8.0**	0.92	4.16	**4.0**
18992	37.6	---	1.83	1.17	3.00	**3.3**	1.86	3.67	1.14	6.67	**7.0**	5.53	----	1.21	8.43	**10.0**
18993	49.9	0.55	---	0.98	1.53	**1.6**	4.02	2.11	1.94	8.07	**9.0**	6.13	**8.0**	8.93	8.93	**10.0**

There must, therefore, be a great difference between them in the relative economy of their purchase. This is brought out clearly by the following table, which shows how much plant food can be bought for the same money, $30.00, in several groups of these special manures.

PURCHASABLE FOR THIRTY DOLLARS.

	Nitrogen, pounds.	Phosphoric acid, pounds.	Potash, pounds.
In the first 11 samples in the table	73	162	143
" next 11 " " "	63	182	126
" " 13 " " "	65	138	119
" " 9 " " "	67	130	111
" " 9 " " "	58	163	92
" " 10 " " "	48	176	114
" " 10 " " "	49	184	80
" " 10 " " "	41	195	84
" " 8 " " "	39	179	82
" " 8 " " "	36	159	97
" " 10 " " "	42	185	75
" " 10 " " "	32	174	77

This table shows that for $30, the buyer of special manures, having the average composition of the ten brands at the beginning of the table, gets twice as much nitrogen and potash for his money and nearly as much phosphoric acid as the buyer who gets a special having about the composition of the last ten brands in the table. The former pays $7.00 per ton more for his fertilizer, but he gets, nevertheless, twice as much plant food for every dollar he spends as the latter gets. This table compared with the table of analyses, where the several brands are arranged in order of their percentage difference, also shows that as the percentage difference between cost and valuation increases, the probable economy in purchase decreases.

2. *Sampled by Purchasers and Others.*

In the table on pages 100 and 101 are nine analyses of special manures made on samples drawn by others than the Station Agent.

Special Tobacco Manures, claimed to contain potash, either wholly or in part in form of Carbonate.

In the table on pages 104 and 105 are given sixteen analyses of mixtures of this kind which require some special explanation, most of it repeated from former reports.

All of these mixtures are claimed to contain potash, largely in form of carbonate, and "available" phosphoric acid. The trade name "available phosphoric acid" has already been discussed on page 33 of this report. It should be added that in strongly alkaline mixtures like these special tobacco manures, from which the alkali cannot be removed by washing with water and which contain no considerable amount of water-soluble phosphates, the conditions prescribed for the use of the ammonium citrate cannot be maintained, and the term "available" phosphoric acid has no definite significance and is of no use in fixing the value of the fertilizer. It is a perfectly meaningless term as applied to such goods as these.

Regarding the guaranty of carbonate of potash, in many cases a chemical analysis cannot certainly prove or disprove the statement that potash is present in that form. The presence of sulphuric acid and chlorine, even in considerable amount, does not necessarily disprove the statement of the manufacturer that the potash in the mixture was introduced wholly as carbonate, for both sulphuric acid and chlorine may have come from other articles used in the mixture, such as acid phosphate, acid fish, plaster, or whatever else may have been employed along with carbonate of potash.

But the object of using carbonate of potash in tobacco fertilizers is to exclude both chlorides and sulphates. The reason for excluding them is the fear that the quality of the crop will be damaged by their presence.

Our experiments, as well as the experience of growers of tobacco in Connecticut, have also proved that some form of carbonate is one of the best sources from which to supply potash to the tobacco crop.

It is an expensive form of potash, but its use is rational, *if thereby sulphates and chlorides are excluded.* But it is quite irrational, because wasteful, to use the relatively expensive carbonate of potash in a mixed fertilizer and to introduce, at the same time, either sulphates or chlorides in other forms than in potash salts, for instance as acid fish, dissolved phosphate, or plaster, for there is no doubt that sulphates or chlorides may be equally harmful to the quality of the tobacco leaf, whether introduced into the fertilizer as potash salts or in other forms.

In making valuations for these fertilizers, potash sufficient to combine with the chlorine present is calculated as chloride;

Tobacco Fertilizers containing Carbonates.

Station No.	Name or Brand.	Manufacturer.	Dealer or Purchaser.
19184	Complete Tobacco Manure	Am. Agric. Chem. Co., N. Y. City	F. S. Bidwell & Co., Windsor Locks C. M. Beach, New Milford F. J. Hartz, R. D., South Manchester
19185	Bowker's Complete Alkaline Tobacco Grower	Bowker Fertilizer Co., N.Y. City	John Parker, Poquonock Bowker's Branch, Hartford Newell St. John, Simsbury J. R. Hayes & Son, No. Granby
19224	Bowker's Complete Alkaline Tobacco Grower	" " " " "	Seth Viets, W. Suffield, by E. N. Austin
19226	Bowker's Tobacco Ash Elements	" " " " "	Seth Viets,* West Suffield
19371	" " " "	" " " " "	" " " " Newell St. John, Simsbury
19373	Mapes' Tobacco Manure, Wrapper Brand	Mapes F. & P. G. Co., " "	Mapes' Branch, Hartford T. S Loomis, Windsor
19259	Mapes' Ash	" " " " " "	Spencer Bros., Suffield
19386	" Tobacco Ash Constituents	" " " " " "	" " " F. S. Bidwell & Co., Windsor Locks
19387	Chittenden's Tobacco Special with Carbonate	National Fertilizer Co., Bridgeport	J. & H. Woodford, Avon
19388	Chittenden's Conn. Valley Tobacco Grower	National Fertilizer Co., Bridgeport	L. O. Pomeroy, Suffield J. N. Lasbury, Broad Brook
18990	Chittenden's Conn. Valley Tobacco Grower	National Fertilizer Co., Bridgeport	C. D. Burbank, Suffield
19183	Chittenden's Conn. Valley Tobacco Grower	National Fertilizer Co., Bridgeport	" " "
19389	N. E. Perfect Tobacco Grower	New England Fertilizer Co., Boston	David May, Glastonbury Warner & Hardin, Glastonbury
19390	O. & W's. Complete Tobacco	Olds & Whipple, Hartford	Manufacturer
18928	" " "	" " "	Clark Brothers, Poquonock
19246	Swift's Lowell Perfect Tobacco Grower	Swift's Lowell Fertilizer Co., Boston	F. S. Bidwell & Co., Windsor Locks J. A. Warner, Tylerville Loomis Bros. Co., Granby

* Stock of Ernest N. Austin, Suffield.

potash sufficient to combine with all the sulphuric acid present is calculated as sulphate, and any excess of potash remaining is then calculated as carbonate. But we repeat that this is merely a calculation for making a valuation and that it does not necessarily conflict with the manufacturers' statements that a part or all of the potash was put into the mixture as high-grade carbonate.

Of the sixteen samples analyzed, ten fail to meet the guaranty of the manufacturer and in every case this failure is a deficiency of potash.

Three of the four samples of Tobacco Ash Elements or Constituents contain the guaranteed amount of potash in water-soluble

Analyses and Valuations.

		Nitrogen.				Phosphoric Acid.							Potash.						
Cost per ton.	Valuation.	As Nitrates.	Organic.	Total. Found.	Total. Guaranteed.	Water-soluble.	Citrate-soluble.	Citrate-insoluble.	Total. Found.	Total. Guaranteed.	So-called "Available." Found.	So-called "Available." Guaranteed.	Calculated as chloride.	Calculated as sulphate.	Calculated as carbonate.	Water-soluble.	Guaranteed.	Chlorine.	Sulphuric acid.
$37.00 37.00 35.00	$30.50	----	4.51	4.51	**4.6**	0.32	5.21	1.74	7.27	**4.0**	5.53	**3.0**	0.85	2.78	1.75	5.38	**5.5**	0.64	2.36
35.00 35.00 35.00 35.00	31.69	----	4.18	4.18	**4.0**	0.27	6.58	4.89	11.74	**5.0**	6.85	**4.0**	0.57	1.12	3.00	4.69	**5.0**	0.43	0.95
34.00	31.06	----	4.00	4.00	**4.0**	0.19	5.47	5.21	10.87	**5.0**	5.66	**4.0**	0.44	1.85	3.28	5.57	**5.0**	0.33	1.57
31.00	24.97	0.02	0.23	0.25	----	0.82	6.76	4.51	12.09	**7.0**	7. 8	**6.0**	1.10	14.32	------	15.42	**15.0**	0.83	15.55
33.00 32.00	22.86	----	0.14	0.14	----	0.46	6.26	4.67	11.39	**7.0**	6.72	**6.0**	0.40	13.99	------	14.39	**15.0**	0.30	----†
48.00 50.00	43.44	3.27	2.99	6.26	**6.2**	----	3.99	1.26	5.25	**4.5**	3.99	----	1.52	3.59	6.32	11.43	**10.5**	1.14	3.05
34.00	29.28	----	0.64	0.64	----	0.11	2.71	3.47	6.29	----	2.82	----	1.99	6.04	9.37	17.40	**15.0**	1.50	5.14
34.00 34.00	27.44	0.11	0.65	0.76	**0.5**	----	3.15	3.08	6.23	**5.7**	3.15	----	2.10	5.06	8.40	15.56	**15.0**	1.58	4.30
34.00	28.37	----	4.66	4.66	**4.6**	0.03	4.70	1.08	5.81	**4.0**	4.73	**3.0**	0.20	4.40	------	4.60	**5.5**	0.15	3.67
47.00 ------	33.45	----	4.80	4.80	**4.9**	0.32	3.50	0.45	4.27	**4.0**	3.82	----	0.20	0.49	5.91	6.60	**8.0**	0.15	0.42
48.00	35.53	----	4.85	4.85	**4.9**	0.10	5.07	1.23	6.40	**4.0**	5.17	----	0.32	1.18	5.65	7.15	**8.0**	0.24	1.00
48.00	35.40	----	4.92	4.92	**4.9**	0.22	5.48	0.44	6.14	**4.0**	5.70	....	0.20	0.95	5.49	6.64	**8.0**	0.15	0.81
38.00 38.00	29.98	0.69	3.33	4.02	**4.1**	5.44	2.24	1.68	9.36	**8.0**	7.68	**7.0**	1.10	4.71	------	5.81	**6.0**	0.83	17.00
35.00	32.56	0.54	4.80	5.34	**4.5**	0.14	3.68	1.26	5.08	**3.0**	3.82	**3.0**	0.90	1.39	2.98	5.27	**5.5**	0.68	1.18
35.00	31.38	0.38	4.68	5.06	**4.5**	0.11	3.41	0.73	4.25	**3.0**	3.52	**3.0**	1.03	1.65	2.99	5.67	**5.5**	0.77	1.40
41.00 36.00 40.00	30.09	0.80	3.44	4.24	**4.1**	3.81	4.34	1.66	9.81	**8.0**	8.15	**7.0**	0.51	4.22	------	4.73	**6.0**	0.38	10.52

† Not determined.

form, and the fourth contains nearly the guaranteed amount. Three brands which contain much organic matter also meet the guaranty, but the others do not.

The cause of some of these discrepancies is, no doubt, that manufacturers in many cases have based their guaranty on the total quantity of potash contained in the potash salts, in the ashes and in the various nitrogenous matters from which the mixtures are made; whereas, the station determines only the potash which is soluble in boiling water. Cotton hull ashes may contain from one to three per cent. of potash insoluble in water but soluble in strong acids. This acid-soluble potash is quite certainly less available to plants than the water-soluble part. It should not be regarded in a valuation.

Moreover, a part of the potash contained in vegetable matters, like cotton seed meal, is not dissolved by boiling in water, although it is generally assumed—though not proved by experiment as far as we know—that this water-insoluble potash becomes quickly available to crops. What difference there may be between the total and the water-soluble potash is shown by determinations made in six of the special tobacco manures tabulated above. This difference ranged from 0.11 per cent. to 0.87 per cent. and on the average was 0.53 per cent.

The methods of the Association of Official Agricultural Chemists, which are followed by this station and by all American stations which do fertilizer control work, recognize only the potash which becomes soluble on boiling with water for a half hour.

Manufacturers should make their guaranties cover only water-soluble forms.

The method of analysis in universal use takes account only of water-soluble potash. It is this which the buyer wants, and any

HOME MIXTURES. FORMULAS,

Station No.	Made by	Formulas. Pounds per Ton of							
		Nitrate of Soda.	Dried Blood.	Cotton Seed Meal.	Castor Pomace.	Dry Fish.	Tankage.	Bone.	Acid Phosphate.
18881	Joseph J. Smith, Farm Manager Insane Hospital, Middletown	---	---	----	---	600	---	1200	---
18883	P. P. Hickey, Burnside	---	---	607	773	---	221	----	---
18964	Nelson Fairman, Thompsonville	---	---	500	---	---	500	500	---
19010	For Grass, Chas M. Williams, Supt. Conn. School for Boys, Meriden	500	---	----	---	---	500	----	400
19011	For Potatoes and Vegetables, Supt. Chas. M. Williams, Conn. School for Boys, Meriden	100	---	----	---	---	750	----	750
19104	H. E. Clark, Middlebury	400	300	----	---	---	---	----	800
19258	C. H. Wells, Suffield	---	---	1150	---	250	---	250	---
19277	Dennis Fenn, Milford	300	---	----	---	---	800	100	---
19278	" " "	200	---	----	---	---	800	200	---
19340	For Peach Trees, C. L. Squires, Branford	---	---	----	---	---	---	381	762
19341	For Cauliflowers, C. L. Squires, Branford	203	---	----	---	---	758	----	810

other method of extraction includes the acid-soluble potash of ashes and of other forms inferior to ashes, which is certainly of very subordinate agricultural value.

HOME MIXTURES.

The home-mixing of fertilizers is not always and everywhere profitable. It cannot be undertaken at the last minute in the rush of spring work. It has little in its favor if the chemicals are to be bought of manufacturers of mixed fertilizers on credit. If the amount required is quite small the saving by mixing at home is relatively small. If the chemicals bought are in coarse lumps, needing considerable work to make them fine, this in itself will cut out a saving which might otherwise be made.

On the other hand, farmers who will and can pay cash for their goods and who use a good deal of commercial fertilizers, or who are willing to join with their neighbors in making a purchase, and will take the time to get quotations and study the quality of the goods offered, and prepare a contract which will ensure them against loss from low grade goods can, and unquestionably do, in

ANALYSES AND VALUATIONS.

Mixtures.						Analyses.									Cost (Unmixed) and Valuation	
Dissolved Bone Black.	High grade Sulphate of Potash.	Low grade Sulphate of Potash.	Muriate of Potash.	Kainit.	Plaster.	Nitrogen as Nitrates.	Nitrogen as Ammonia.	Nitrogen, Organic.	Total Nitrogen.	Water-soluble Phosphoric Acid.	Citrate-soluble Phosphoric Acid.	Citrate-insoluble Phosphoric Acid.	Total Phosphoric Acid.	Potash.	Cost per ton.	Valuation per ton.
---	---	---	200	---	---	---	---	4.08	4.08	0.42	12.83	4.76	18 01	5.53	-----	$35.30
---	399	---	---	---	---	---	---	5.74	5.74	0.22	1.76	0.13	2.11	9.72	$33.90	34.97
---	---	---	100	400	---	---	---	3.68	3.68	1.52	7.24	2.40	11.16	6.39	30.20	29.52
---	---	---	250	350	---	3.69	---	1.53	5.22	2.32	2.96	0.82	6.10	8.90	28.69	32.80
---	---	200	200	---	---	0.76	---	2.36	3.12	4.32	4.10	1.52	9.94	8.18	23.27	28.18
---	---	---	300	---	200	2.75	---	1.47	4.22	5.09	1.37	0.58	7.04	7.58	29.25	29.20
---	120	230	---	---	---	---	---	5.68	5.68	0.11	5.46	0.72	6.29	6.53	32.00	35.12
600	---	---	200	---	---	1.98	0.23	2.57	4.78	4.32	3.05	2.38	9.75	4.54	34.20	30.56
600	---	---	200	---	---	0.92	---	3.24	4.16	4.00	3.69	2.83	10.52	5 13	29.49	32.70
---	---	---	857	---	---	---	---	0.80	0.80	2.29	5.37	4.05	11.71	21.96	31.10	30.68
---	---	---	229	---	---	1.38	---	3.19	4.57	2.94	3.45	3.97	10.36	6.52	32.11	31.37

the present state of the fertilizer trade, save a good deal by buying fertilizer chemicals and mixing on the farm.

This is merely saying that the intelligent, foreseeing man, practicing business methods in his farming, has ways of saving money in the use of commercial fertilizers which are not open to the improvident and shiftless.

In the table on pages 106 and 107 are given the analyses of eleven of these home-mixtures, together with the formulas by which they were made, the cost per ton of the ingredients, *unmixed,* and the valuations.

Excepting **19340,** which is very unlike the others, or the general average of factory-mixed goods, in composition, the average composition of these home-mixtures is given below. To the cost of the materials is added $2.00 per ton for mixing. For comparison are given the corresponding data for the nitrogenous superphosphates and special manures.

	Home Mixtures.	Nitrogenous Superphosphates.		Special Manures.	
		Average.	First 15 in the Table.	Average.	First 11 in the Table.
Nitrogen	4.52	2.81	3.82	3.09	4.45
Phosphoric acid	9.12	9.66	9.63	9.63	9.81
Potash	6.90	5.04	6.34	5.92	8.72
Cost per ton	$29.31	$32.04	$31.08	$34.48	$36.29
Valuation per ton	31.97	23.80	27.57	25.42	33.36

VEGETABLE POTASH.

This material, sold by Olds & Whipple, Hartford, is understood to be the ashes of beet residues from the manufacture of beet sugar; **18820,** sampled and sent by L. H. Brewer, Hockanum; **19047,** sampled from stock of H. Ude, Suffield.

ANALYSES OF VEGETABLE ASH.

Station No.	18820	19047
Percentage amounts of		
Potash* calculated as muriate	2.03	2.10
Potash " " sulphate	5.34	4.92
Potash " " carbonate	18.37	17.84
Total potash	25.74	24.86
Chlorine	1.53	1.58
Sulphuric acid	4.54	4.18

Both samples substantially meet the guaranty of 25 per cent. of potash.

* See note regarding this calculation, p. 103.

COTTON HULL ASHES AND COTTON BOLL ASHES.

This material is the ashes of the hulls which are separated from the "meats" of the cotton seed preliminary to the expression of cotton seed oil. For a time these ashes were abundant in our market and were the most generally satisfactory potash fertilizer for tobacco ever offered in Connecticut.

The more extensive use of hulls in cattle feeding at the south, however, has greatly diminished the supply, and the quality of the several shipments this year has been very variable, as appears from the following analyses:

19229, 19066, 18764, 19096 and **19155** were from Humphreys, Godwin & Co., Memphis, Tenn.

19229. Sold by Spencer Bros., Suffield. Sampled and sent by E. N. Austin, Suffield.

19066. Sold by Spencer Bros. Sampled and sent by Arthur Sikes, Suffield.

18764. Sold by Spencer Bros. Sampled and sent by Bissell-Graves Co., Suffield.

19096. Sold by Arthur Sikes. Sampled and sent by Charles A. Prout, Suffield.

19060. Cotton Boll Ashes, American Cotton Oil Co., Memphis, Tenn. Sold by Spencer Bros. Sampled by station agent.

19087 and **19088.** Sold by Arthur Sikes, Suffield. Sampled and sent by him.

19155. Sold by Spencer Bros. Sampled and sent by H. E. Hastings, Suffield.

19089. Sold by Olds & Whipple, Hartford. Sampled and sent by Albert Epstein, Windsor Locks.

ANALYSES OF COTTON HULL AND COTTON BOLL ASHES.

Station No.	19229	19066	18764	19096	19060	19087	19088	19155	19089
Percentage amounts of									
Water soluble potash	28.74	26.82	22.25	17.40	18.49	17.08	16.70	17.26	15.18
Chlorine	0.07	0.07	0.19	.....	0.03	.....	.....	.....	0.11
Sulphuric acid	3.29	2.98	3.17	.....	2.02	.....	.....	.....	0.99
Charcoal	2.65	2.52	1.55	.....	2.41	.....	.....	.....	10.14
Sand	8.73	11.94	10.98	.....	19.61	.....	.....	.....	6.63
Cost per ton	$45.00	45.00	45.00	37.00	41.50	43.00	43.00	*	43.00
Potash costs cents per lb.	6.7	7.2	8.7	8.8	9.5	10.7	10.9	11.2	12.1

* $2.25 per unit, i.e. 20 lbs. of potash.

Valuing the three forms of phosphoric acid at 4½, 4 and 2 cents, respectively, the valuation of the phosphoric acid in a ton of cotton hull ashes will be, on the average, $6.30, as was explained in the report of this station for 1906, page 98. Deducting this from the cost price and dividing the remainder by the number of pounds of water-soluble potash in a ton gives the cost per pound of water-soluble potash, as shown in the last column of the table.

In the nine samples of cotton hull ashes analyzed this year the cost of water-soluble potash has ranged from 6.7 cents to 12.1 cents per pound, the average being 9.5 cents.

This is 2.2 cents per pound more than potash in form of high grade carbonate has cost, yet, as has been said before, no form of potash has given such general satisfaction to tobacco growers for a term of years.

CHARRED "COTTON HULLS."

In the spring of 1907 a number of carloads of so-called cotton hull ashes came into Connecticut, most if not all of them through the commission house of Humphreys, Godwin & Co., of Memphis, Tenn., and shipped from mills further south, with a guaranty of 18 to 20 per cent. water-soluble potash. When the first analysis was reported from this station showing between 10 and 11 per cent. of potash, protest was made by the seller. New samples were drawn and the analyses repeated. In the mean time, however, the commission merchants discovered that they had been defrauded by fake certificates of composition and made a satisfactory settlement with the dealers in Connecticut and they in turn with their customers. By the prompt analyses of these hulls more than $2,000 was saved to the buyers of these bogus hull ashes.

The samples analyzed were as follows:

19097, 18861, 18963. Sold by W. F. Fletcher, Southwick, Mass.

19097, sampled and sent by J. B. Cannon, **18861** by E. M. Griffin, and **18963** by R. W. Griffin, all of Granby.

18968, 18969, 19094 and **19095** were sold by Arthur Sikes, Suffield.

18968, sampled and sent by F. B. Hathaway, **18969** by G. S. Phelps, **19094** by Arthur Sikes, and **19095** by Chas. H. Prout, all of Suffield.

The lots named below were sold by Spencer Bros., Suffield:

18835, 18836. Sampled and sent by Timothy Conley.

18837 by Anthony Zucofski, **18895** by James Sullivan.

18896 by Spencer Brothers, **18897** by S. R. Spencer.

19197 by O. J. Hazard, and **18899** by Arthur Sikes, all of Suffield.

ANALYSES OF CHARRED "COTTON HULLS."

Station No.	Phosphoric Acid.	Water-soluble Potash.	Chlorine.	Sulphuric Acid.	Coal.	Sand.
19097	...	10.10	...	...	....	....
18861	9.77	10.04	0.11	1.32	16.20	15.50
18963	...	11.02	0.18	1.43	15.62	14.88
18968	9.70	9.74	...	...	....	....
18969	...	9.76	0.07	0.84	20.22	15.05
19094	...	10.16	...	...	....	....
19095	...	11.94	...	...	....	....
18835	...	10.60	...	...	....	....
18836	...	9.96	...	...	20.88	17.24
18837	...	11.46	...	...	....	....
18895	...	13.20	0.14	1.78	14.11	12.11
18896	...	12.72	...	...	....	....
18897	...	12.40	0.15	1.71	15.52	14.91
19197	...	13.48	...	...	....	....
18899	...	9.57	0.21	1.37	18.01	16.52

It may be doubted whether the material here analyzed came wholly from cotton hulls. No blame seems to attach either to the dealers or to the commission house. Both were imposed upon and in consequence put to great trouble and expense, and both made suitable concessions to the purchasers.

WOOD ASHES.

In the table are given twenty analyses of wood ashes, of which fifteen are sold as Canada ashes, two are of unknown origin and three are of domestic manufacture; two from brass mills and one from a smoke house.

The Canada wood ashes show a very wide range of composition, soluble potash ranging from 1.79 to 5.25, lime from 19.27 to 35.07 and sand from 5.52 to 28.87 per cent. The guaranties of the sellers amount to little. The ashes are ordinarily collected from door to door and their composition cannot be at all accurately fixed unless the whole bulk is screened, thoroughly mixed, sampled and examined, a work which could not be profitable.

WOOD ASHES.

PERCENTAGE COMPOSITION.

Station No.	Dealer or Purchaser.	Sampled or sent by	Total potash.	Water soluble potash.	Phosphoric acid.	Lime.	Magnesia.	Sand.	Charcoal.	Cost per ton.
	Bowker Fertilizer Co., N. Y. City:									
18864	Dennis B. Megin, Bethany	Purchaser	----	3.83	1.38	24.93	2.39	7.43	1.28	$ 9.75
18943	Lightbourn & Pond Co., New Haven	Station agent	----	1.79	1.02	22.91	5.65	27.90	4.85	18.00
19042	John E. Thompson, Warehouse Point	F. M. Thompson, Warehouse Point	----	4.46	1.65	28.11	----	10.68	3.00	10.00
19195	Newell St. John, Simsbury	Station agent	----	4.57	1.55	24.23	3.77	14.52	1.35	10.75
	John Joynt, Lucknow, Ontario:									
18707	J. H. Elwood, Greens Farms	Station agent	----	1.67	0.84	35.07	3.04	5.52	2.07	10.00
18738	Dr. J. L. Hetzel, Southport	Station agent	----	3.30	1.21	19.27	2.21	28.87	2.70	9.00
19024	W. B. Dayton, Southington	Purchaser	----	5.25	1.37	22.08	2.23	12 02	2.13	11.00
19059	H. K. Brainard, Thompsonville	Station agent	----	2.83	1.29	32.98	----	9.08	4.46	11.50
19196	W. A. Henry & Son, Wallingford	Station agent	----	3.17	1.06	23.65	2.42	17.22	2.43	11.75
19198	C. H. Eno, Simsbury	Purchaser	3.57	2.89	1.15	28.90	3.37	25.46	2 95	11.00
19400	H. K. Brainard, Thompsonville	Station agent	----	2.64	1.28	31.63	3.04	9.46	4.01	11.50
	F. R. Lalor, Dunnville, Canada:									
19001	Thomas Holt, Southington	Purchaser	----	4.94	1.55	25.31	2.07	13.65	1.27	----
	G. L. Munroe & Sons, Oswego, N. Y.:									
19025	P. H. Woodford, Avon	Purchaser	----	4.44	1.52	27.95	2.19	14.26	1.65	10.25
	George Stevens, Peterborough, Ont., Canada:									
18898	E. B. Marsh & Son, New Milford	Purchaser	----	5.22	1.54	34.93	2.51	8.50	1.43	11.50
19023	E. A. Wildman, New Milford	Purchaser	----	4.54	1.59	33.19	2.29	6.40	1.43	11.50
18799	Made by B. & B. City Brass Mills, Waterbury. Samuel Wilson, Wolcott	Purchaser	----	2.89	1.92	31.00	4.12	8.54	2.85	8.00
19168	Made by Torrington Brass Mills, James E. Perkins, Suffield	Purchaser	4.01	3.50	2.10	25.35	6.32	3.52	9.00	10.00
18796	Made by Sperry & Barnes, New Haven, C. M. Abbe, New Haven	Purchaser	----	6.76	1.69	34.95	6.72	4.73	0.22	----
19000	James E. Perkins, Suffield	Geo. S. Phelps, Suffield	----	3.62	2.10	31.48	3.91	9.79	6.50	10.00
18959	E. E. Burwell, New Haven	Purchaser	----	4.96	1.92	32.91	3.77	12.44	1.47	----

Three of the samples, **18943, 18738** and **19198,** contain more than one-quarter of their weight of sand, indicating gross carelessness or fraud somewhere. Most of the prices are for car lots.

The average percentage composition of the fifteen samples of Canada ashes is

Water-soluble potash	3.70
Phosphoric acid	1.30
Lime	27.67
Magnesia	2.86
Sand	14.06
Coal	2.47
Cost per ton	$10.72

If we value the water-soluble potash (as carbonate) at 7 1-2 cents and phosphoric acid at 4 cents, the lime in these ashes costs on an average about 74 cents per 100 pounds, considerably less than it has cost in agricultural lime. The lime of ashes is in form of carbonate finely divided and in excellent shape to correct soil acidity and furnish lime to crops without too quickly exhausting the soil humus.

The serious objection to the buying of ashes is the uncertainty as to their quality and the chance of having to pay $10 or $11 for an article more than one-quarter of which is sand.

LIME AND LIME-KILN ASHES.

Lime.

18308, **18942** and **19404** R. R. Agricultural Lime, made by the Rockland-Rockport Lime Co., Rockland, Me.

19404 was sampled from stock of Ackley & Burnham, East Hartford.

19280. Spong's Improved Fertilizer Lime B. B. brand. Walton Quarries, Harrisburg, Penn.

18777. Limestone from West Stockbridge, Mass.; **18778**, Limestone from Adams, Mass., both sent by Olds & Whipple, Hartford.

Lime-Kiln Ashes.

These are the ashes of wood used for burning limestone in the manufacture of quick-lime, which are unavoidably mixed with much lime in the kilns.

18862 and **18944** are from the New England Lime Co., Canaan; **18862**, sampled and sent by William H. Daly, Warehouse Point; **18944**, from stock of E. N. Austin, Suffield.

SHEEP MANURE.

This is understood to be dried manure from corrals and cattle pens and cars in which sheep have been confined. Four samples have been analyzed.

18304. Sold by the Pulverized Manure Co., Union Stock Yards, Chicago. Sampled and sent by Andrew Ure, Hamden.

18916. Sent by S. D. Woodruff & Sons, Orange.

19021. Sent by Edwin Hoyt, New Canaan.

19403. Sold by the Pulverized Manure Co., Chicago. Sampled from stock of Meeker Coal Co., Norwalk.

ANALYSES OF LIME, LIME STONE AND LIME-KILN ASHES.

	Lime.				Lime Stone.		Lime-Kiln Ashes.	
Station No.	18308	18942	19404	19280	18777	18778	18944	18862
Percentage amounts of								
Lime	59.18	68.76	64.78	49.79	31.21	54.38	33.87	41.10
Magnesia	1.14	...	0.74	3.57	16.77	0.29	...	...
Phosphoric Acid	...	...	...	...	...	...	0.91	1.20
Sulphuric Acid	...	...	...	0.71	...	...	...	...
Sand	1.44	...	...	...	...	...	...	...
Water-soluble Potash	...	...	...	...	...	...	1.73	2.75
Price per ton	...	...	$10.00	...	...	...	$7.00	$8.30
Lime costs cents per 100 pounds	...	...	0.77	...	...	...	103	101

ANALYSES OF SHEEP MANURE.

Percentage amounts of	18304	18916	19021	19403	Average of four Analyses.	Average of 38 Analyses "Barnyard Manure."*
Water	9.27	.....	.....	11.04	10.16	73.38
Organic and volatile matter	67.05	.....	.....	75.59	71.32	18.33
Mineral matter	23.68	.....	.....	13.37	18.52	8.29
Total	100.00			100.00	100.00	100.00
Nitrogen	2.22	2.55	2.30	2.30	2.34	0.42
Phosphoric acid	1.41	1.80	1.47	1.92	1.65	0.31
Potash	2.07	1.80	1.86	2.04	1.94	0.53
Insoluble matters	...	...	...	6.21	...	

The price quoted has been $30 to $32 per ton.

The question is asked, how does this material compare with yard manure?

The foregoing table gives the average composition of "barnyard manure." If such manure costs $1.00 per ton, or $2.50 per ton delivered on the field, and dried sheep manure costs $32.00, one can buy 12.8 tons of yard manure for the same money he pays for one ton of dry sheep manure.

For $32.00 one buys the following:

	In 12.8 Tons Yard Manure, pounds.	In 1 Ton Dry "Sheep Manure," pounds.
Organic matter (humus formers)	4,692	1,426
Nitrogen	107	47
Phosphoric acid	79	33
Potash	136	39

The only point of superiority of the sheep manure is its fine mechanical condition.

"SHREDDED MANURE."

A single sample of this material, No. **19692**, bought from Stock Yards and sent by Prof. C. S. Phelps, Chapinville, contained:

Water	10.80
Organic and volatile matters	68.75
Ash	20.45
	100.00
Nitrogen	1.55
Phosphoric acid	1.01
Potash	1.60

It contains rather less plant food and organic matter than the sheep manure.

* Mass. Ag'l Sta. Rept., 1905, p. 169.

GROUND TOBACCO STALKS.

18912. Sampled and sent by F. C. Latham, South Windsor, Conn. This sample contained 3.19 per cent. of nitrogen, 0.69 per cent. of phosphoric acid and 5.08 per cent. of potash.

"AMMONIATES."

A sample, **18315**, bearing this name and offered as a material for mixed fertilizers, contained 3.06 per cent. of nitrogen but appeared to be dry peat, the nitrogen of which is only very slowly available to crops and therefore worthless in a commercial fertilizer.

19630, a fertilizing material unnamed, contained 3.68 per cent. of nitrogen, 9.61 of phosphoric acid and 2.17 per cent. of potash.

It contained coarse fragments of bone, broken wooden skewers and stuff resembling wool waste. It is some kind of slaughter house or butcher's waste, of very moderate value as a fertilizer.

ASHES OF TOBACCO STALKS.

19234. Sent by W. E. Pinney, Suffield, who states that these ashes were made by burning tobacco stalks which had been spread on the land all winter and gathered and burned in the spring.

They contained:

Water-soluble potash	22.00 per cent.
Lime	17.08 "

The large amount of potash left in the weathered stalks is surprising. If such amounts of potash are commonly to be found in weathered stalks, it would be well to study the possibility and economy of burning them for the ashes. Whether their pronounced effect where spread on lawns through the winter is due largely to their action as a mulch or to the nitrogen in them is not certain, but the above single result if confirmed by other work would indicate that weathering does not extract the larger part of the potash.

RICE HULL ASHES.

18782. From Humphreys, Godwin & Co., Houston, Texas. Sent by the Loomis Bros. Co., Granby.

Total phosphoric acid	0.64
Potash soluble in water	1.16
Charcoal	14.34
Sand and silica	81.31

Obviously a worthless article agriculturally.

"GLUTEN MEAL."

19697. Sent by W. H. Burr, Wesport, who states that the sample came from a single bag of so-called gluten meal given him to try as a fertilizer.

The sample contained 11.16 per cent. of nitrogen, and consists of meat tissues mixed with some grain residues. It should be a good fertilizer, but the name "gluten meal" is a misnomer.

Gluten meal, a by-product from glucose manufacture, not at present on the market, contained about 5.9 per cent. of nitrogen.

TARTAR POMACE.

19645. This is supposed to be the ground press-cake from the manufacture of wine, containing the skins, seeds and expressed pulp of grapes, and has been used as a "filler" and "ammoniate" in mixed fertilizers. It contains:

Nitrogen	4.08 per cent.
Phosphoric acid	0.35 "
Water-soluble potash	0.05 "
Acid-soluble potash	0.10 "

SALT-WASTE AND SALTPETER WASTE.

Two samples of these wastes, probably by-products in the manufacture of saltpeter, sent by Andrew Kingsbury, Rockville, had the following composition:

	Saltpeter Waste. 18960	Salt Waste. 18800
Moisture	6.39	3.08
Nitrogen as nitrate	1.24	0.12
Nitrogen, organic	0.12	0.06
Water-soluble potash	35.56	2.87
Chlorine	41.95	57.90
Sulphuric acid	3.11	0.56
Insoluble in water	0.14	0.28

The saltpeter waste is a mixture of muriate of potash and common salt, with a small amount of nitrate. The nitrogen and potash in a ton of this waste, valued as in commercial fertilizers, are worth about $34.00.

The salt waste is of little more agricultural value than common salt.

"I. M. P. PLANT FOOD."

Made by the Eastern Chemical Co., 37 Pittsburg St., Boston. Stated to contain 13.0 per cent. of nitrogen, 25.3 per cent. of phosphoric acid and 24.6 per cent. of potash. A sample, **18788**, sent by A. A. Young, Jewett City, contained:

Nitrogen as nitrate	7.69
Nitrogen as ammonia	5.44
Total nitrogen	13.36
Phosphoric acid	25.89
Potash	25.32
Chlorine	none
Sulphuric acid	none

It fully meets the guaranty. Valuing the nitrate-nitrogen at 18½ cents, ammonia nitrogen at 17½ cents, phosphoric acid at 4½ cents and potash at 5½ cents, the valuation per ton is $98.65.

It contains essentially 55 per cent. of nitrate of potash (saltpeter) and 45 per cent. of phosphate of soda. Nitrate of potash costs at retail about 8 cents per pound and phosphate of soda 12 cents per pound.

While the same amount of fertilizer ingredients as are contained in a ton of this mixture could be got in forms commonly used as fertilizers for about $98.65, to buy them in concentrated forms, in pure chemicals, would cost about $196.

MARINE MUD.

19647. This material was pumped from a salt-water inlet where a channel for boats was being cut, and was used as filling on a marsh. The fill was about four feet deep and on draining and drying had shrunk, leaving cracks in the mud an inch or more wide and in places two feet deep.

ANALYSIS.

Water	43.73
Organic and volatile matter	4.59
Mineral matter	51.68
	100.00

Nitrogen	0.13
Chlorine	1.76
Equivalent salt	2.91

Experiments are in progress to determine whether this "soil" can be utilized for growing any kind of grass or other profitable crop.

"BONE BLACK."

A substance, improperly called bone black, No. **18917**, sent by a manufacturer of fertilizers, contained:

Nitrogen as ammonia	2.28
Nitrogen organic	4.26
Total nitrogen	6.54
Total phosphoric acid	0.17

MISCELLANEOUS ANALYSES OF LITTLE VALUE.

19642. From H. Ude, Suffield, used for waterproofing cement, contains 51.70 per cent. of mineral matter, of which 24.89 per cent. is lime. It also contains much magnesia.

18986. From Wm. Pinney, Suffield, an efflorescence on flower pots used in the greenhouses, contained 1.80 per cent. of nitrogen, chiefly in form of nitrates.

18715. From Andrew Ure, Highwood, smoke water from chimney flues, contained 0.12 per cent. of nitrogen and 1.65 per cent of acid as acetic acid.

PART II.

FOOD PRODUCTS.

The State Food and Drug Laws and the share of the Station in making them effective.

BY E. H. JENKINS.

A brief notice of the State laws regarding food products and of what has been already done in Connecticut to check adulteration and misbranding and to aid in the work of food examination throughout the country is appropriate at this time, when a national food law first comes into operation, supplementing State action, and when the State has changed its own law to conform with the act of the National Congress.

Such a review is also appropriate to the pages of a report of this station, because practically all that has been done in Connecticut in the examination of food products with reference to their purity has been done in the laboratory of this station, all prosecutions brought by the dairy commissioner under the law have been based on expert evidence supplied by the station, and in its reports from year to year have been given to the public, as far as the limited editions would permit, *all* the facts regarding both pure and adulterated food products which the station had in its possession. There are at present eighteen distinct state laws regulating the manufacture and sale of various articles of food, drink, confections, drugs and medicines, exclusive of six or more relating to water-supplies.

They are as follows:—

In the general statutes, Sanitary condition of bakeshops §2569; Sale or shipment of diseased flesh, including "bob veal," §1346; Penalty for selling milk of diseased cows, §2591; Adulteration of candy, §§1353 and 2568; Adulteration of sugar, §2581; Adulteration of beer, §§2582 and 2583; Adulteration of drugs, §4732; Analysis of food by health boards, §§2579 and 2580; Regarding imitation butter, §§2557 to 2562; Adulteration of molasses, §2563; Sale of impure vinegar forbidden, §§2564 and 2565; Regulating the manufacture and sale of food products, §§2573 to 2578.

In the volumes of public acts passed since 1901, Concerning the sale of renovated butter, Public Acts of 1903, Chap. 65; Concerning the sale of certain narcotic drugs, Public Acts of 1905, Chap. 127; Concerning the adulteration, inspection and sale of milk, Public Acts of 1907, Chap. 143; Concerning the powers and duties of the dairy commissioner, Public Acts of 1907, Chap. 137; Concerning the manufacture, sale, or transportation of adulterated, misbranded, poisonous or deleterious foods, drugs and liquors, Public Acts, 1907, Chap. 255. The last named act takes effect on January 1, 1908, and the two immediately preceding have been operative for only a few months.

While each of the other fifteen may have had some indirect moral effect, half of them have never, as far as our knowledge goes, been enforced, either because no one was specially directed to enforce them, or because no strong public sentiment called for enforcement.

The laws regarding vinegar, molasses and butter and the general food law in sections 2573 to 2578 have been executed because State officials have been required by law to attend to their execution. Their effects on the quality of food products offered for sale in Connecticut have been marked and beneficial.

The reports of the dairy commissioners of the State for twelve years note about two hundred convictions secured, all of them based on evidence supplied by this station.

The convicted persons had continued to sell certain food products after they had been officially told that the goods were adulterated, or had known of their fraudulent character in other ways.

This number of convictions is small but does not by any means indicate the number of prosecutions brought, because often the indicted persons settled out of court rather than to have the matter advertised by a trial.

In very many cases also the sellers of adulterated foods, who are often as ignorant as the buyer regarding the fact of the adulteration, having been informed and warned by the Commissioner, have promptly stopped selling the adulterated brands.

The most comprehensive and practical food law now in force is that in sections 2573 to 2578 of the General Statutes, passed in 1895, which charged this station with the duty of inspecting and testing food products and reporting the findings to the dairy commissioner, who is directed to bring prosecutions against violators of the law.

Under this act this station has examined—to Aug. 1, 1907—16,859 samples of food, of which about 1,050 were sent by private individuals, about 5,600 by the dairy commissioner and more than 10,200 were bought in market by the station agent.

Of these 10,000 samples over thirty per cent. were either adulterated or misbranded within the meaning of the law, or were found objectionable; that is, not of standard quality but not making the seller unquestionably liable under the law which can be strictly interpreted only by court decisions. The facts regarding all of them were, however, published in our reports.

The law above referred to renders liable only those who knowingly sell adulterated food. The fact of such knowledge must be established by the prosecution.

It has, therefore, been necessary to buy and examine samples of suspected articles, then to inform the sellers if these articles were found adulterated, and subsequently to buy other samples of these goods at the same place, which, if found adulterated, would be the basis of prosecution.

This cumbersome and expensive process, while amply protecting all dealers who were innocently handling adulterated goods, has made the work of enforcing the law slow and costly and doubles the work required of the station.

The amount yearly appropriated by the State, $2,500, is quite insufficient for any thorough enforcement of the law. The station has yearly spent on the work more than the State appropriation made for this specific purpose.

But the station has done a great deal more in the interest of pure food than the examination of the 16,000 or more samples above mentioned.

This was the first agricultural station in the country to be charged with food control work by the State legislature.*

* The Stations in Kentucky, 1898, in North Dakota and Wyoming, 1903, and in Maine, 1905, have since been charged with the same kind of work.

At the beginning of our work there was no generally accepted schedule of methods for testing for food adulterants. In our publications, therefore, our methods were at first described in full for the help of other analysts and for their criticism.

Some methods were modified and improved by investigations which are described in our reports, and formed the basis on which the methods now adopted by the Association of Official Chemists were founded. Chief among these are:—

Methods of Examining Carbonated Beverages, by Winton, Ogden and Mitchell, Rep. 1899, pp. 112-137.

Methods of Examining Vanilla Extract, by Winton and Silverman, Rep. 1901, pp. 149-162.

Methods of Examining Lemon Extract, by Winton and Ogden, Rep. 1901, pp. 163-174.

Methods of Examining Chocolate and other products of the Cocoa Bean, by Winton, Bailey and Silverman, Rep. 1903, pp. 123-145.

Extended series of analyses of several food products were made on authenticated samples to determine the possible range in their percentage composition, for the help of analysts in examining samples from the markets.

Among these are:—

The Chemical Composition of Authentic Samples of Spices and Spice Adulterants, by Winton, Ogden and Mitchell, Rep. 1898, pp. 184-217.

Effects of Roasting on the Chemical Composition of Cocoa Beans, by Winton, Silverman and Bailey, Rep. 1902, pp. 270-287.

The Composition of Acheen and Lampong Black Pepper, by Winton and Bailey, Rep. 1903, pp. 158-165.

The Composition of Diabetic Foods, by Winton, Rep. 1906, pp. 153-165.

Mention should also be made of a new form of micro-polariscope for food examination, described by Winton, Rep. 1900, pp. 195-198.

The most permanently valuable work, however, done in this connection has been that of Dr. Winton, chief of the chemical laboratory, in studies of the microscopic characters of a considerable number of seeds and other vegetable products, with reference to their detection in articles of food.

These studies, with original drawings, are as follows:—

Anatomy of Maize Cob with Special Reference to the Detection of Ground Cobs in Wheat or Rye Bran, Rep. 1900, pp. 186-195, figs. 9.

The Anatomy of the Fruit of the Cocoanut (Cocos nucifera), Rep. 1901, pp. 208-225, figs. 11.

The Anatomy of Edible Berries, Rep. 1902, pp. 288-325, figs. 36.

The Anatomy of the Fruits of Certain Cultivated Sorghums, Rep. 1902, pp. 326-338, figs. 8.

American Wheat Screenings, Rep. 1902, pp. 339-358, figs. 15.

The Anatomy and Microscopic Identification of the Fruits of Darnel and Chess, Rep. 1903, pp. 165-174, figs. 8.

The Anatomy of Certain Oil Seeds, with Especial Reference to the Microscopic Examination of Cattle Foods, Rep. 1903, pp. 175-198, figs. 18.

The Anatomy of the Peanut, with Special Reference to the Microscopic Identification in Food Products, Rep. 1904, pp. 191-198, figs. 6.

Reference should also be made here to the standard works, The Microscopy of Vegetable Foods, pp. 701, figs. 589, by Dr. A. L. Winton, chemist in charge of the analytical laboratory of this station, and Dr. Josef Moeller of the University of Gratz, and The Microscopy of Technical Products, pp. 471, figs. 276, by Dr. T. F. Hanausek, translated, with the addition of much new material, by Dr. A. L. Winton, chief chemist, with the collaboration of Dr. Kate G. Barber, microscopist of this station.

It may also be noted that the director of this station is one of the committee of five, appointed by the American Association of Official Agricultural Chemists and later commissioned by the United States Secretary of Agriculture, to establish standards of purity for food products, which have been approved and proclaimed by the United States Secretary of Agriculture, as he was authorized to do by Act of Congress, for use in the federal courts. These standards have also been adopted by the Association of State and National Dairy Departments.

It is a matter of deep regret to us that Dr. Winton, who has had charge of the laboratory work on foods in this state since the passage of the pure food law, and who has contributed so largely to its success, has left the station to take charge of the larger work of the United States Food and Drug Laboratory at Chicago.

Such is the record of work done under the previous food law. The station now begins its work under a new law, operative on and after January 1, 1908.

As required by law, the dairy commissioner and the director of this station have jointly prepared regulations for the enforcement of this law.

Both the law and the regulations may be had by applying to J. B. Noble, Dairy Commissioner, Hartford, Conn., or to the Connecticut Agricultural Station, New Haven, Conn.

Twelfth Report on Food Products.

(Examined during the year ending August 1, 1907.)

By A. L. Winton, Ph.D.

This station is required by law to make examinations of food products and to report to the dairy commissioner all cases of adulteration which are discovered. Under this law the sampling agent of the station has visited a considerable number of places and has bought a large number of samples which have been examined and reported to the dairy commissioner. An account of this work is given in the following pages.

The dairy commissioner and his deputy have sent a large number of samples of molasses, vinegar and butter, the sale of which is regulated by special statutes, as well as samples of other foods, which he is authorized to take under the food law. These are but briefly referred to in these pages, being discussed in his report, where account is also given of the results of prosecution under the law.

Lastly, a considerable number of samples of food products have been examined for individuals, which likewise receive brief mention here.

A large part of the chemical work has been done by Mr. Bailey, Miss Barber and Mr. Shanley; the microscopic examinations have been carried out by Miss Barber and myself.

BUCKWHEAT FLOUR.

This flour is prepared by grinding the whole grain and bolting, to remove as completely as possible the black outer hulls and the inner hulls, or bran. The presence of any other flour in appreciable amount constitutes an adulteration. The adulterants which have been most commonly employed are inferior wheat flour, or middlings, and corn flour. During the past year we have detected a new adulterant consisting of starchy matter, hairs, and bran fragments of oats. We have been unable to learn the source of this product, although it has been suggested that it may be the loose dust separated from rolled oats by bolting.

TABLE I.—ADULTERATED BUCKWHEAT FLOUR.

Station No.	Dealer.	Price per pound, cents.	Foreign Flour.
	Ansonia.		
18385	D. M. Welch & Son, 186 Main st.	5	Wheat.
	Bridgeport.		
18337	Logan Bros., 1705 Main st.	3	Wheat.
18340	Village Store Co., 1624 Main st.	3	Oat.
18338	Village Store Co., 244 State st.	3	Oat.
	Bristol.		
18423	C. H. Beaudoin, Laurel st.	4	Corn.
	Danbury.		
18399	Ehle's Cash Grocery, 7 West st.	4	Wheat.
	Derby.		
18387	New York Grocery, 217 Main st.	4	Wheat.
	Greenwich.		
18364	John L. Mahoney, 384 Greenwich ave.	4	Wheat.
	Hartford.		
18279	D. F. Burns, 304 Park st.	4	Corn.
18275	Hartford Public Market Co., Main & Mulberry sts.	4	Corn.
18262	P. S. Kennedy, 1046 Main st.	4	Wheat, oat.
18280	The Wadsworth Grocery, 100 Park st.	4	Wheat.
	Meriden.		
18252	Meriden Tea & Coffee Co., 77 E. Main st.	4	Wheat.
	Middletown.		
18469	Middletown Cash Grocery, 354 Main st.	4	Oat.
	New Haven.		
18360	S. S. Adams, 406 State st.	4	Wheat.
	Shelton.		
18388	Wray & Co., Howe ave.	4	Wheat.
	South Norwalk.		
18380	United Grocery Co., 20 N. Main st.	4	Wheat.
	Stamford.		
18370	H. L. Wood, 280 Main st.	5	Wheat.
	Torrington.		
18416	William Mulcunry, 16 S. Main st.	4	Wheat.
18418	Torrington Cash Grocery, 34 Water st.	4	Wheat,
	Waterbury.		
18406	W. N. Ladd, 428 N. Main st.	4	Wheat.
18405	Model Market Co., 72 E. Main st.	4	Oat.
18408	Spencer Pierpont Co., 352 E. Main st.	4	Wheat.
18407	Waterbury Market Co., 156 S. Main st.	5	Wheat.
	Willimantic.		
18461	C. R. Hibbard, 22 North st.	5	Wheat.
	Winsted.		
18421	King & Gay, 683 Main st.	4	Oat.

Examination of Samples.—Twenty-six of the 77 samples examined were adulterated. (Table I.) The foreign material in 17 samples was wheat flour or middlings, in three samples, corn flour, in five samples, an oat product, and in one sample, a mixture of wheat and oat products.

CATSUP AND CHILI SAUCE.

Catsup is the "clean sound product made from the properly prepared pulp of clean, sound, ripe tomatoes with spices and with or without sugar and vinegar."

Chili sauce is an unstrained product made from the same ingredients as catsup, with the addition of chopped peppers (chillies).

These products, when prepared with chemical preservatives and artificial colors, can be legally sold only in suitably labelled bottles. Formerly salicylic acid was used as a preservative, but at the present time benzoate of soda is almost exclusively employed for this purpose. The artificial colors commonly added are eosines, ponceaus, and others of coal-tar origin, also cochineal and lichen dyes.

Examination of Samples.—Two samples of catsup were found not to contain benzoic acid or artificial color, namely:—

18369. Hazard's Shrewsbury Tomato Ketchup, E. C. Hazard and Co., New York and Shrewsbury, N. J.

18427. Heinz's Tomato Ketchup, H. J. Heinz Co., Pittsburg, Pa.

Forty-one samples of catsup bore labels stating the presence of either benzoic acid or artificial color, or both, and were consequently legal compounds. (See Table II.) The remaining seven samples contained one or both of the above-named materials, which fact was not indicated on the label; they were therefore adulterated. (See Table III.)

The labels of six samples of chili sauce declared the presence of benzoic acid and the labels of two of them artificial color as well; these are, therefore, classed as compounds. Six other samples, not suitably labeled, contained benzoic acid; two were also artificially colored. (See Table III.)

Details with regard to the adulterated and compound samples of catsup and chili sauce are given in the tables.

TABLE II.—COMPOUND CATSUPS AND CHILI SAUCES.

Station No.	Brand.	Dealer.	Price per bottle, cents.	Indicated on Label. Color.	Indicated on Label. Preservative.
	Tomato Catsup.				
18391	A. F. Beckmann & Co., New York. Monarch Brand	*Derby:* N. Y. Grocery, 217 Main st.	10	*Natural	Benzoic acid.
18389	The Garret Bergen Co., Brooklyn, N. Y. Pride of Long Island	*Ansonia:* D. M. Welch & Son, 186 Main st.	10	Artificial	Benzoic acid.
18368	The Berwick Pres. Co., New York. New England Brand	*Greenwich:* Hunter & Latham, 54 Greenwich ave.	10	*Natural	Benzoic acid.
18332	The Berwick Pres. Co., New York. New England Home Made	*Bridgeport:* Coe & White, 1256 Main st.	10	*Natural	Benzoic acid.
18283	Blue Bell Preserve Co., New Haven, Conn. Blue Bell	*New Britain:* Wm. Foulds, 258 Park st.	10	Artificial	Benzoic acid.
18266	The Wm. Boardman Sons Co., Hartford, Conn. Star Brand	*Hartford:* Dow's Cash Grocery, 2 Church st.	10	*Natural	Benzoic acid.
18467	Chas. E. Brown & Co., Springfield, Mass. Climax Brand	*Rockville:* Ransom Bros., Market st.	20	*Natural	Benzoic acid.
18284	The F. C. Bushnell Co., New Haven and Waterbury, Conn. Magnes	*New Britain:* Miller & Olson, 75 Arch st.	10	Artificial	Benzoic acid.
18328	The Columbia Conserve Co., Indianapolis, Ind. Columbia	*Bridgeport:* Bridgeport Public Market, State st.	10	*Natural	Benzoic acid.
18351	Crescent Preserving Co., Camden, N. J. Surprise	*Bridgeport:* H. E. Bailey & Co., 857 Kossuth st.	10	*Natural	Benzoic acid.
18472	Curtice Bros. Co., Rochester, N. Y. Blue Label	*Middletown:* Middletown Cash Groc., 354 Main st.	25	*Natural	Benzoic acid.
18390	Lewis De Groff & Son, New York. Red Jacket	*Shelton:* Z. C. Beard, Howe ave.	10	*Natural	Benzoic acid.
18324	Edward D. Depew & Co., New York. Social Brand	*Bridgeport:* E. E. Wheeler, 1131 Main st.	10	*Natural	Benzoic acid.

* No artificial color found on examination.

TABLE II.—COMPOUND CATSUPS AND CHILI SAUCES—*Continued.*

Station No.	Brand.	Dealer.	Price per bottle, cents.	Indicated on Label. Color.	Indicated on Label. Preservative.
18256	The John T. Doyle Co., New Haven, Conn. Doyle's Country Club	*Meriden:* C. F. Cox, 26 E. Main st.	10	Artificial	Benzoic acid.
18412	R. N. Fitzgerald Co., Hartford, Conn. Bon Ton	*Waterbury:* Waterbury Market Co., 156 S. Main st.	10	*Natural	Benzoic acid.
18354	The Great Atl. & Pac. Tea Co. A. & P.	*Bridgeport:* The Great A. & P. Tea Co., 707 E. Main st.	10	*Natural	Benzoic acid.
18428	Chas. L. Hirsh & Co., New York. Crescent	*New Haven:* Logan Bros., 406 Congress ave.	5	Artificial	Benzoic acid.
18374	Hudson Preserving Co., New York. Lion	*Stamford:* R. T. Woodbury, 107 Pacific st.	10	*Natural	Benzoic acid.
18375	Wm. A. Leggett & Co., New York. Liberty	*Stamford:* I. L. Smallhorn, 235 Main st.	10	*Natural	Benzoic acid.
18254	Mansfield, Witham & Co., Lowell, Mass. Spindle City Brand	*Meriden:* Julius Augur, 23 Lewis ave.	10	Artificial	Benzoic acid.
18285	Jas. G. Powers & Co., New York. 20th Century	*New Britain:* T. C. Flynn, 590 Main st.	10	*Natural	Benzoic acid.
18413	Pressing & Orr Co., Pittsburg, Pa. Winorr	*Waterbury:* Dixon's Grocery, 332 N. Main st.	25	*Natural	Benzoic acid.
18373	E. Pritchard, New York. The Celebrated Pride of the Farm	*Stamford:* Empire State Tea Co., 24 Park Row	10	*Natural	Benzoic acid.
18352	The Pyle & Tomlinson Co., Bridgeport, Conn. Superior	*Bridgeport:* G. Englehardt, 587 E. Main st.	10	*Natural	Benzoic acid.
18327	Rafferty & Hosier, New York. Club House	*Bridgeport:* S. Newman, 1447 Main st.	10	*Natural	Benzoic acid.
18326	M. Schoenberg & Co., New York. The Celebrated White Label	*Bridgeport:* R. Wundrack, 1273 Main st.	10	Artificial	Benzoic acid.
18424	The Roger I. Sherman Co., Boston, Mass. Lawson Pint Brand	*Bristol:* L. G. Merich, Main and Prospect sts.	20	Artificial	Benzoic acid.
18331	A. P. Sichel & Co., New York. Apsco Jersey Ripe Tomato	*Bridgeport:* Logan Bros., 1705 Main st.	10	*Natural	Benzoic acid.
18414	Sprague, Warner & Co., Chicago. Richelieu	*Waterbury:* Model Market Co., 72 E. Main st.	15	*Natural	Benzoic acid.
18425	Standard Packing Co., Indianapolis, Ind. Berkshire	*Bristol:* South Side Cash Market, Main st.	10	*Natural	Benzoic acid.

* No artificial color found on examination.

TABLE II.—COMPOUND CATSUPS AND CHILI SAUCES.—*Concluded.*

Station No.	Brand.	Dealer.	Price per bottle cents.	Indicated on Label. Color.	Indicated on Label. Preservative.
18253	Stoddard, Gilbert & Co., New Haven, Conn. High Grade	*Meriden:* Joseph Ansell, 290 W. Main st.	10	Artificial	Benzoic acid.
18473	The Tip Top Ketchup Co., Cincinnati, O. Sunny Side	*Middletown:* Briggs & Walker, 234 Main st.	10	*Natural	Benzoic acid.
18362	Union Supply Co., New Haven, Waterbury, New Britain, Conn. Jewell	*New Haven:* Enterprise Specialty Co., 417 State st.	12	Artificial	Benzoic acid.
18441	The J. Weller Co., Cincinnati, O. Hoffman House	*New London:* W. H. Slocum, 93 Broad st.	10	*Natural	Benzoic acid.
18269	The West Virginia Pres. Co., Wheeling, W. Va. Nail City	*Hartford:* Brown, Thomson & Co., Main st.	10	Artificial	Benzoic acid.
18353	The West Virginia Pres. Co., Wheeling, W. Va. Parker House	*Bridgeport:* Village Store Co., 746 E. Main st.	10	Artificial	Benzoic acid.
18383	The Williams Bros. Co., Detroit, Mich. Wilcox Brand	*South Norwalk:* E. Wilcox, 74 Washington st.	10	*Natural	Benzoic acid.
18268	Wise, Smith & Co., Hartford, Conn. UN-X-LD	*Hartford:* Wise, Smith & Co., Main st.	13	*Natural	Benzoic acid.
18401	The Worcester Specialty Co., Worcester, Mass.	*Norwich:* The Mohican Co., 260 Main st.	10	Artificial	Benzoic acid.
18344	The Celebrated Bar Harbor Tomato Ketchup	*New Haven:* A. H. Waterbury, 250 Grand ave.	10	Artificial	Benzoic acid.
18255	Saratoga Tomato Catsup	*Meriden:* Meriden Tea & Coffee Co., 77 E. Main st.	10	Artificial	Benzoic acid.
	Chili Sauce.				
18419	Austin, Nichols & Co., New York. Sunbeam Brand	*Torrington:* Torrington Coöperative Co., 135 Main st.	25	*Natural	Benzoic acid.
18382	Columbia Conserve Co., Indianapolis, Ind. Columbia	*South Norwalk:* C. Becker & Son, 141 Washington st.	10	*Natural	Benzoic acid.
18443	Cruikshank Bros. Co., Allegheny, Pa. Cruikshank's Highest Grade	*Norwich:* C. W. Hill & Son, 147 Franklin st.	10	*Natural	Benzoic acid.
18415	Sprague, Warner & Co., Chicago. Richelieu	*Waterbury:* Model Market Co., 72 E. Main st.	20	*Natural	Benzoic acid.
18330	The West Virginia Pres. Co., Wheeling, W. Va. Fort Henry Brand	*Bridgeport:* Village Store Co., 244 State st.	9	Artificial	Benzoic acid.
18336	The Williams Bros. Co., Detroit, Mich. Waldorf	*Bridgeport:* H. Isenburg & Co., 50 Cannon st.	10	Cochineal	Benzoic acid.

* No artificial color found on examination.

TABLE III.—ADULTERATED CATSUPS AND CHILI SAUCES.

Station No.	Brand.	Dealer.	Price per bottle, cents.	Color.	Preservative.
	Tomato Catsup.				
18361	S. S. Adams, New Haven, Conn. Faultless Brand	*New Haven:* S. S. Adams, 406 State st.	10	Natural.	Benzoic acid.
18267	Blue Seal Packing Co., Red Bank, N. J.—New York. Blue Seal	*Hartford:* P. S. Kennedy, 1046 Main st.	5	Natural.	Benzoic acid.
18384	Joseph Campbell Preserve Co., Camden, N. J. Campbell's	*Norwalk:* F. D. Lawton, 47 Main st.	25	Artificial.	Benzoic acid.
18323	McMechen Preserving Co., Wheeling, W. Va. Old Virginia	*Bridgeport:* Village Store Co., 244 State st.	15	Natural.	Benzoic acid.
18402	The Standard Co., Hartford, Conn.	*Danbury:* Ehle's Cash Grocery, 7 West st.	10	Natural.	Benzoic acid.
18442	Van Camp Packing Co., Indianapolis, Ind. Van Camp's	*Norwich:* Russell & Capewell, 86 Franklin st.	20	Artificial.	Benzoic acid.
18429	Richard Zastrow, New Haven, Conn. Zastrow's Special Brand	*New Haven:* Wm. R. Bailey, 413 Congress ave.	10	Artificial.	Benzoic acid.
	Chili Sauce.				
18381	F. C. Gould, Silver Lane, E. Hartford, Conn. The Silver Lane Pickle Factory	*Norwalk:* Union Grocery Co., 10 Main st.	10	Artificial.	Benzoic acid.
18377	E. C. Hazard & Co., Shrewsbury, N. J. Shrewsbury	*Stamford:* G. A. Ferris, 446 Main st.	15	Natural.	Benzoic acid.
18458	Lutz & Schramm Co., Allegheny, Pa.	*Putnam:* J. E. Sullivan, 35 Main st.	15	Artificial.	Benzoic acid.
18366	E. Pritchard, New York. The Celebrated Pride of the Farm	*Greenwich:* John L. Mahoney, 384 Greenwich avenue	10	Natural.	Benzoic acid.
18397	The T. A. Snider Preserve Co., Cincinnati, O. Snider's	*New Milford:* C. I. Leach, Church st.	15	Natural.	Benzoic acid.
18376	259 Greenwich st., New York. Thompson's	*Stamford:* H. L. Wood, 280 Main st.	15	Natural.	Benzoic acid.

CHOCOLATE AND COCOA.

Cocoa nibs are roasted and broken cocoa beans freed from shells. When ground with or without removal of the germ, they yield a plastic mass which on cooling forms a solid cake known as plain chocolate.

Sweetened chocolate is plain chocolate mixed with sugar and usually with vanilla, spices, or other flavoring.

Cocoa differs from chocolate in that it has been deprived of a portion of the fat (cocoa butter) and has been finely pulverized.

The common adulterants of cocoa bean products are wheat flour, corn flour or starch, and potato flour. The removal of a portion of the fat from chocolate also constitutes an adulteration.

Examination of Samples.—Of eighteen samples of plain chocolate examined, fourteen were not found adulterated, the brands being as follows:

TABLE IV. BRANDS OF PLAIN CHOCOLATE NOT FOUND ADULTERATED.

17738. Justice Brand Chocolate Premium No. 1. Wm. H. Baker, Syracuse, Inc., New York.

17286 and 17421. W. H. Baker's Chocolate Premium No. 1. Fleur de lis. W. H. Baker, Winchester, Va.

17935. Purity Chocolate Premium No. 1. Boston Tea and Coffee Co., South Norwalk, Conn.

17484. Genuine Swiss Milk Chocolate. F. L. Cailler, Vevey.

17331. No. 1 Premium Howco Chocolate. Howland's, Bridgeport, Conn.

17332. White Lily Premium Plain Chocolate. H. Isenberg & Co., Bridgeport, Conn., and Springfield, Mass.

17439. Mohican Plain Premium Chocolate. The Mohican Co., New York.

17420. Powell's New York Premium Chocolate.

17815. Rockwood & Co.'s Chocolate (Premium Chocolate). Rockwood & Co., New York.

17570. Runkel's Premium Baking Chocolate. Runkel Bros., New York.

17350. Unsweetened Stollwerck Chocolate.

17387. Best Premium Plain Chocolate, Jewell Brand, Union Supply Co., New Haven and Waterbury, Conn.

17385. Premium Brand Chocolate, Premium No. 1. M. T. Co.

Four plain chocolates were adulterated; two containing potato starch and two being cocoa sold under the name of chocolate. One of these also contained corn starch.

SWEET CHOCOLATE NOT FOUND ADULTERATED.

Three brands of sweet chocolate were not found adulterated, namely:

17311. Sweet Chocolate, Best. Fleur de lis. W. H. Baker, Winchester, Va., and New York City.

17270. Lowney's Sweet Chocolate Powder.

17440. Powell's Vanilla Chocolate. Alex. M. Powell, New York City.

Four brands of sweet chocolate were adulterated with a wheat product.

COMPOUND CHOCOLATE.

17760. Collins' Chocoloet Powder. The Health Supply Co., New Haven, Conn.

COCOA.

Examination was made of 43 samples of cocoa. Of these three were adulterated with a wheat product and one with a corn (maize) product.

The brands of cocoa not found adulterated are given in Table V.

TABLE V.—COCOA NOT FOUND ADULTERATED.

Station No.	Brand.
17356	C. Andresen & Co., New York. Excelsior Brand.
17309	W. H. Baker, Winchester, Va. Best Cocoa, Fleur de lis.
17355	A. F. Beckmann & Co., New York. Beckmann's Best.
17534	Bennett, Sloan & Co., New York. Princess.
17287	The Wm. Boardman & Sons Co., Hartford, Conn. Boardman's Gold Star.
17936	Boston Tea and Coffee Co., So. Norwalk, Conn. Purity Brand.
17609	Brewster Cocoa Mfg. Co., Jersey City, N. J. Royal.
17859	" " " " " " Savoy.
17417	Brownell & Field Co., Providence, R. I. Autocrat.
17467	Cloverdale Creamery Co., Boston, Mass. Cloverdale Extra Quality.
17676	Croft & Allen, Philadelphia, Pa. Croft's Breakfast.
17308	" " " " " "
17675	Danbury Grocery Co., Danbury, Conn. Challenge Brand.
17625	Lewis De Groff & Son, New York. Health Brand.
17798	M. C. Dingwall, New Haven, Conn. Pure.
17383	The Great Atlantic and Pacific Tea Co. Grandmother's A. and P.
17610	" " " " A. and P. Lunch.
17418	Hooton Cocoa and Chocolate Co., Newark, N. J. Hooton's Amazon.
17330	Howland's, Bridgeport, Conn. Howland's Hasty Lunch.
17328	H. Isenberg & Co., Springfield, Mass. White Lily.
17358	Knickerbocker Chocolate Co., New York. Blue Ribbon.
17723	Francis H. Leggett & Co., New York. Nabob.
17533	Middletown Cash Grocery Co., Middletown, Conn. Gold Medal.
17627	W. Nelson & Co., Philadelphia, Pa. Nelson's.
17310	N. J. Chocolate Works, Jersey City, N. J. Best Lunch.
17419	Alex. M. Powell, New York. Powell's.
17612	Jas. G. Powers & Co., New York. Red Shield.
17994	Puritan Pure Food Co., New York. Manilla.
17672	Rockwood & Co., New York. Golden Lion Brand.
17357	" " " Semper Idem.
17496	T. R. Sadd Co., Willimantic, Conn. Sadd's.
17359	Stollwerck Bros., New York and Chicago. Milk.
17329	" " " " Stollwerck.
17922	The Union Pacific Tea Co., New York. Pure Sovereign.
17497	Up to Date Cocoa Co., Newburgh, N. Y. Up to Date.
17495	R. C. Williams & Co., New York. The Famous Royal Scarlet Brand.
17384	Premium Brand. M. T. Co.
17962	Welcome, New York.
17626	In bulk. (Columbia Tea Co., Stamford, Conn.)

COFFEE.

Of the twenty-two samples examined twenty-one were not found adulterated. The brands represented were the following:

TABLE VI.—COFFEE NOT FOUND ADULTERATED.

Station No.	Brand.
17471	*Bower & Bartlett, Boston and New York. Blue Ribbon Brand, Java and Mocha.
17921	Dwinell-Wright Co., Boston and Chicago. Our Tip Top Mocha and Java.
17441	*The German-American Coffee Co., New York. Java Brand.
17972	The E. S. Kibbe Co., Hartford, Conn. Aunt Mary's Breakfast Gem.
17724	Lipton's Perfection Mocha and Java, London, New York, etc.
17306	G. A. Murphy, Bridgeport, Conn. Our Gold Medal Java and Mocha.
17879	Geo. Patterson, Hartford, Conn. Our Special Java and Mocha.
17759	*The Reliance Coffee Co., New Haven, Conn. Reliance.
17517	*T. A. Sheffield & Co., New York. Old Homestead Java and Mocha.
17532	E. O. Smith Co., Springfield, Mass. Arabian Mocha and Java.
17269	Stoddard, Gilbert & Co., New Haven, Conn. Universal.

* Whole coffee; other samples are ground coffee.

The single adulterated sample was,

17636. Sold in bulk. Dealer: Empire State Tea Co., 24 Park Row, Stamford. 25 cents per pound. *Adulterated with chicory and starchy matter.*

The following were sold as compounds:

17442. Boston Combination Wilson's Leader. Thomas Wilson, Norwich, Conn. Dealer: Thomas Wilson, 78 Franklin St., Norwich. 22 cents per pound. *Contained imitation coffee, made of coffee chaff and wheat product, and chicory.*

17554. Granulated 8 o'clock Breakfast Compound. The Great Atlantic and Pacific Tea Co. Dealer: The Great Atlantic and Pacific Tea Co., 186 Main St., New Britain. 25 cents per pound. Stated to contain 45 per cent. coffee, 30 per cent. chicory, 25 per cent. cereals.

17668. Same brand as 17554. Dealer: The Great Atlantic and Pacific Tea Co., 161 Main St., Danbury. 25 cents per pound.

CREAM OF TARTAR.

Cream of tartar or potassium bitartrate (*potassii bitartras* of the apothecary) is purified argol, a deposit which settles out from wine in the cask. It should contain 99 per cent. of pure potassium bitartrate. The common substitutes are acid phosphate of lime, alum, and aluminium sulphate, all of which, like cream of tartar, react with bicarbonate of soda, liberating carbonic acid. These substitutes, also starch and sulphate of lime (plaster), are frequently used as adulterants of the genuine product.

Examination of Samples.—Thirty samples have been collected by the station, of which two were adulterated. The brands not found adulterated were the following:

CREAM OF TARTAR NOT FOUND ADULTERATED.

17521. Crest Brand. Edward D. Depew & Co., New York.

17374. Genuine 99½ per cent. Pure. Dwinell-Wright Co., Boston, Mass.

17547. Colonial Mills, Seyms & Co., Hartford, Conn.

17403. Slade's. D. & L. Slade Co., Boston, Mass.

The other 24 unadulterated samples were sold in bulk and bore no brand names.

The adulterated samples are:

17776. Sold in bulk. Dealer: Clarke & Foster, 199 Exchange St., New Haven. 10 cents per quarter pound. *Adulterated with acid phosphate of lime, sulphate of lime, and corn starch.*

17370. Sold in bulk. Dealer: United Grocery Co., 20 N. Main St., South Norwalk. 12 cents per quarter pound. *Adulterated with acid phosphate of lime and corn starch.*

Partial analyses of these two samples follow:

	17776	17370
Lime	6.00	0.63
Phosphoric acid	6.07	2.49
Sulphuric acid	5.11	trace

DIABETIC FOODS.

Three samples of preparations for diabetics from R. O. Bischof, Importer, London, have been examined at the request of Mr. James W. Thompson, Bridgeport.

18814 Diabetic Gluten Bread.

18815 "Essentiel" Bread for Super Alimentation.

18816 Gluten Flour.

	18814		18815		18816	
	As received.	Calculated water-free.	As received.	Calculated water-free.	As received.	Calculated water-free.
Water	7.40%	----	7.28%	----	10.08%	----
Ash	4.74	5.11	4.84	5.21	1.26	1.38
Protein	73.13	78.98	26.63	28.72	79.75	88.71
Fiber	0.02	.02	0.08	.09	0.15	.17
Nitrogen-free extract	14.26	15.41	59.57	64.26	5.21	5.79
Fat	0.45	0.48	1.60	1.72	3.55	3.95
	100.00	100.00	100.00	100.00	100.00	100.00

Obviously 18815 "Essentiel Bread" contains too large a percentage of nitrogen-free extract. (starch, sugar, dextrin, etc.) to be used by diabetic patients.

Analyses of 64 other diabetic foods, with a general discussion of the subject, are given in the report of this station for 1906.

HONEY.

Formerly strained honey was extensively adulterated with glucose and to some extent with cane sugar. It was also a common practice to feed bees with sugar, which yielded, when stored in the comb, an inferior and flavorless product. At the present time these frauds are not so commonly practiced.

During the present year 45 samples of strained honey were bought and examined, of which only one was adulterated. A description of the adulterated sample follows:

17997. Label: "Hallett Table Water Co., Bridgeport, Conn. Nonquit Pure Honey Superior Quality, Sparkling, Delicious." Dealer: S. Manjoney, 1362 Main St., Bridgeport. 15 cents per bottle. *Adulterated with glucose.*

The brands not found adulterated are given in Table VII, on the next page.

COMPOUND HONEY.

Three other samples collected by the station also contained glucose but these were all suitably labelled. They were

17998. White Clover Honey Compound, 25 per cent. Honey, 75 per cent. Corn Syrup. Sold by Sam Newman, Bridgeport.

17991. Table Syrup Compound, Corn Syrup Comb Honey, 25 per cent. Honey, 75 per cent. Corn Syrup. Sold by United Grocery Co., So. Norwalk.

17999. Superior Quality Nonquit Honey, Sparkling, Delicious,

TABLE VII.—HONEY NOT FOUND ADULTERATED.

Station No.	Brand.
17986	W. H. Archer, Port Chester, N. Y. Pure White Clover.
18006	J. C. Barton, Newington Junc., Conn. Pure Extracted.
17990	Bishop & Co., Los Angeles, Cal. Medallion California Pure.
18282	W. H. Branch, Hartsfield, Ga. Warranted Pure.
18438	Brownell & Field Co., Providence, R. I. Pure White Clover.
18009	City Hall Grocery, Hartford, Conn. California.
17985	H. W. Coley, Westport, Conn. Pure.
18426	W. D. Foote, Westville, Conn. Choice.
17995	F. C. Gould, East Hartford, Conn. Pure.
18437	A. Graves & Bros., New London, Conn. California White Sage.
18012	E. E. Hall & Son, New Haven, Conn. Pure.
18334	Hallett Table Water Co., Bridgeport, Conn. Superior Quality Nonquit.
18396	G. W. Hatch, Still River, Conn. Pure.
18011	E. C. Hazard & Co., New York. Pure Blossom Nectar.
18004	Hildreth Bros. & Segelken, New York. Pure California White Sage.
17992	Hudson Mfg. & Pres. Co., New York. Busy Bee Brand.
17987	" " " " " " " " " "
18393	F. W. Humphrey, Oronoque, Conn. Warranted Pure.
18403	J. D. Kroha, Danbury, Conn. Warranted Pure.
18013	W. J. Lamb Co., West Somerville, Mass. Pure Orange Bloom.
18466	" " " " " " " " "
18445	P. W. Latham & Co., Norwich, Conn. Guaranteed Pure.
18439	Miss M. E. Laverty, Rochester, N. Y. California White Sage.
18007	Francis H. Leggett & Co., New York. Nabob Pure.
17993	" " " " " " " "
18010	" " " " " " " "
18000	Le Roy Packing Co., Boston, Mass. Extra quality.
18261	Wesley I. Loan, Nutley, N. J. Pure.
18008	J. E. Mayhew, Windsor, Conn. Warranted Pure.
18335	Jos. M. McCaul & Son, New York. Orange Bloom.
18345	Geo. K. McMechen & Son Co., Wheeling, W. Va. Old Virginia Pure.
18002	New England Maple Syrup Co., Pasadena, Cal. Fancy California White Sage.
17988	New England Maple Syrup Co., Pasadena, Cal. Fancy California White Sage.
17996	New England Maple Syrup Co., Boston, Mass. Golden Tree Fancy Clover.
18392	Philip J. Ritter Conserve Co., Phila., Pa. Extra Fine Quality.
18014	Wm. A. Selser, Jenkintown, Pa. Pure Blossom Nectar.
18444	Simpson Spring Co., S. Easton, Mass. Royal Brand.
18005	" " " " " Victor.
18281	C. A. Stanton, Wethersfield, Conn. Pure.
17989	Vermont Maple Syrup Co., New Haven, Conn. Pride of Vermont.
18355	Frank H. Whiting, Greenfield Hill, Conn. Warranted Pure.
18456	California Honey. (E. T. Tucker, Putnam.)
18003	Strictly Pure Honey. (Ladd's Grocery, Waterbury.)
18001	Warranted Pure. (The White-Simmons Co., Waterbury.)

Pure Honey, 50 per cent., Pure Corn Syrup, 50 per cent. Made by Hallett Table Water Co., Bridgeport, Conn. Sold by Centennial Tea Co., Bridgeport.

HYGIENIC COFFEE.

The following three brands of coffee, claimed to be free from tannic acid or tannic acid and caffein, have been examined with reference to these constituents.

18478. "DE-TAN-ATED BRAND COFFEE. High grade and absolutely pure. Harmless even to invalids. Clark, Coggin & Johnson Co., Importers and Roasters, Boston, Mass." "DE-TAN-ATED BRAND COFFEE is the best, purest coffee obtainable made healthful by the removal of tannin and other injurious ingredients by a special process, the fragrant healthful stimulating delicious parts of the coffee are retained in a highly concentrated state. Can be used even by invalids without any bad after effects." "By specially constructed machinery the importers of the perfect berries that constitute DE-TAN-ATED COFFEE have extracted and discarded the bitter Tannin-bearing Cellulose. In this way the crude Tannic Acid has been entirely eliminated from DE-TAN-ATED COFFEE. It is the Tannic Acid that causes Indigestion, Headache, Sleeplessness, disorders of the Liver and Kidneys, Stomach Derangements, and many other ills. The Tannin-bearing cellulose which has been discarded, contains nearly 9 per cent. crude Tannic Acid." Bought of John Gilbert & Son, 918 Chapel St., New Haven. Price 40 cents per pound can.

18479. "Pure Coffee, Digesto-Coffee, Fine Flavor. Contains no caffeine or tannin which causes the bad effects of coffee drinking. No more substitutes for coffee; does not cause wakefulness. Digesto Coffee Co., New York, U. S. A." "Digesto Coffee is pure coffee. This package contains the highest grade of pure coffee, with the caffeine eliminated by our own method. This does not destroy the delightful flavor resulting from our special blend and nicety of roasting." "No more headaches, no more nervous dyspepsia, no more sleepless nights for lovers of coffee if they drink Digesto Coffee. Free from tannin and caffeine." Bought of John Gilbert & Son, 918 Chapel St., New Haven, Price 25 cents per pound package.

18480. "Royal Dutch Coffee. National Coffee and Spice Mills. Walter McEwan Co., Albany, N. Y., U. S. A." "Prepared by the Beach Process (patented) which removes by steam, before roasting, the TANNIC ACID, a powerful astringent, injurious to many, producing headaches, biliousness, etc. Royal Dutch Coffee prepared by the Beach process can be drunk by the most delicate without discomfort or injury." Bought of The S. W. Hurlburt Co., 1074 Chapel St., New Haven. Price 70 cents per two pound can.

Determinations of caffetannic acid (the tannic acid of coffee) and caffein have been made in these three brands and also, for comparison, in samples of "Java," "Mocha," and Rio coffee. All the samples were roasted. The results follow:

Station No.	Brand.	Caffetannic Acid. Per cent.	Caffein. Per cent.
18478	De-tan-ated coffee	9.89	1.14
18479	Digesto coffee	9.45	1.11
18480	Royal Dutch coffee	9.96	1.12
18476	"Java" coffee	9.51	1.13
18475	"Mocha" coffee	9.96	1.26
18477	Rio coffee	9.47	1.13

From the above results it is obvious that the coffees claimed to have been treated by a special process to eliminate the injurious constituents contain practically the same amount of tannic acid and caffein as ordinary coffee. If they are less injurious to health, it must be for other reasons. The manufacturers of De-tan-ated Coffee claim that by removing the "bitter tannin-bearing cellulose" they have entirely eliminated the crude tannic acid. In order to ascertain how much tannic acid is removed in this chaff, weighed portions of the samples of "Mocha," "Java," and Rio coffee were cracked, the chaff was carefully removed by hand, and the percentages of this chaff in the whole beans and the content of caffetannic acid in the chaff were determined. The crude fiber was also determined by the usual process. The following results were obtained:

	Per cent. of chaff in the roasted bean.	Per cent. of caffetannic acid in the chaff.	Per cent. of crude fiber in the chaff.
Chaff from "Java" coffee	1.80	5.46	39.62
Chaff from "Mocha" coffee	2.38	7.55	30.25
Chaff from Rio coffee	1.77	6.79	35.00

These figures show that the percentage of tannic acid in the chaff, instead of being more than in the remainder of the bean, is considerably less and its removal would tend to actually increase the percentage tannic acid content of the product, although, owing to the small percentage of chaff in the bean, the increase would be very slight.

The removal of the tannic acid by steam, as employed by the manufacturers of Royal Dutch Coffee, appears to be equally inefficient and irrational.

LARD.

Lard, according to the United States Standards, "is the rendered fresh fat from hogs in good health at the time of

TABLE VIII.—ADULTERATED LARD.

Station No.	Dealer.	Price per pound, cents.
	Bridgeport.	
17322	Bridgeport Public Market, State st.	9
17267	G. W. Burch, 575 Harral ave.	10
17266	The Centennial Tea Co., 1689 Main st.	10
17305	Smulowitz Bros., 708 Pembroke st.	10
	Danbury.	
17657	J. K. Knowlton, 56 White st.	10
	Hartford.	
17598	Dow's Grocery, 2 Church st.	10
	Meriden.	
17279	Henry Behrens, 78 E. Main st.	10
	Middletown.	
17529	O. Thompson & Co., 592 Main st.	10
17528	John J. Walsh, 584 Main st.	10
	New Haven.	
17832	A. D. Hopman, 105 Dixwell ave.	10
17801	E. Schoenberger & Son, 15 Congress ave.	9
	New London.	
17411	New York Cash Grocery, 155 Bank st.	10
17410	W. H. Slocum, 93 Broad st.	12
	Putnam.	
17482	J. E. Sullivan, 35 Elm st.	10
	Stamford.	
17632	Empire State Tea Co., 24 Park Row	10
	Waterbury.	
17721	J. P. McCarthy, 713 E. Main st.	10
17720	C. E. Peck, 455 E. Main st.	10
17715	Public Market, 161 S. Main st.	10
17717	Domenico Santoro, S. Main and Union sts.	10
17714	Waterbury Market Co., 160 S. Main st.	10

slaughter, is clean, free from rancidity, and contains, necessarily incorporated in the process of rendering, not more than one per cent. of substances other than fatty acids and fat." Compound lard is a mixture of cotton seed oil, with enough beef stearin to give it the requisite degree of solidity, and a small amount of real lard. Lard stearin (the residue left after expressing lard oil), cotton seed stearin (obtained in the manufacture of "Winter" cotton seed oil,) or, rarely, paraffine, may be used in place of beef stearin.

Although compound lard is made according to different formulas to meet the requirements of different markets, the product almost invariably contains more cotton seed oil than all the other ingredients taken together. Real lard is a minor constituent.

The sale of compound lard as such is legitimate. The sale of compound lard when "lard" is called for is fraudulent.

Of 108 samples bought for lard by the station, 22 proved on examination to be compound lard (Table VIII). Only two samples were sold under the name of compound lard.

LEMON EXTRACT.

"Lemon Extract," as defined by the United States Standards, "is the flavoring extract prepared from oil of lemon, or from lemon peel, or both, and contains not less than five (5) per cent. by volume of oil of lemon." Spirit or essence of lemon (commonly known as lemon extract) of the U. S. Pharmacopœia for 1890 is made from oil of lemon (50 cc.), lemon peel freshly grated (50 grams), and deodorized alcohol (sufficient to make 1000 cc.). This preparation is dropped from the Pharmacopœia of 1900 and in its place is given tincture of lemon peel made from shredded peel from the fresh fruit (500 grams) and alcohol (sufficient to make 1000 cc.).

Since the alcohol in a standard extract containing 5 per cent. of lemon oil costs about four times as much as all the other constituents together, unscrupulous manufacturers are accustomed to reduce the expense of manufacture by substituting dilute alcohol.

But lemon oil is practically insoluble in dilute alcohol, hence by reducing the strength of the alcohol the manufacturer cuts out the lemon oil almost entirely, thus rendering the extract almost worthless for flavoring purposes.

A good extract, on dilution with half its bulk of water, should at once become cloudy from the separation of lemon oil, which later rises to the surface.

Many preparations on the market contain so little lemon oil that it can hardly be detected either by chemical analysis or by the nostrils. They are commonly made either by shaking lemon oil with weak alcohol and removing the excess of oil, or by dissolving a little "citral" or other substitute in dilute alcohol. These extracts are usually colored a beautiful golden-yellow with turmeric tincture or, more commonly, a coal-tar dye. An ounce of such an extract selling for 10 cents contains material costing but a fraction of a cent, and almost worthless as a flavor.

Examination of Samples.—Forty-nine samples were collected by the station, of which 38 were bought from druggists and 11 from grocers. Fourteen samples from druggists and seven from grocers, none of which was labelled compound, contained less than 5 per cent. by volume of lemon oil, the amount required by the United States standards, and were pronounced adulterated or below standard. (Table IX.) Two of these were colored with turmeric and three with coal-tar colors. In addition to the foregoing, two samples deficient in lemon oil were suitably labelled as compounds:—

17955 and 17968. Royal Brand Concentrated Extract Lemon. Lambert and Lowman, Detroit, Mich. Formula compound: 70 parts Hydro-Alcoholic Solution Oil Lemon, 30 parts Aqua. Colored artificially with trace of Turmeric.

Lemon Extract not found Adulterated.

All but two of the samples not found adulterated were sold in druggist's vials and bore no brand name; these two were

17847. Sovereign Lemon Flavoring. The Union Pacific Tea Co., New York.

17976. Supreme Concentrated Extract Lemon. The T. R. Sadd Co., Willimantic, Conn.

TABLE IX.—LEMON EXTRACT ADULTERATED OR BELOW STANDARD.
(LEMON OIL BELOW 5.00 PER CENT. BY VOLUME.)

Station No.	Brand.	Dealer.	Price per bottle, cents.	Capacity of bottle, fluid ounces.	Lemon oil by volume. Polariscopic method.	Lemon oil by volume. Mitchell's Precipitation method.	Color.
		Bridgeport.			%	%	
17852	Sold in druggist's vial	Hartigan's Pharmacy, 1299 Main st.	20	4	2.73	2.70	
17851	" " "	Lee's Pharmacy, Stratford ave. and E. Main st.	20	4	3.59	3.70	
17850	" " "	Jennie Hamilton's Pharmacy, Main and State sts.	20	4	2.50	2.80	
17848	" " "	W. L. Watson, Fairfield and Park aves.	30	4	0.65	0.70	
		Danbury.					
17919	" " "	Coughlin's Pharmacy, Main and Elm streets	35	4	3.24	3.40	
		Meriden.					
17863	" " "	F. H. Lewis, 98 W. Main st.	32	4	1.76	1.90	
		Middletown.					
17983	" " "	The Hartman Drug Co., 390 Main st.	20	4	2.00	2.20	Artificial
		New Britain.					
17875	" " "	Odell's Pharmacy, 306 Park st.	40	4	3.59	3.60	
17878	B. N. P. Co. Pure Concentrated	Radom's Pharmacy, Park and Elm streets	10	--	0.10	0.00	
17877	Sold in druggist's vial	Chas. Scherp, 151 Main st.	20	4	0.12	0.40	
		New Haven.					
17811	" " "	John A. Caryl, State and Bradley sts.	30	4	1.18	1.20	Turmeric
17807	Miner, Read & Garrette, New Haven and New Britain, Conn. Pure Concentrated	G. W. Eul, 357 Congress ave.	10	--	0.00	0.00	Artificial
17812	Sold in druggist's vial	C. S. Leete Co., 330 State st.	25	4	3.17	2.70	Turmeric
17810	" " "	J. A. Notkin, Congress and Washington aves.	35	4	0.88	0.80	
17854	Star Extract Co., Boston, Mass. Extra Strength, Star Brand	D. M. Welch & Son, 28 Congress ave.	8	--	0.15	0.00	Artificial
		New London.					
17953	The Mohican Co., U. S. A. Mohican Pure	The Mohican Co., State st.	10	--	0.82	0.90	
		Norwalk.					
17925	Crescent B Lemon	Union Grocery Co., 10 Main st.	10	--	0.00	0.00	
		Norwich.					
17970	Sold in druggist's vial	James Duggan, 50 Main st.	25	4	3.38	3.50	
		Stamford.					
17944	R. W. Robinson & Son, New York. Robinson's Pure Flavoring	H. L. Wood, 282 Main st.	25	--	3.59	4.00	
		Waterbury.					
17912	Sold in druggist's vial	G. T. Geddes, 826 Bank st.	20	4	2.94	3.00	
		Willimantic.					
17978	The John T. Doyle Co., New Haven, Conn. Doyle's Pure Concentrated	Chagnon & Bacon, 40 Jackson st.	10	--	0.80	0.80	

Table X.—Maple Syrup Adulterated with Common Sugar.

Station No.	Brand.	Dealer.	Price per bottle, cents.	Hortvet number.*	Lead number.	Total ash.
						%
18471	C. M. Tice & Co., Boston, Mass. Sugar Notch Pure Vermont	*Middletown.* Conn. Cash Grocery, 418 Main st.	10	0.12	0.07	0.09
18470	Vermont Maple Sugar and Syrup Co., New Haven, Conn. Pride of Vermont	W. K. Spencer, 98 Main st.	10	0.00	0.90	0.07
18446	Crystal Conserve Co., New York City*	*Norwich.* R. F. Smith, 47 Shetucket st.	10	0.14	0.60	0.26
18410	Simpson Spring Co., South Easton, Mass. Gold Label Brand Maple Sap†	*Waterbury.* J. R. Archambault, 294 S. Main street	10	0.14	0.52	0.26
18462	Mullen & St. Onge, Willimantic, Conn. Warranted Pure Vermont‡	*Willimantic.* Mullen & St. Onge, 901 Main st.	25	0.00	0.84	0.12

* "Ingredients—Vermont Maple and Cane Sugar." In small type.
† "Pure Maple Syrup 40%, Refined Sugar Syrup 60%." In small type.
‡ "Made from Maple and Refined Sugars." In small type.

Table XI.—Compound* Maple Syrup.

Station No.	Brand.	Dealer.	Price per bottle, cents.	Hortvet number.*	Lead number.	Total ash.
						%
18333	Hallett Table Water Co., Bridgeport, Conn. Warranted Pure Nonquit	*Bridgeport.* Centennial Tea Co., 1688 Main st.	10	0.24	1.79	0.79
18329	Huntington Maple Syrup and Sugar Co., E. Providence, R. I. Gold Leaf Brand	Sam. Newman, 1447 Main st.	10	0.19	0.33	0.16
18325	Vermont Maple Syrup Co., Woodstock, Vt. Peerless Brand Vermont	E. E. Wheeler, 1131 Main st.	12	0.00	0.77	0.04
18367	James G. Powers & Co., New York, U. S. A. Red Shield	*Greenwich.* Geo. A. Finch, 173 Greenwich ave.	10	0.12	0.33	0.15
18270	New England Maple Syrup Co., Fairfax, Morrisville, Vt. Houghton Farm Brand Fancy Quality	*Hartford.* Brown, Thomson & Co., Main st.	15	0.00	0.09	0.08
18272	Hudson Packing Co., New York. Hudson Brand	Union Grocery, 1032 Main st.	10	0.00	0.74	0.04
18257	Miner, Read & Garrette, New Haven, Conn. Home Brand Warranted Strictly Pure Vermont	*Meriden.* F. C. Buhlis, 213 Pratt st.	10	0.00	0.53	0.08
18258	Mansfield, Witham & Co., Lowell, Mass. Spindle City	M. Keegan, 250 W. Main st.	10	0.09	0.49	0.10
18259	Rigney & Co., Rutland, Vt. Brooklyn, N. Y. Park Brand	Meriden Tea and Coffee Co., 77 E. Main st.	10	0.09	0.12	0.12
18430	D. M. Welch & Son, New Haven, Conn. Green Mountain Brand	*New Haven.* D. M. Welch & Son, 28 Congress avenue	20	0.04	0.08	0.05
18457	J. H. Barker & Co,, New York. Barker's Brand	*Putnam.* Edward Mullan, Main st.	15	0.04	0.69	0.23

* Stated on the labels to be mixtures containing maple and cane sugar.

* c.c. of lead subacetate precipitate from 5 grams of the material.

MAPLE SYRUP.

Maple syrup is prepared by the evaporation of maple sap to the proper consistency or by dissolving maple sugar in water. The chief saccharine constituent is sucrose, the same sugar as is contained in the sugar cane and the sugar beet, but the value of the product depends largely on certain flavoring principles peculiar to maple sap.

Formerly maple syrup was adulterated with or substituted by glucose syrup or brown sugar syrup, the maple flavoring being imitated by the addition of oil of hickory bark or extract of corn cob, but for some years the chief adulteration has consisted in the addition of refined sugar syrup, the real maple syrup present being depended on to flavor the whole. Since pure maple syrup consists largely of ordinary sugar (sucrose), the direct detection of added sugar syrup is obviously impossible, but its presence is easily shown by the determination of minor constituents peculiar to maple products. Maple syrup contains at least 0.45 per cent. of ash and a certain percentage of malic acid, whereas refined sugar contains but a trace of either. Valuable information is gained by the addition of basic lead acetate, which forms with true maple syrup a copious precipitate but none whatever with refined sugar syrup.

Examination of Samples.—Twenty-four samples have been examined, of which seven had the composition of pure maple syrup. These are the following:

MAPLE SYRUP NOT FOUND ADULTERATED.

18447. Sunbeam Maple Syrup. Austin, Nichols & Co., New York.

18273. Puritan Brand Pure Vermont Maple Syrup. Huntington Maple Syrup & Sugar Co., Brattleboro, Vt., and E. Providence, R. I.

18453. White Label Brand Pure Vermont Maple Syrup. Simpson Spring Co., So. Easton, Mass.

18411. Richelieu Brand Maple Syrup. Sprague, Warner & Co., Chicago.

18271. Our Finest Brand Genuine Maple Sap Syrup. Vermont Farmers Company, Springfield, Mass.

18440. Vermont's Finest Quality Pure Maple Sap Syrup. Welch Bros. Maple Co., Burlington, Vt.

18322. Elite Maple Syrup. R. C. Williams and Co., New York.

Five were adulterated with common sugar (Table X). Three of these had a statement on the label that they were mixtures of maple and cane sugar syrups, but are held to be adulterated because the statement was in much smaller type than the rest of the label and did not "plainly show" the facts in the case. Eleven samples contained common sugar but were labelled in compliance with the law and must be classed as compounds (Table XI, pages 148 and 149).

OLIVE OIL.

Of 77 samples bought by the station of druggists, six were adulterated with cotton seed oil, five were adulterated with sesame

TABLE XII.—ADULTERATED OLIVE OIL.

Station No.	Brand.	Dealer.	Price per bottle, cents.	Ounces of oil in bottle.
	Adulterated with Cotton Seed Oil.	*Bridgeport.*		
17347	Sold in druggist's vial	J. A. Leverty & Bro., 2071 Main st.	15	4
		Hartford.		
17582	" " "	P. J. Cavanaugh, 391 Main st.	20	4
		Meriden.		
17284	" " "	F. M. Kibbe & Co., 40 W. Main st.	15	4
		New Haven.		
17382	" " "	Harry A. Siller, 573 Grand ave.	15	4
		Norwich.		
17437	" " "	Wm. H. Nicholson, N. Main st.	20	4
		Waterbury.		
17736	" " "	McLinden's Pharmacy, 814 N. Main st.	25	4
	Adulterated with Sesame Oil.	*Bridgeport.*		
17314	Sold in druggist's vial	Frank Ostrofsky, 268 Pembroke st.	20	4
		Hartford.		
17581	" " "	Jacob P. Barnett, Governor and Sheldon sts.	15	4
17606	" " "	S. N. Rubin, 18 Ashley st.	30	4
		New London.		
17412	" " "	Starr Brothers, 108 State st.	20	4
		Winsted.		
17705	" " "	L. P. Case, 74 Main st.	20	4

oil (see Table XII), and one was sold as a compound. None of the seven samples bought of grocers was found to be adulterated.

The only sample bearing a brand name was not found adulterated; it was

17667. Pure Italian Olive Oil. Union Extract Co., Buckland, Conn.

SPICES.

Probably no class of products has been so commonly and grossly adulterated as ground spices. Examination of numerous samples at this station during the few years following 1896, when the pure food law went into effect, showed that from one-quarter to one-third of the spice sold in Connecticut was adulterated. Since the annual retail cost of the spices sold in the state during these years, according to a conservative estimate, was about $200,000, fully $50,000 of this amount must have been expended for fraudulent mixtures.

One of the commonest adulterants is ground cocoanut shells, of which, so it is stated, several hundred tons have been annually prepared for mixing with spices in a single American city. The shells, without further treatment, resemble closely ground allspice and are a common admixture of this spice. A clove adulterant is prepared by roasting the cocoanut shell powder sufficiently to give it the desired color, while for use in pepper it is reduced to a black powder by charring. In the latter case a gray color is often secured by the addition of a light colored material, such as flour or olive stones, and the pungency reënforced by a small amount of cayenne.

Wheat flour, middlings and bran, ground biscuit, white corn (maize) meal and cornstarch, rice flour and bran, buckwheat flour and middlings, bean meal, pea meal, cassava (tapioca) starch, ground olive stones, sawdust, and sulphate of lime (plaster or gypsum) are common light-colored adulterants. These are of a suitable color for white and black pepper but for cayenne pepper are often colored with red coal-tar dyes and for mustard are commonly used in conjunction with turmeric or some other yellow dye stuff.

Other make-weights are buckwheat hulls (for black pepper), ground screenings, linseed meal, rice bran, and mustard hulls.

TABLE XIII.—SUMMARY OF EXAMINATIONS OF SPICES.

	Number of samples not found adulterated.	Number of samples adulterated or below standard.	Number of samples marked compound.	Foreign matter.
Allspice	32	6	0	Cocoanut shells, foreign stems, wheat product.
Black Pepper	49	7	0	Cocoanut shells, olive stones, cayenne, coffee hulls, beans, wheat product, corn product, biscuit, excess of ash.
Cinnamon	35	0	0	
Cloves	23	5	0	Wheat product, excess of stems.
Ginger	37	5	0	Coffee hulls, cayenne, cocoanut shells, rice product, corn product.
Mustard	46	2	1	Wheat product, corn product, rice product, turmeric.
White Pepper	26	1	0	Corn meal.

White pepper and black pepper are products of the same plant, the berry in the former case being deprived of its outer coating. The so-called pepper shells containing more or less adhering dirt, obtained as a by-product in the preparation of white pepper, are extensively used as an adulterant for black pepper. Clove stems are often ground with cloves to the detriment of the latter, since they contain only about one-quarter as much oil of cloves, which is the valuable flavoring constituent. Ground clove stems are also frequently substituted for ground allspice. The dried residues, obtained in the manufacture of ginger extract and ginger ale, are mixed with ground ginger. Exhausted cloves, a by-product in the manufacture of oil of cloves, are also utilized. Mace is sometimes mixed with Macassar mace or with Bombay mace, the former being inferior and the latter worthless.

Excessively dirty spices containing percentages of ash and sand above those prescribed by the standards are also classed as adulterated.

Examination of Samples.—A tabular statement of the total number of samples collected by the station, the number found

TABLE XIV.—SPICES, ADULTERATED OR BELOW STANDARD.

Station No.	Brand.	Dealer.	Price per ¼ pound, cents.	Ash.	Sand.	Adulterants.
	Allspice.	*Ansonia.*		%	%	
17508	Sold in bulk	P. W. Fogarty, 11 High st.	10	8.88	1.55	Clove stems.
		Bridgeport.				
17277	Sold in bulk	H. Schurr, 556 Broad st.	10	4.55	....	Cocoanut shells, starchy product.
		Danielson.				
17474	Sold in bulk	Waldo Bros., 120 Main st.	10	7.42	1.27	Excess of ash.
		New Britain.				
17568	Sold in bulk	Wray & Co., Spring & Hartford av.	10	8.49	1.42	Clove stems.
		New Haven.				
17774	Sold in bulk	A. H. Duhan, 1184 State st.	8	7.35	1.67	Stems.
		Waterbury.				
17742	Sold in bulk	Santoro Bros., 34 Abbott ave.	10	5.72	....	Wheat product.
	Black Pepper.	*Bridgeport.*				
17336	Sold in bulk	Sam. Newman, 1447 Main st.	5	7.61	2.90	Corn product, cayenne, excess of ash and sand.
17317	" " "	Smulowitz Bros., 708 Pembroke st.	8	6.62	....	Beans, coffee hulls.
		Danbury.				
17677	Sold in bulk	Danbury Grocery Co., 291 Main st.	5	8.09	2.46	Excess of ash and sand.

TABLE XIV.—SPICES, ADULTERATED OR BELOW STANDARD—*Continued.*

Station No.	Brand.	Dealer.	Price per ¼ pound, cents.	Ash.	Sand.	Adulterants.
	Black Pepper.	*Meriden.*		%	%	
17298	Sold in bulk	A. Post, 8 Cedar st.	10	4.90	....	Olive stones, coffee hulls, cayenne.
		Norwich.				
17461	Sold in bulk	M. B. Prentice, Sachem & Lafayette streets	9	23.08	18.01	Excess of sand.
		Stamford.				
17647	Sold in bulk	Empire State Tea Co., 24 Park Row	10	13.23	8.99	Corn product, cayenne, excess of sand.
		Winsted.				
17708	Sold in bnlk	People's Cash Grocery, 367 Main st.	8	9.39	1.41	Biscuit, cocoanut shells, cayenne, excess of ash.
	Cloves.	*Ansonia.*				
17514	B. Fischer & Co., New York	Lawlor & Dwyer, 246 Main st.	10	8.55	0.83	Excess of stems.
		Hartford.				
17620	Sold in bulk	P. S. Kennedy, 1046 Main st.	10	7.70	0.90	Excess of stems.
		New Britain.				
17566	Sold in bulk	Francis Dobson, 37 Spring st.	10	7.72	....	Excess of stems.
		Waterbury.				
17752	Sold in bulk	Phelan's Tea Store, 42 E. Main st.	10	8.24	0.80	Excess of stems.

TABLE XIV.—SPICES, ADULTERATED OR BELOW STANDARD—*Concluded.*

Station No.	Brand.	Dealer.	Price per ¼ pound, cents.	Ash.	Sand.	Adulterants.
				%	%	
	Cloves.	*Winsted.*				
17710	Sold in bulk	McMahon & Dolet, 441 Main st.	10	6.80	....	Wheat product.
	Ginger.	*Bridgeport.*				
17274	Sold in bulk	G. W. Burch, 575 Harral ave.	10	5.66	....	Coffee hulls.
		Danbury.				
17689	Sold in bulk	Ketcham Grocery, 33 Elm st.	10	5.97	2.05	Rice product, corn product, coffee hulls, cayenne.
		Meriden.				
17293	Sold in bulk	A. Post, 8 Cedar st.	10	5.50	....	Coffee hulls.
17291	Hubert Spice Mills, Hubert & Hudson sts., New York, Blue Bell Brand	A. C. Tryon, Liberty st.	10	6.69	2.45	Rice bran, cocoanut shells.
		New London.				
17425	The A. Colburn Co., Philadelphia. C. Andresen & Co., New York. Excelsior	New York Cash Grocery, 155 Bank street	10	3.72	....	Coffee hulls.
	Mustard.	*Stamford.*				
17937	Sold in bulk	Empire State Tea Co., 24 Park Row	10	8.19	....	Wheat product, corn product, turmeric.
		Waterbury.				
17905	Sold in bulk	Prisavage Bros., 798 Bank st.	5	4.77	....	Corn product, rice product, turmeric.
	White Pepper.	*Bridgeport.*				
17338	Sold in bulk	E. E. Wheeler, 1131 Main st.	8	0.90	....	Corn meal.

adulterated, and the names of the adulterants appear on page 153 (Table XIII), and further details are given in Table XIV.

One sample of mustard, 17822, Jewell Brand Compound Mustard, Union Supply Co., Waterbury, Conn., was labelled compound. It contained a wheat product, cassava starch and turmeric.

All but 36 of the samples of spices not found adulterated were sold in bulk; the 36 samples which bore brand names are given in Table XV.

TABLE XV.—SPICES NOT FOUND ADULTERATED.

Station No.	Brand.
	Allspice.
17340	East India Tea Co., Bridgeport, Conn.
17388	Enterprise Specialty Co., Bridgeport, Conn. Pure Spices.
17362	C. L. Glover, Norwalk, Conn. High Grade.
17569	The Great Atl. & Pac. Tea Co., New York. Grandmother's Spices.
17391	Importer's Branch Ltd., New York, etc. Gold Medal.
	Cinnamon.
17621	Capitol Mills, Hartford, Conn. Pure.
17645	Columbia Tea Co., Stamford, Conn.
17513	B. Fischer & Co., New York. Pure Spices.
	Cloves.
17646	Columbia Tea Co., Stamford, Conn. Pure.
17643	Thomas & Turner, Star Mills, New York. Pure.
	Ginger.
17443	Brownell & Field Co., Providence, R. I. Autocrat Spices.
17541	The F. C. Bushnell Co., New Haven, Conn. Absolutely Pure.
17373	Dwinell-Wright Co., Boston, Mass. Royal.
17341	East India Tea Co., Bridgeport, Conn.
17364	B. Fischer & Co., New York. Dakota Brand.
17799	D. & L. Slade Co., Boston, Mass. Slade's Absolutely Pure.
	Mustard.
17840	Pyle & Tomlinson, Bridgeport, Conn. Warranted Pure.
17836	S. Scheuer & Son. Scheuer's Premium.
17837	D. & L. Slade Co., Boston, Mass. Slade's Absolutely Pure.
17906	Stickney & Poor Spice Co., Boston, Mass.
	Black Pepper.
17791	John P. Augur, New Haven, Conn. Crescent Mills.
17394	Austin, Nichols & Co., New York. Blue Ribbon.
17367	A. F. Beckmann & Co., New York. Monarch Brand.
17424	Bugbee & Brownell, Providence, R. I.
17580	Clark, Chapin & Bushnell, New York. Reliable Brand.
17337	East India Tea Co., Bridgeport, Conn.
17546	Middlesex Tea Co., Middletown, Conn. Four Leaf Clover Brand.
17737	W. H. Montanye & Co., New York. Our Own Spice Mills.
17642	Thomas & Turner, New York. Star Mills.
	White Pepper.
17473	Austin, Nichols & Co., New York. Blue Ribbon.
17413	Lewis de Groff & Son, New York. Health Brand.
17288	Knickerbocker Mills Co., New York. Royal Standard.
17393	Francis H. Leggett & Co., New York. Nabob.
17637	Wm. A. Leggett & Co., New York. Rajah Brand.
17545	Middlesex Tea Co., Middletown, Conn. Four Leaf Clover.
17644	Sam'l Wilde's Sons Co., New York. Wild Boar.

VANILLA EXTRACT.

According to the United States standards "vanilla extract is the flavoring extract prepared from vanilla beans with or without sugar or glycerine and contains in one hundred (100) cubic centimeters the soluble matters from not less than ten (10) grams of the vanilla bean." Tincture of vanilla of the United States Pharmacopœia, known commonly as vanilla extract, is prepared from vanilla beans, cane sugar, and dilute alcohol, 100 grams of the beans being used for each 1000 cc. of the extract. It will be noted that the proportion of vanilla beans is the same in both of the foregoing preparations.

The common adulterants of vanilla extract are tonka bean extract, artificial vanillin, artificial coumarin, and caramel, the latter being used as a color. Artificial vanillin is identical with the chief flavoring principle of the vanilla bean, but the extract made from this substance lacks the true flavor of genuine vanilla extract, owing to the absence of other substances which cannot be successfully imitated. At the present time vanillin, itself an adulterant, is adulterated with acetanilid (antifebrine), which not only is worthless for flavoring but is injurious to health. Tonka beans are much cheaper than vanilla beans and have a ranker flavor due to coumarin, which is also prepared artificially for use in extracts.

Sixty-six samples, 41 from druggists and 25 from grocers, have been examined, of which 10 were labelled as compounds.

Twelve samples not found adulterated and five samples labelled compounds bore brand names; these are found in Tables XVI and XVII. Nineteen samples, all but three of which were from druggists, were found to be adulterated. All of these adulterated samples contained coumarin, and in addition two contained acetanilid, and 14 were artificially colored (Table XVIII).

TABLE XVI.—VANILLA EXTRACT NOT FOUND ADULTERATED.

Station No.	Brand.
17956	Austin, Nichols & Co., New York. Monarch.
17872	Bergquist Bros., New Britain, Conn.
17930	The Boston Tea & Coffee Co., S. Norwalk, Conn. Double Strength.
17874	Charter Oak Extract Co., Hartford, Conn. Charter Oak.
17957	Lewis de Groff & Son, New York. Health Brand.
17933	East India Tea Co., S. Norwalk, Conn. Acme.
17839	Ideal Mfg. Co., New York. Ideal Concentrated.
17910	Model Market Co., Waterbury, Conn. Gold Seal Brand.
17967	The Mohican Co., Norwich, Conn. Supreme.
17966	Puritan Drug Co., Boston, Mass. Puritan.
17917	Union Extract Co., Buckland, Conn. "D" Pure Concentrated.
17838	R. C. Williams & Co., New York. The Famous Royal Scarlet Brand.

TABLE XVII.—COMPOUND VANILLA EXTRACT.

Station No.	Brand.
17766	Wm. J. Fuller & Son, New Haven, Conn. Compound.
17960	John Holly. Synthetic Vanilla.
17789	New Haven Extract Co., New Haven, Conn. Atwood's Extra Strong.
17961	Nichols & Harris, New London, Conn. Concentrated.
17918	The Union Pacific Tea Co., New York. Sovereign.

Table XVIII.—Adulterated Vanilla Extract

Station No.	Brand.	Dealer.	Price per bottle, cents.	Capacity of bottle, ounces.	Vanillin.	Coumarin.	Acetanilid.	Color.
		Bridgeport.			%	%	%	
17844	Sold in druggist's vial	Ballard, Wood and Iranistan aves.	35	4	0.25	0.08	0.00	Artificial.
17842	" " " "	J. W. Roberts, 1128 E. Main st.	35	4	0.09	0.05	0.00	Artificial.
		Danbury.						
17916	" " " "	M. J. Shanley, 147 Main st.	32	4	0.66	0.23	0.00	Artificial.
		Hartford.						
17894	" " " "	A. Deutschberger, 1049 Main st.	25	4	0.25	0.05	0.00	Artificial.
17893	John Holly. H.	Mike Rates, 41 Albany ave.	10		0.63	0.06	0.00	Artificial.
		Meriden.						
17860	Sold in druggist's vial	W. N. Barber, 298 E. Main st.	35	4	2.41	0.12	0.00	Artificial.
17861	" " " "	Kapitzke Bros., 80 E. Main st.	40	4	0.63	0.21	0.00	Artificial.
		Middletown.						
17982	" " " "	Chas. A. Pelton, 88 Main st.	25	4	0.11	0.10	0.00	Natural.
17980	The McKee Medicine Co., Middletown, Conn. Dr. McKee's Concentrated Fruit Extract	Wall, Donovan & Wall, 468 Main st.	25		0.22	0.04	0.03	Artificial.
		New Britain.						
17870	Sold in druggist's vial	Ed. F. Farrell, 355 Arch st.	25	3	0.47	0.08	0.00	Natural.
17873	The McKee Medicine Co., Middletown, Conn. Dr. McKee's Concentrated Fruit Extract	Wray & Co., Hartford ave. and Spring st.	5		0.20	0.06	0.11	Artificial.
		New Haven.						
17788	Sold in druggist's vial	Chas. A. Lamb, 245 Dixwell ave.	40	4	0.46	0.07	0.00	Natural.
17764	" " " "	E. J. McGuire, 1320 State st.	45	4	0.27	0.05	0.00	Artificial.
17787	" " " "	Morris Pharmacy, 29 Dixwell ave.	40	4	0.11	0.03	0.00	Natural.
17785	" " " "	S. H. Williams & Co., 183 Shelton ave.	25	4	0.31	0.08	0.00	
		New London.						
17958	" " " "	Wm. P. McBride, 429 Bank st.	45	4	0.09	0.04	0.00	Artificial.
17946	" " " "	Nichols & Harris, State st.	45	4	0.07	0.04	0.00	Artificial.
17959	" " " "	Taylor's Pharmacy, 239 State st.	45	4	0.43	0.08	0.00	Artificial.
		South Norwalk.						
17931	" " " "	Ed. W. Kelly, Jr., 8 N. Main st.	30	4	0.10	0.04	0.00	Artificial.

MISCELLANEOUS MATERIALS SENT BY PRIVATE INDIVIDUALS.

Milk. Thirty-three samples were tested, the results of which are not of general interest.

Cream. Eighteen samples were tested; the percentage of fat ranged from 15.64 to 50.24. Only the following sample was found to be below standard:

18728. Bought from L. B. Pond, Unionville. Sent by A. G. Root, Forestville. It contained only 15.64 per cent. of fat.

17728. *Separator Skim Milk,* sent by Albert N. Beard, Milford, contained 0.03 per cent. of fat.

18307. *Honey,* sent by Allen Latham, Norwich. This sample gave a direct polarization of —20.7°, and after inversion—27.1°, both at 21°C.

18958. *Canned Corn.* Sent by Henry S. Noble, Middletown. No borax or formaldehyde found.

FOOD PRODUCTS EXAMINED FOR THE DAIRY COMMISSIONER IN THE YEAR ENDING JULY 31, 1907.

The following samples were referred to this station by the Dairy Commissioner for examination:

Butter and Butter Substitutes. Eighty samples of butter were examined, of which fifty-nine were unadulterated, one was artificially colored, nineteen were renovated butter, and one was oleomargarine. Sixteen samples of renovated butter, seven samples of oleomargarine and one butter substitute were examined and were found true to name.

Milk. Seventeen samples were examined, of which eight were unadulterated, six were watered, one was skimmed and two were below the standard for total solids.

Molasses. Two hundred and seventy-six samples were examined, five of which were adulterated with glucose.

Vinegar. Two hundred and nine samples were examined, forty-nine of which contained less than the four per cent. of acidity, calculated as acetic acid, which is required by law.

Miscellaneous Foods. One sample of black pepper, one of chocolate, two of maple syrup, one of mustard and one of olive oil were not found to be adulterated. Of three samples of buckwheat flour examined, one was found to be adulterated with a wheat product; one sample of catsup examined contained

benzoic acid and artificial color; one sample of lemon extract was found to be adulterated, containing only 0.14 per cent. by volume of lemon oil; the three samples of lard examined were all found to be adulterated with cotton seed oil.

TABLE XIX.—SUMMARY OF RESULTS OF EXAMINATIONS OF FOOD PRODUCTS IN 1907.

	Not found adulterated.	Adulterated or below standard.	Compound.	Total number examined.
Sampled by Station.				
Buckwheat Flour	51	26	----	77
Catsup	2	7	41	50
Chili Sauce	----	6	6	12
Chocolate	17	8	1	26
Cocoa	39	4	----	43
Coffee	18	1	3	22
Cream of Tartar	28	2	----	30
Diabetic Foods	----	----	----	3
Honey	44	1	3	48
Hygienic Coffee	----	----	----	3
Lard	86	20	2	108
Lemon Extract	26	21	2	49
Maple Syrup	8	5	11	24
Olive Oil	72	11	1	84
Spices	248	26	1	275
Vanilla Extract	37	19	10	66
Total	676	157	81	920
Sampled by Dairy Commissioner.				
Black Pepper	1	----	----	1
Buckwheat Flour	2	1	----	3
Butter and Butter Substitutes	59	21	24	104
Catsup	----	1	----	1
Chocolate	1	----	----	1
Lard	----	3	----	3
Lemon Extract	----	1	----	1
Maple Syrup	2	----	----	2
Milk	8	9	----	17
Molasses	271	5	----	276
Mustard	1	----	----	1
Olive Oil	1	----	----	1
Vinegar	160	49	----	209
Total	506	90	24	620
Sampled by Health Officers, Consumers and Dealers.				
Canned Corn	1	----	----	1
Cream	17	1	----	18
Honey	1	----	----	1
Milk	27	6	----	33
Separator Skim Milk	1	----	----	1
Total	47	7	----	54
Total from all sources	1229	254	105	1594

The station is constantly called upon by individuals to make examinations of foods, drugs and patent medicines, as well as minerals, rocks, bodies of animals suspected of being poisoned and a great variety of other materials.

There seems to be an impression that it is a duty of the station to meet all such calls for work from residents of Connecticut. This is not at all the case. The station does all in its power to make itself of use to the citizens of the state, but the resources of its laboratory are insufficient to do much more than is required by law, namely, to examine authenticated samples of foods, cattle feeds and fertilizers and to publish the results with appropriate discussion. Even if its resources were much larger it would still be obviously wrong to examine at public expense samples which had little or no importance for the general public.

PART III.

COMMERCIAL FEEDING STUFFS.

By E. H. Jenkins and J. P. Street.

THE LAW REGULATING THEIR SALE.

Section 4591 of the general statutes of Connecticut so defines the term "concentrated commercial feeding stuff" that it covers practically all feeds *excepting the following:*—hay and straw, whole seeds, unmixed meal made directly from any one of the cereals or from buckwheat, and feed ground from whole grain and sold directly from manufacturer to consumer.

Section 4592 requires that every package of concentrated commercial feeding stuff shall bear a statement giving the name and address of manufacturer or importer, the number of net pounds in the package, the name of the article and the percentages of protein and fat contained in it.

Section 4593 requires every manufacturer, importer, agent, or seller to file with this station, upon request, a certified copy of the statement above described.

The penalty prescribed for violation of the foregoing sections is not more than $100 for the first offense and not more than $200 for each subsequent offense.

Section 4595 authorizes this station to take samples from any manufacturer, importer, agent, or dealer, in a prescribed fashion and requires this station to analyze, annually, at least one sample of each brand which it has collected and to publish these analyses in station bulletins, "together with such additional information in relation to the character, composition and use thereof as may be of importance."

The dairy commissioner is charged with the enforcement of the provisions of these sections of the statutes.

In compliance with these requirements the following report has been prepared.

SAMPLING OF COMMERCIAL FEEDING STUFFS.

During the fall of 1907, Mr. V. L. Churchill, the sampling agent of this station, visited 43 towns and villages of this state and took 197 samples of feeds in the way prescribed by law. These samples have been examined chemically and microscopically and the results appear in the following pages with appropriate discussion.

There are also given 40 analyses of feeds which were sent to the station for analysis by individuals.

EXPLANATIONS OF ANALYSES OF FEEDING STUFFS.

An analysis gives the percentage amounts of Water, Ash, Protein, Fiber, Nitrogen-free Extract and Fat.

Percentage Amount is the amount in 100. If the protein in a feed is 17.5 per cent., every 100 pounds of that feed contain 17.5 pounds of protein; and since a ton is twenty hundred pounds, a ton of the feed will contain twenty times 17.5 or 350 pounds of protein.

Water. However dry a feeding stuff appears to be, it always contains a considerable and variable quantity of water which cannot be seen or felt, but which can be driven out by heat. The amount of water thus present in feeding stuffs is constantly changing with the temperature and moisture-content of the air about them, and accordingly no very close comparison of different feeds is possible, unless the proportions of water they contain are known and comparison is made on perfectly dry or water-free substance.

Ash is what is left when the combustible part of a feeding stuff is burned away by heating to faint redness in a current of air. Besides sand, usually an accidental impurity, the ash consists chiefly of lime, magnesia, potash and soda, combined with chlorine, and carbonic, sulphuric or phosphoric acid.

It is from some of these that the bones of the animal are constructed and repaired, and mineral matters are as necessary to continued health and life as any of the so-called nutrients which the analysis takes separate account of.

The rations commonly fed, however, have a sufficient amount of these mineral matters to meet the wants of the animal, although

the addition of salt and of phosphate sometimes has a noticeably favorable effect on the condition of the animal.

Protein is a general expression for the nitrogenous matters of a feed, and in this report the term simply means the nitrogen percentage multiplied by 6¼. It is a general and only approximate expression for the amount of those flesh-forming ingredients of feed which contain nitrogen as an essential constituent, which are the most costly and are absolutely essential for the building and repair of the tissues of the body. The protein bodies are those which should be most considered in buying feeds, for besides being the most expensive, they are less easily produced on the farm and their residues are more valuable than those of the other nutrients in the manure.

Nitrogen-free Extract, sometimes called *Carbohydrates,* includes starch, gum, sugar, and pectin bodies. They are readily extracted from the feeding stuff by water and dilute acid. While they cannot build up the tissues of the growing animal, or directly restore the waste and wear of the tissues of adults, they, together with fat, by their combustion within the body, maintain the animal heat, and in well nourished animals, supply the energy needed for the bodily functions and for any form of work.

Fiber is the essential constituent of the walls of vegetable cells and is seen in a nearly pure state in cotton fiber or paper pulp. It is the most insoluble part of the vegetable substance and of subordinate value in the ration.

Ether Extract includes fat oil, solid fat, wax, chlorophyl (the green coloring matter of plants) and other coloring matters, in brief anything which can be extracted from the perfectly dry feeding stuff by absolute ether. Its use in the ration is largely the same as that of the nitrogen-free extract, although the digested ether extract has about 2.4 times as much heat-producing value as the digested nitrogen-free extract.

Experience has proven that for each special case of animal nutrition a special ratio of digestible proteins to digestible ether extract, fiber and nitrogen-free extract is the best and most economical, and within certain limits is necessary.

THE USES OF ANALYSES OF FEEDING STUFFS.

These uses are several. First, by an analysis compared with the average of others, any buyer of a feed can see whether it is of the usual quality. Thus on page 193 the analysis of cotton seed meal, No. 19795, compared with the average of eleven analyses given on the same page, shows that it has four per cent. less of protein and two and three-quarters per cent. less of fat than the average and is to that extent inferior.

Secondly, by an analysis compared with the manufacturer's guaranty the buyer can see whether in composition the feed meets what is claimed for it. Thus on page 199 the analysis of Hubinger's Gluten Feed shows that it contains about 2½ per cent. less of protein than the manufacturer guarantees.

Thirdly, an analysis often shows clearly whether or not the feed is adulterated and may indicate also the form of adulteration.

It also makes clear the composition of mixtures which are sold under names which either convey no meaning or convey a false impression.

Fourthly, comparison of analyses of a number of kinds of feed with their prices will greatly help in deciding whether any one of them is worth to the feeder what is asked for it. Too often the prices of feeds bear no relation to their real feeding value. This matter is discussed in following pages.

Lastly, the chief use of these tables by feeders should be as a guide to the skillful compounding of rations for farm animals. How this is done cannot be briefly explained within the limits of this report. A knowledge of the principles of cattle-feeding is essential, which should be gathered by studying books which treat of the principles of cattle-feeding and of the art of compounding rations.

DISCUSSION OF THE ANALYSES.

The microscopical and chemical work in connection with these analyses has been done by Mr. Street and under his direction, with the coöperation of Messrs. Bailey, Morrison and Stevens; the results have been discussed by the director.

Oil Seed Products.

Cotton Seed Meal.

Analyses on pages 192 and 193.

Of the eleven samples examined four fail to meet the seller's guaranty of protein,* as follows:

19711	Owl Brand, F. W. Brode & Co.	Protein deficient by	2.44 per cent.
19853	" " " " "	" " "	3.31 "
19795	Hunter Bros. Milling Co.	" " "	3.75 "

Very large quantities of cotton seed meal are yearly brought into the state for use as a fertilizer as well as a feed. But last spring more than a third of the 170 samples analyzed fell below their guaranty, some southern shippers rejected all claims for rebates on account of low grade meal, knowing that they could not be reached by legal process without too great expense to warrant the attempt, and cotton seed meal has never been so poor in quality nor so high in price as at present. The protein average, 38.89, is the lowest found in any inspection by this station.

Cotton Seed Meal, sampled and sent by Purchasers.

18718. Sent by Thos. Holt, Southington, contained 40.75 per cent. of protein and 9.70 per cent. of fat.

18765. *Phenix Brand,* sold by D. L. Marshall Co., Boston, guaranteed 41 per cent. of protein, sampled by Henry Ineson, Watertown, from stock of M. D. Leonard & Co., Watertown, contained 31.18 per cent. of protein, or nearly ten per cent. less than was guaranteed. Its high fiber content, 15.89 per cent., indicates adulteration with hulls.

18817. *Cotton Seed Cake,* sold by Continuous Extracting Press Corporation, New York, sent by J. J. McNally, Springfield, Mass., contained 40.31 per cent. of protein and 10.74 per cent. of fat; rather more fat than is usually found in cotton seed meal prepared by the usual process.

---

* In this report the protein in a feed is considered in substantial agreement with the guaranty if it is not more than one per cent. below it. An allowance of fifteen one-hundredth per cent. of nitrogen is made in comparing the actual and guaranteed composition of fertilizers (to cover possible errors of sampling and analysis), and as protein is calculated from nitrogen by multiplying by 6¼, an allowance about 6¼ times as large as that for nitrogen is made for protein.

Linseed Meal.

Analyses on pages 192 and 193.

"Linseed Meal," "Oil Meal" and "Flax Seed Meal" are trade names for ground flax seed from which more or less of the oil has been removed. By the "old process" the oil is partly removed by pressure, leaving from 5 to 10 per cent. in the meal. By the "new process" the oil is so far extracted by naphtha as to leave, usually, less than 2½ per cent. in the meal. New process meal is rather more uniform in composition and contains more protein than old process meal.

Two samples of new process and three of old process meal have been examined. All are of good quality, unadulterated and fully meet the manufacturers' guaranty.

A sample of linseed meal, **18719**, sent by Thos. Holt, Southington, contained 35.50 per cent. of protein and 7.10 per cent. of fat.

WHEAT PRODUCTS.

These are by-products in the manufacture of wheat flour. Several different processes of milling are in common use, yielding by-products which are not alike in composition.

Wheat Bran consists of the outer layers of the wheat kernel, which are dark in color and do not easily pulverize.

Wheat Middlings, as found in the feed market, consist of inner layers of the covering of the kernel, which are lighter in color and more easily pulverized than bran, and of other parts from which fine white flour cannot be made.

Many mills do not sell bran and middlings separately, but run them together, often with other waste wheat products, and sell the mixture as "Mixed Feed."

Bran from Winter Wheat.

Analyses on pages 192 and 193.

Analyses of eight samples are given in the table; in the four cases where guaranties were given the composition corresponded with them.

Bran from Spring Wheat.

Analyses on pages 192 to 195.

Of the nineteen samples analyzed sixteen had the guaranty of composition which is required by law and in every case but one

the analysis showed as much protein and fat as the guaranty called for. Sample 19776, *Clover Leaf Bran,* contained only 13.06 per cent. protein and 4.82 per cent. fat; some oat hulls were found in this sample, not, however, in quantity sufficient to explain the low protein.

The guaranteed amount of protein in the spring bran ranged from 12 to 16 and the actual amount present from 13.06 to 16.25 per cent.

A sample of *Jersey Bran,* **18721**, sold by Christian & Co., sent by Thos. Holt, Southington, contained 15.00 per cent. of protein and 5.21 per cent. of fat.

A sample of *Banner Bran,* **18803**, sold by Banner Milling Co., Buffalo, N. Y., sent by N. M. Nettleton, Washington Depot, contained 16.00 per cent. of protein.

A sample of bran, **18813**, sent by Wilson H. Lee, Orange, contained 15.00 per cent. of protein.

Middlings from Winter Wheat.

Analyses on pages 194 and 195.

Eleven samples were analyzed; all were pure and of average composition, and the composition of those which had a guaranty corresponded with that guaranty. Five brands did not have the required guaranty.

Middlings from Spring Wheat.

Analyses on pages 194 to 197.

Sixteen samples were analyzed; all appear to be pure and of average composition. Of the 16 samples, 12 had the guaranties required by law, and in all cases the protein guaranty was satisfied; in two cases there was a slight deficiency in fat.

Mixed Feed from Winter Wheat.

Analyses on pages 196 and 197.

All of the seventeen samples analyzed were of good average composition, but only seven of them bore the guaranty required by law. This guaranty in each case corresponded with the composition of the goods as regards protein, but in one case there was a slight deficiency in fat.

Mixed Feed from Spring Wheat.

Analyses on pages 196 to 199.

The analyses of the eleven samples show them all to be of average composition; the six samples guaranteed as required by law satisfy their guaranties.

A sample of *Trojan Mixed Feed,* **18731,** sold by The Allen & Wheeler Co., Troy, Ohio, and sent by W. F. Griswold, Rocky Hill, contained 16.87 per cent. of protein, 4.35 per cent. of fat and 5.66 per cent. of fiber.

A sample of *Buckeye Mixed Feed,* **19199,** sold by American Cereal Co., Chicago, through A. N. Goddard, Simsbury, and sent by C. H. Eno, Simsbury, contained 16.25 per cent. of protein and 5.17 per cent. of fat; being in close accord with the analysis of the sample of the same brand collected in the regular inspection.

Maize Meal.

Two samples of corn meal, sent by A. H. Gallup, Scotland, were analyzed. **18786** was ground and sold by the E. A. Buck Co., Willimantic; it represented western corn grown in 1905. **18787** was ground from corn grown by Mr. Gallup in 1906 and represented a mixed variety of flint corn. The composition of the samples follows:

	18786	18787
Water	10.05	9.95
Ash	1.31	1.46
Protein	9.63	9.54
Fiber	1.55	1.18
Nitrogen-free Extract	73.39	73.21
Fat	4.07	4.66
	100.00	100.00

A sample of a corn product, **18727,** sent by B. Hawley & Co., Stepney, contained 9.37 per cent. of protein and 3.76 per cent. of fat; it resembled corn meal in composition.

Gluten Feed.

Analyses on pages 198 to 201.

Nine different brands of Gluten Feed have been offered in the state this fall. All of them have the guaranty of composition as required by law. Five of the brands, however, do not by any means meet this guaranty. These deficient brands are Bay State, Hubinger's, Illinois, Michigan and Union Starch and Refining Co.

Bay State Gluten Feed. The single sample of this brand was 5.50 per cent. below its guaranty in protein.

Buffalo Gluten Feed. Five samples were analyzed, all of which substantially satisfied their guaranty of both protein and fat.

Globe Gluten Feed. The six samples analyzed all exceeded their protein guaranty, the average excess being about two per cent. One sample was not guaranteed as required by law.

Hubinger's Gluten Feed. The single sample contained 2.38 per cent. less protein than was guaranteed; the guaranty of 27 per cent. is much too high for gluten feed of its quality.

This brand of gluten feed for the last three years has not met the claims of the manufacturer. Each year the percentage of protein found has been very decidedly less than the guaranty. The manufacturer, whose attention was called to these facts, gives assurance that hereafter the guaranty shall correspond with the composition of the feed.

Illinois Gluten Feed. The single sample analyzed was 4.13 per cent. below its protein guaranty.

Michigan Gluten Feed. A single sample analyzed 5.50 per cent. less than its protein guaranty.

Queen Gluten Feed. The single sample exceeded by 3.87 per cent. its rather low protein guaranty of 20 per cent.

Union Starch & Refining Co.'s Gluten Feed. The single sample analyzed was 2.63 per cent. low in protein.

Warner's Gluten Feed. The three samples analyzed satisfied their guaranties.

A sample of *Buffalo Gluten Feed,* **18720,** sent by Thos. Holt, Southington, contained 24.12 per cent. of protein and 2.56 per cent. of fat. Another sample of the same brand, **18737,** purchased from Abner Hendee, New Haven, and sent by Wilson H. Lee, Orange, contained 25.25 per cent. of protein. Both samples satisfied the usual guaranty for this product.

A sample of *Gluten Feed,* **19029,** sold by Douglas & Co., Cedar Rapids, Iowa, sent by Meech & Stoddard, Middletown, and guaranteed to contain 24.00 per cent. of protein, was deficient in this ingredient by nearly three per cent. The analysis follows:

	19029
Water	8.19
Ash	1.47
Protein	21.13
Fiber	6.94
Nitrogen-free Extract	57.71
Fat	4.56
	100.00

A sample of *Gluten Feed,* **19383**, brand unknown, sent by Wilson H. Lee, Orange, contained 23.13 per cent. of protein.

Hominy Feed.

Analyses on pages 200 to 203.

This material, also called "Hominy Chop" and "White Meal," is a by-product from hominy mills and breweries.

Five brands of Hominy Feed did not bear the statement of composition as required by law.

Sixteen samples were analyzed, and of the ten bearing guaranties three were low in fat and one, **19787**, sold by Chase Grain Co., Norwalk, was distinctly inferior in quality, containing 2.00 per cent. less protein and 1.85 per cent. less fat than was guaranteed. It contained 11.06 per cent. of fiber and a microscopical examination showed the presence of considerable corn cob.

Star Feed. Three samples of this material were examined, one of which was not guaranteed; all showed a marked deficiency in fat, and contained considerable corn cob. Although this material is sold under a guaranty somewhat lower that that of pure hominy feed, the price asked is practically the same.

Rye Products.

Analyses on pages 202 and 203.

Three samples of rye products were analyzed, marked bran, middlings and feed respectively. None of the samples was guaranteed as required by law. The sample of bran was much below the average for this material; in composition it resembled more a ground rye.

Buckwheat Middlings.

Analysis on pages 202 and 203.

The single sample analyzed was of good quality and in spite of the increased selling price over previous years was a cheaper feed than any of the wheat or rye products examined this year.

Rice Products.

Analysis on pages 202 and 203.

The single sample of Ground Rice analyzed was somewhat under average composition. It appeared to be the residue from a cooked rice product.

A sample of rice bran, **19696**, sent by Chas. M. Cox Co., Boston, had the following composition:

Water	10.85
Ash	7.45
Protein	13.19
Fiber	6.70
Nitrogen-free Extract	49.91
Fat	11.90
	100.00

Miscellaneous Products.

19356. *Beet Pulp,* **19356**, sold by F. A. Rolston, South Manchester, sent by O. E. Bailey, Glastonbury; cost $22.00 per ton.

19429. *Ground Peas and Beans,* **19429**, sent by P. A. Holt, Newington.

The analyses of the above samples follow:

	19356	19429
Water	11.50	13.97
Ash	3.62	2.71
Protein	9.38	20.25
Fiber	18.31	18.49
Nitrogen-free Extract	56.24	43.02
Fat	0.95	1.56
	100.00	100.00

Barley Products.

Malt Sprouts.

Analyses on pages 202 and 203.

Barley, previously soaked in water, is allowed to germinate until the characteristic ferment, diastase, has developed, when the grain is killed by drying it. The barley sprouts become brittle and are removed from the grain before it is used for the "malting" of starch.

The six samples of sprouts, four of which have a guaranty, are quite uniform in composition and of average quality; all of them had somewhat less fat than was guaranteed.

Dried Distillery Grains.

Analyses on pages 202 and 203.

This is a residue from the whiskey or spirit manufacture. Certain grains, corn, or oats, or a mixture of the two ground fine and mixed with water, are first cooked to disintegrate and dissolve the starchy matter in them. This starch is then converted into sugar, usually by the action of barley malt, yeast is next added, which ferments the sugar, forming alcohol, and finally the whole fluid mixture is pumped into a closed vessel or still and the alcohol driven off by heat.

There is left a cooked semi-liquid mass called "distillery slop", containing all that was in the grain originally, except the starch and sugar. This distillery slop if dried at once, or after putting through a filter press, makes an excellent cattle food.

Five samples were analyzed, representing four different brands.

Ajax Flakes. The two samples examined contained on the average 31.69 per cent. of protein, and were slightly below the guaranty; the percentage of fat, however, was 1.19 per cent. above the guaranty.

Fourex Grains. The single sample analyzed was 1.06 per cent. low in protein, with an excess of 3.75 per cent. of fat.

A 1 Distillers' Grains. This is a lower grade product, also made by the J. W. Biles Co. It contained only 21.56 per cent. of protein, 4.44 per cent. under the guaranty.

Continental Gluten Feed. This material continues to be sold erroneously under the name "gluten feed." The single sample analyzed was 3.44 per cent. below the protein guaranty and 1.80 per cent. below in fat.

Six samples of distillers' grains were sent in by the purchasers, and their analyses are given in the following table.

18723. *Biles' Fourex Grains,* made by the J. W. Biles Co., Cincinnati, Ohio, sent by Thos. Holt, Southington.

19102. *Biles' Fourex Grains,* sent by Thos. Holt, Southington.

19101. *Biles' Twoex Grains,* sent by Thos. Holt, Southington.

19100. *Continental Gluten Feed,* made by Continental Cereal Co., Peoria, Ill., sent by Thos. Holt, Southington.

18907. *Climax Grains,* from stock of S. E. and W. G. Brown, South Manchester, sent by O. E. Bailey, Glastonbury.

19682. Sold by a Kentucky distillery, sent by Meech & Stoddard, Middletown.

	18723	19102	19101	19100	18907	19682
Water	8.07	7.81	8.32	6.97	7.36	11.58
Ash	2.23	2.57	2.75	4.07	2.62	2.67
Protein	29.37	32.38	28.13	29.44	32.63	24.00
Fiber	12.47	11.41	10.97	8.69	11.03	10.78
Nitrogen-free Extract	35.37	32.07	38.56	35.29	34.27	42.02
Fat	12.49	13.76	11.27	15.54	12.09	8.95
	100.00	100.00	100.00	100.00	100.00	100.00

Dried Brewers' Grains.

Analysis on pages 204 and 205.

These are the dried residue of the mash from beer brewing and consist chiefly of barley grains deprived of their starch and soluble matter. The sample examined fully satisfied its protein guaranty but was somewhat low in fat. At present prices this is one of the cheapest feeds on the market.

A sample of *Schlitz's Brewers Grains,* **19008,** sold by Brower & Malone, Norwalk, guaranteed 24.5 per cent. of protein and 6.5 per cent. of fat, and sent by D. A. St. John, New Canaan, had the following composition:

Water	8.41
Ash	3.32
Protein	30.12
Fiber	11.56
Nitrogen-free Extract	39.40
Fat	7.19
	100.00

Mixed Feeds.

Corn and Oat Feeds.

Analyses on pages 204 and 205.

These are mostly manufacturing wastes, sold under various proprietary names, some of them containing a considerable amount of hulls. The protein in them ranges from 7.75 to 10.25 and the woody fiber from 2.58 to 10.85. All of them are mixtures of corn and oat wastes, some with added hulls. Eclipse Feed also contains a wheat product. All the samples, except the two provenders, 19884 and 19829, bore a guaranty, which was satisfied in all cases. Their selling prices range from $32.00 to $37.00; the average, $33.35, strange to say, is higher than that of any of the standard high-grade feeds, except linseed meal, while supplying but from one-fifth to one-half as much protein.

Three corn and oat feeds, sent by individuals, were partially analyzed as follows:

18507. *Victor Feed,* sent by P. Schwartz, New London, and guaranteed 7.50 per cent. of protein and 3.00 per cent. of fat, contained 7.75 per cent. of protein.

18866. *Provender,* sent by J. L. Glover, Shelton, contained 9.56 per cent. of protein. Mr. Glover writes of this feed "Our horse refuses to eat it or even smell of it." Under the microscope it appeared to consist entirely of corn and oats.

19648. This feed was sent by Mrs. S. R. Hull, New Haven, who complained that it seemed to poison her horse. The sample was free from mustiness, and consisted of corn and oats; under the microscope no foreign matters were detected.

Wheat and Cobs.

Analyses on pages 206 and 207.

Here are included two mixtures of wheat products and ground corn cobs sold under the name "mixed feed." This name has been long recognized by the trade as applied to a mixture of bran and middlings from the flour mills. Its use applied to a mixture of wheat feed with the comparatively worthless cobs is clearly a deception unless the tag plainly discloses the real nature of the mixture. Cobs have a certain feeding value but this value is small as compared with bran or genuine mixed feed. The two mixtures in question were sold with tags attached, which showed the presence of cobs, and they both bore a guaranty which to the

intelligent purchaser should have indicated that they were not pure wheat feed. The *Jersey Mixed Feed* contained but 8.69 per cent. of protein, 1.31 per cent. under the guaranty. It is to be noted that the average selling price of these feeds was $28.50, only $3.00 less than that of genuine mixed feed, while they contained only a little more than half as much protein.

A sample of *Stone's Winter Mixed Feed,* **19384**, sent by Ira C. Peck, Hartford, contained only 10.38 per cent. of protein. It is stated to consist of bran, middlings, corn and a little low grade flour; corn cob was detected under the microscope.

Corn, Oats and Barley.

Analysis on pages 206 and 207.

Schumacher's Stock Feed is a mixture of products from these three grains, and satisfied its guaranty in both particulars.

Molasses Grains.

Analyses on pages 206 and 207.

The single sample analyzed contained 14.87 per cent. of protein, 2.13 per cent. less than the guaranty.

Flax Feed.

Three samples, representing two brands, of this feed were analyzed; it is a new feed in the Connecticut markets. A microscopical examination of *H. J. Flax Feed* showed it to contain broken flax seed, straw and many seeds or screenings (foxtails, mustard, cockle, wheat, oats, rye, bindweed, etc.); it was very clean and contained very little dirt. The feed is characterized by its high content of fat, from 18 to 19 per cent.; in protein it runs about the same as high-grade wheat middlings; its average selling price was $26.67, about $6.00 lower than that of middlings.

A sample of *H. J. Flax Feed,* **19679**, sent by E. H. Talcott Est., Torrington, had the following composition:

	19679
Water	8.56
Ash	7.81
Protein	17.25
Fiber	11.41
Nitrogen-free Extract	38.34
Fat	16.63
	100.00

Proprietary Horse Feeds.

Analyses on pages 206 and 207.

Here are included the analyses of five samples. The sample of *Husted's Horse Feed* was not guaranteed as required by law; the other four samples satisfied both their protein and fat requirements.

Sucrene Horse Feed contains malt sprouts, linseed, barley and corn products, oat product (hulls), weed seeds and a sugar product.

Buffalo Cereal Co.'s Horse Feed contains cracked corn and oat product (hulls), a wheat product, and a little linseed meal.

Husted's Horse Feed contains corn, oats and wheat products.

Molac Molasses Horse Feed contains corn, oats and wheat products, weed seeds, a little cotton seed meal, linseed meal and molasses.

Proprietary Dairy and Stock Feeds.

Analyses on pages 206 to 209.

Here are included a number of feeds apparently designed especially for cows in milk. All of them have a guaranty of composition.

One sample of *Biles' Union Grains,* bearing a protein guaranty two per cent. higher than the other two samples of this feed, was deficient by 2.88 per cent. *Blatchford's Calf Meal* and *Buffalo Creamery Feed* were slightly deficient in fat. The sample of *Hammond's Dairy Feed* analyzed contained only 15 per cent. of protein, two per cent. below the guaranty.

The materials found in these dairy feeds are as follows:

Sucrene Dairy Feed. Corn, barley, oat and wheat products, cotton seed meal, linseed meal and a sugar product.

Biles' Union Grains. Corn product (gluten feed), wheat, oat and barley products, cotton seed meal, linseed meal and malt sprouts.

Blatchford's Calf Meal. Linseed meal, bean meal, cotton seed meal and fenugreek.

Buffalo Creamery Feed. Corn product (gluten feed), wheat product, cotton seed meal and oat chaff.

Buffalo Stock Feed. Corn and oat products.

Wirthmore Stock Feed. Corn product (hominy) and oat product.

Daisy Dairy Feed. Corn, oat and wheat products, cotton seed meal, malt sprouts, barley residues and molasses.

Sterling Stock Feed. Corn, oat and wheat products.

Matchless Stock Feed. Corn product (hominy), wheat product and oat hulls.

Molac Dairy Feed. Wheat, oat and corn products, cotton seed meal, weed seeds and molasses.

Quaker Dairy Feed. Wheat, corn and oat products and a little cotton seed meal.

Hammond's Dairy Feed. Corn and oat products, malt sprouts, distillery residues and molasses.

A sample of *H. O. Dairy Feed,* 18722, sent by Thos. Holt, Southington, and one of *Biles' Union Grains,* 19430, sent by Jos. J. Smith, Middletown, had the following composition:

	18722	19430
Water	9.30	10.74
Ash	4.35	6.56
Protein	14.25	23.75
Fiber	11.35	8.42
Nitrogen-free Extract	56.72	41.50
Fat	4.03	9.03
	100.00	100.00

Proprietary Poultry Feeds.

Analyses on pages 208 and 209.

Four samples were examined, all of which were guaranteed as required by law.

Buffalo Poultry Feed was 1.75 per cent. low in protein and 0.37 per cent. low in fat.

Purina Mill Feed Alfalfa Meal was 1.75 per cent. low in protein, and 1.13 per cent. low in fat. It appeared to be pure alfalfa, but the hay seemed very mature and the sample contained a high percentage of fiber, 31.58 per cent.

The poultry feeds consisted of the following materials:

Buffalo Poultry Feed. Wheat and corn products.

Husted's Poultry Feed. Wheat bran, corn and oat products and alfalfa.

American Poultry Feed. Corn and wheat products and a little oats.

A sample of *Rellom Mash,* 18749, made and sent by C. G. Moller, New Canaan, had the following composition:

	18749
Water	8.95
Ash	7.66
Protein	24.19
Fiber	7.93
Nitrogen-free Extract	44.81
Fat	6.46
	100.00

A sample of screenings, **18793**, sent by P. A. Holt, Farmington, was subjected to a botanical analysis with the following result:

	Per cent. by weight
Linseed	8.4
Cereals, Broken Wheat	19.1
Cracked Corn	2.3
Oats	2.2
Barley	0.7
Grasses, German millet, (*Setaria Italica* Beauv.)	0.1
Barnyard grass, (*Panicum Crus-galli* L.)	0.1
Yellow Foxtail, (*Setaria glauca* Beauv.)	3.7
Green Foxtail, (*Setaria viridis* Beauv.)	11.4
Weeds, Charlock and other crucifers	10.6
Black Bindweed, (*Polygonum convolvulus* L.)	8.3
Lady's Thumb, (*Polygonum persicaria* L.)	1.3
Other polygonums	0.1
White dock, (*Rumex salicifolius* Weinm)	1.2
False flax, (*Camelina sativa* L.)	0.4
Pig weed, (*Chenopodium* sp.)	8.1
Compositae	1.0
Dust, broken seeds, etc.	15.5
Straw, stems, etc.	5.5
	100.0

Meat Scrap.

Analyses on pages 208 and 209.

One sample was analyzed and was found to be of average quality. It did not bear a guaranty as required by law.

Two samples of beef scrap were sent by W. E. Sayles, Danielson. One, **18929**, made by Darling & Co., Long Island City, N. Y., contained 62.75 per cent. of protein and 13.27 per cent. of fat. The other, **18930**, manufacturer unknown, sold by Park Pollard Co., Boston, contained 56.13 per cent. of protein and 15.04 per cent. of fat. Both samples exceeded their guaranties in both particulars.

Miscellaneous.

Peanut Refuse, a by-product in the manufacture of peanut butter, consists of the hulls and small bits of the roasted peanut. A sample, **18795**, was sent by R. B. Smith, Berlin, who reports that poultry like it very much. It contained:

Water	3.57
Ash	4.68
Protein	22.38
Fiber	7.73
Nitrogen-free Extract	28.75
Fat	32.89
	100.00

Extra Vim Molasses. This is sold as a stock feed by the Boston Molasses Co. for 14 cents a gallon and, with freight added, cost the purchaser 16⅙ cents delivered. The gallon weighs 12 pounds.

A sample, **19961**, was sent for analysis by E. H. Austin, Gaylordsville, who reports feeding with good results a pint a day in three feeds on grain to horses which are fond of it. The sample contained

Moisture		25.72
Total ash		6.24
Of which soluble in water	4.02	
insoluble in water	2.22	
Total nitrogen calculated as protein		2.88
Matters by difference, sugar, gums, etc.		65.16
		100.00

THE DIGESTIBILITY OF FEEDING-STUFFS.

A certain part of every feeding-stuff is indigestible and passes through the body into the dung without doing anything to sustain the animal. The value of a commercial feed rests wholly in that portion of it which the animal can, under favorable conditions, digest or appropriate and make a part of itself. Some animals have greater power of digestion than others, and the amount of any ingredient, protein, fat, or fiber, digested by a given animal depends much on the proportion of other ingredients which are fed along with it. Thus, if starchy matter is fed in too large proportion, a considerable part of it will pass into the dung and be wasted. But fed in proper fashion over 90 per cent. of it may be taken up by the body and nourish it.

Table I gives the "digestion coefficients" of most of the feeds mentioned in Table IV.

The digestion coefficient of protein, for example, in cotton seed meal is 84. This means that in a properly made ration, neat cattle, in good health, may be expected, on the average, to digest about 84 parts out of every 100 parts of the protein of cotton seed meal of good quality. The table has no great mathematical precision, but is, nevertheless, a valuable general guide in feeding.

The use of the table is quite simple. Suppose analysis shows a certain sample of cotton seed meal to contain 43.5 per cent. of protein; that is, 43.5 pounds of protein in 100 pounds of the meal. It is desired to know how much *digestible* protein is contained in 100 pounds of meal. The table of "digestion coefficients" shows that of every 100 pounds of crude protein in cotton seed meal 84 pounds are digestible. It follows, by the rule of three (100 is to 84 as 43.5 is to 36.54), that, of the 43.5 pounds of protein, 36.54 pounds are digestible. To apply the table, multiply the percentage found on analysis by the proper coefficient taken from the table and divide the product by 100. The result will be the percentage amount of *digestible* protein, fiber, etc., as the case may be.

In Table IV, under the averages of analyses, will be found calculated the average digestible nutrients contained in the different feeding-stuffs, so far as the data at hand permit.

TABLE I.—DIGESTION COEFFICIENTS, OR PERCENTAGES OF THE FOOD INGREDIENTS, FOUND BY ANALYSES, WHICH ARE DIGESTIBLE BY NEAT CATTLE.

(Lindsley's Compilation, Eighteenth Report Massachusetts (Hatch) Agricultural Station 1905, page 240 *et seq.*)

	Protein.	Fiber.	Nitrogen-free Extract.	Fat.
Cotton Seed Meal	84	35	78	94
Linseed Meal, new process	84	74	80	89
Linseed Meal, old process	89	57	78	89
Corn Meal	66	..	92	91
Hominy Meal and Star Feed	65	67	89	92
Gluten Feed	85	76	89	83
Wheat Bran	77	39	71	63
Wheat Middlings	77	30	78	88
Wheat Mixed Feed	78	62	77	87
Rye Feed	80	..	88	90
Oats	77	31	77	89
Buckwheat Middlings	85	17	83	89
Malt Sprouts	80	34	69	100
Dried Distillers' Grains	73	95	81	95
Brewers' Grains	81	49	57	89
Quaker Dairy Feed	70	55	59	74
Corn and Oat Feed, Provender	71	48	83	87
Wheat and Corn Cob	63	28	71	92
Sucrene Dairy Feed	61	72	73	95

REGARDING THE PURCHASE OF COMMERCIAL FEEDING-STUFFS.

A well-managed dairy farm should produce all of the coarse fodder,—in form of corn fodder or stover, hay and ensilage,—which is needed for the stock, and, excepting under unusual conditions, should also supply an abundance of starchy food, such as corn meal and in some cases oats and barley, for feeding purposes.

These the farmer should be able to produce in abundance.

But in order to feed them without waste and also to supply a deficiency in them, it is almost always advisable or necessary, in the absence of clover, alfalfa or other leguminous crops, to buy feeds *rich in digestible protein*;—considerably richer in it than corn meal.

This will appear from a glance at the following statement of the average composition of the coarse fodders commonly raised on the farm, and of the amounts of digestible matters,—nutrients,—in them.

Composition. Pounds per one hundred.

	Hay of Mixed Grasses.	Timothy Hay.	Red Top Hay.	Corn Stover.	Corn Silage.	Corn Fodder.	Corn Meal.
Water	14.0	14.0	14.0	40.0	80.0	40.0	13.3
Ash	5.3	4.2	4.6	3.9	1.1	2.8	1.4
Protein	7.9	8.4	6.5	4.6	1.7	4.7	9.1
Fiber	27.7	28.1	28.5	20.6	5.4	14.8	2.0
N.-free Ext.	42.8	43.4	44.9	30.1	11.1	36.0	70.3
Fat	2.3	1.9	1.5	0.8	0.7	1.7	3.9
	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Digestible matter, "Nutrients," in pounds.

	Hay of Mixed Grasses.	Timothy Hay.	Red Top Hay.	Corn Stover.	Corn Silage.	Corn Fodder.	Corn Meal.
Protein	3.7	4.0	4.0	1.7	0.8	2.1	6.0
Fiber	18.0	14.1	17.4	13.2	3.5	9.3	....
N.-free Ext.	25.3	26.9	27.8	17.8	7.7	26.3	64.6
Fat	1.0	1.0	0.8	0.5	0.5	1.2	3.3
Pounds of nitrogen, phosphoric acid and potash.							
Nitrogen	1.26	1.34	1.04	0.74	0.27	0.75	1.45
Phosphoric acid	0.32	0.33	0.33	0.20	0.13	0.54	0.7
Potash	1.61	1.42	0.95	0.92	0.39	0.89	0.3

Twenty-five pounds of dry, coarse fodder is about as much as the average cow, weighing perhaps 850 pounds, ought to eat per day of such kind of feed. The following statement shows the digestible food in this quantity of hay, and for comparison the approximate amounts which experience shows are required by a cow of 850 pounds in full milk.

	In 25 lbs. hay pounds.	Standard Requirement pounds.
Organic matter	20.0	21.
Digestible protein	0.9	1.8–2.1
" fiber and N.-free Ext.	10.8	10.6–11.2
" fat	0.2	0.4–0.6

From this it appears that meadow hay, if fed in sufficient amount to supply the daily need of the animal for non-nitrogenous nutrients and organic matter, supplies only a scant half of the protein requirements. It cannot be fed in quantity sufficient to meet this protein requirement because the animal cannot handle this quantity.

The case cannot be greatly improved with corn meal alone. Fifteen pounds of hay with 8 pounds of corn meal will supply:

1.04 pounds of digestible protein,
11.65 " " " fiber and N.-free ext.,
0.41 " " " fat,

which is far from enough protein but is about as near as we can come to a standard ration with these two things. There is needed some feed, rich in protein and relatively poor in starchy matter, to "balance" the ration so that neither the coarse fodder nor the meal shall be fed to waste.

A ration made up of 12½ pounds of hay, 2 pounds cotton seed meal and five pounds each of corn meal and wheat bran would supply about:

20.0 pounds of dry organic matter,
2.1 " " digestible protein,
11.2 " " " fiber and N.-free ext.,
0.6 " " " fat,

which fully meets the requirements of a standard ration for a cow in full milk.

The analyses given on following pages show what feeds are at present on our market, which of them meet this demand for digestible protein at reasonable prices and which of them do not meet this demand and cannot be fed to advantage.

The main facts given in Table IV are summarized in Table III, which shows, first, the average composition of these feeding stuffs as determined by our recent examination and arranged according to the per cent. of protein in them; second, the amount of digestible matter in each feed, as far as we have been able to calculate it, third, the average retail prices of the feeds in October and November last; fourth, the number of pounds of digestible matter (nutrients) purchasable for one dollar in each of the feeds; and lastly the quantities of nitrogen, phosphoric acid and potash contained in each. The figures regarding phosphoric acid and potash have been taken chiefly from recent bulletins of other stations. They were not obtained from the analyses of the feeds examined here but are approximately correct for them.

The feeds examined are tabulated in six groups. The following statement gives the average quantities (in pounds) of digestible protein, fiber and nitrogen-free extract and fat purchasable for one dollar in each of these groups.

NUTRIENTS PURCHASABLE FOR ONE DOLLAR.

	Protein.	Fiber and Nitrogen-free Extract.	Fat.
1 Feeds containing over 30 per cent. protein	17.7	19.3	4.8
2 " " 25 to 30 " "	15.6	25.2	2.8
3 " " 20 to 25 " "	12.1	33.7	2.4
4 " " 15 to 20 " "	8.3	29.6	2.4
5 " " 10 to 15 " "	6.0	27.6	2.6
6 " " less than 10 " "	3.8	36.0	2.3

The amount of digestible fat is nearly the same in these different groups. The chief difference is in the amounts of the other two ingredients. Protein is by far the more expensive of these two, more than one-sixth of it being nitrogen, the element most generally lacking in our soils, most expensive to buy in fertilizers and most necessary to "balance" the feed of our stock.

If the feeder is mainly concerned in getting protein for his grain feed he certainly cannot afford to buy feeds of the last three groups, containing less than about 20 per cent. of nitrogen. But even if he wishes to buy starchy food, he can get more for the same money in group three than in four and five, and considering that he gets more than twice as much protein along with his carbohydrates in group three than in group six, while the quantity of starchy matter is but little less, the economy of buying these very low protein foods even for the starchy matter in them is more than doubtful.

To these considerations should be added that of the manure value of the feed.

The richer the feed in protein, the richer will be the manure in nitrogen—its most costly ingredient. With the figures given here, the quantities of nitrogen, phosphoric acid and potash of the ration can be computed.

If from these one-fifth is deducted for what goes into the milk, the remainder is approximately what goes into the dung.

THE WEIGHT OF ONE QUART OF VARIOUS FEEDING STUFFS.

The following table gives the weight of one quart of the feeds named, and is useful to calculate the weight of grain ration fed, from the measure which is almost universally used on farms.

This table was prepared by Mr. H. G. Manchester, of Winsted.

TABLE II.—THE AVERAGE WEIGHT OF ONE QUART OF EACH OF THE FEEDS NAMED.

	Pounds.
Cotton Seed Meal	1.5
Linseed Meal, old process	1.1
Linseed Meal, new process	0.9
Gluten Feed	1.4
Distillers' Grains	0.7
Wheat Bran, coarse	0.5
Wheat Middlings, coarse	0.8
Wheat Middlings, fine	1.1
Mixed Wheat Feed	0.6
Corn Meal	1.5
Hominy Meal	1.3
Provender	1.5
Oats	1.2
Rye Bran	0.6
H. O. Dairy Feed	0.7
Alfalfa Meal	1.0
Molasses or Sugar Feed	1.1
Victor Corn and Oat Feed	0.7

TABLE III.—AVERAGE COMPOSITION OF FEEDS, SELLING PRICE.

	In 100 pounds of feed are contained pounds of						In 100 pounds of feed are contained pounds of digestible			
	Water.	Ash.	Protein (N x 6.25).	Fiber.	Nitrogen-free Extract (Starch, etc.)	Ether Extract (Fat).	Protein.	Fiber.	Nitrogen-free Extract.	Fat.
1. Protein over 30 per cent.										
Cotton Seed Meal	9.44	6.87	38.89	8.82	26.34	9.64	32.5	3.1	20.5	9.1
Linseed Meal, new process	10.97	6.22	36.69	8.46	34.60	3.06	30.8	6.3	27.7	2.7
" " old process	11.33	5.39	34.40	6.87	34.45	7.56	30.6	3.9	26.9	6.7
H. G. Dried Distillery Grains	8.06	2.89	31.22	11.80	32.70	13.33	22.8	11.2	26.5	12.7
2. Protein 30–25 per cent.										
Buckwheat Middlings	17.27	3.94	28.37	3.34	39.94	7.14	24.1	0.6	33.2	6.4
Gluten Feed, Globe	8.62	3.32	27.28	6.54	51.26	2.98	23.2	5.0	45.6	2.5
Malt Sprouts	9.80	5.96	27.04	11.61	44.15	1.44	21.6	3.9	30.5	1.4
Dried Brewers' Grains	9.64	3.39	27.00	11.42	41.29	7.26	21.9	5.6	23.5	6.5
3. Protein 25–20 per cent.										
Gluten Feed, Warner's	10.59	1.76	24.81	6.95	52.49	3.40	21.1	5.3	46.7	2.8
" " Hubinger's	11.19	1.05	24.62	7.26	53.31	2.57	20.9	5.5	47.4	2.1
" " Buffalo	9.93	2.03	24.35	6.74	54.08	2.87	20.7	5.1	48.1	2.4
" " Queen	9.96	1.83	23.87	6.14	55.52	2.68	20.3	4.7	49.4	2.2
Union Grains, Biles Ready Ration	8.90	6.33	23.44	9.16	44.48	7.69	---	---	---	---
A1 Distillers' Grains	7.55	2.18	21.56	11.66	46.43	10.62	15.7	11.1	37.6	10.1
Gluten Feed, Union	9.13	0.69	21.37	6.69	56.98	5.14	18.2	5.1	50.7	4.3
" " Illinois	11.22	0.97	20.87	6.47	57.38	3.09	17.7	4.9	51.1	2.6
Buffalo Creamery Feed	9.51	4.38	20.62	10.91	49.91	4.67	---	---	---	---
4. Protein 20–15 per cent.										
Gluten Feed, Michigan	10.25	0.90	19.50	5.97	57.48	5.90	16.6	4.5	51.2	4.9
" " Bay State	8.87	0.91	18.50	5.50	58.80	7.42	15.7	4.2	52.3	6.2
Daisy Dairy Feed	10.01	7.94	17.94	8.80	51.81	3.50	---	---	---	---
Sucrene Dairy Feed	11.56	7.82	17.75	10.06	48.39	4.42	10.8	7.2	35.3	4.2
Flax Feed	9.71	6.92	17.54	10.39	37.69	17.75	---	---	---	---
Rye Middlings	12.51	2.93	17.25	2.84	61.80	2.67	---	---	---	---
Wheat Middlings, Spring	11.60	4.38	17.26	5.85	55.60	5.31	13.3	1.8	43.4	4.7
Molac Dairy Feed	10.11	5.98	17.06	11.20	51.10	4.55	---	---	---	---
Wheat Middlings, Winter	11.72	4.41	17.02	5.09	56.81	4.95	13.1	1.5	44.3	4.4
Wheat Mixed Feed, Spring	11.35	5.27	16.54	6.94	54.90	5.00	12.9	4.3	42.2	4.4
" " " Winter	11.51	5.79	16.07	6.93	54.90	4.80	12.5	4.3	42.3	4.2
Wheat Bran, Winter	11.01	6.90	15.74	8.12	53.78	4.45	12.1	3.2	38.2	2.8
" " Spring	11.21	6.55	15.16	9.40	52.68	5.00	11.7	3.7	37.4	3.2
5. Protein 15–10 per cent.										
Molasses Grains	15.48	6.48	14.87	10.61	50.30	2.26	---	---	---	---
Hammond Dairy Feed	8.82	7.54	15.00	10.30	55.01	3.33	---	---	---	---
Rye Feed	12.32	3.80	14.50	2.97	63.66	2.75	11.6	---	56.0	2.5
Husted Horse Feed	9.95	3.00	13.25	5.79	62.67	5.34	---	---	---	---
Quaker Dairy Feed	8.40	5.71	13.19	16.29	52.79	3.62	9.2	9.0	31.1	2.7
Sucrene Horse Feed	11.83	7.27	13.12	8.69	55.51	3.58	---	---	---	---
Buffalo Horse Feed	11.35	2.76	13.01	5.95	61.68	5.25	---	---	---	---
Molac Molasses Horse Feed	10.52	6.04	12.50	14.00	53.64	3.30	---	---	---	---
Rye Bran	12.50	2.52	11.87	1.93	68.81	2.37	---	---	---	---
Sterling Stock Feed	12.05	3.54	11.00	6.46	63.15	3.80	---	---	---	---
Hominy Feed	10.23	2.56	10.50	4.28	64.43	8.00	6.8	2.9	57.3	7.4
Corn, Oats and Barley	10.64	4.02	10.50	10.14	60.60	4.10	---	---	---	---
6. Protein under 10 per cent.										
Matchless Stock Feed	9.55	4.12	9.75	10.49	58.97	7.12	---	---	---	---
Wirthmore Stock Feed	9.62	3.46	9.69	8.16	61.89	7.18	---	---	---	---
Wheat and Corn Cob	10.25	4.39	9.16	16.65	56.90	2.65	5.8	4.7	40.4	2.4
Corn and Oat Feeds	11.25	2.83	8.99	6.36	66.06	4.51	6.4	3.1	54.8	3.9
Buffalo Stock Feed	10.89	2.55	8.75	7.29	65.84	4.68	---	---	---	---
Star Feed	9.96	2.16	8.27	9.33	65.15	5.13	5.4	6.3	58.0	4.7
Ground Rice	9.30	0.63	7.87	0.06	81.79	0.35	---	---	---	---

TOTAL DIGESTIBLE MATTER, DIGESTIBLE MATTER PURCHASABLE FOR ONE DOLLAR AND FERTILIZER INGREDIENTS.

	Pounds nutrients (digestible) purchasable for one dollar.			In 100 pounds are contained pounds of			Cost per ton.
	Protein.	Fiber and Nitrogen-free Extract.	Fat.	Nitrogen.	Phosphoric acid.	Potash.	
Cotton Seed Meal	20.1	14.6	5.6	6.2	2.9	1.9	$32.36
Linseed Meal, new process	18.4	20.3	1.6	5.9	1.8	1.4	33.50
" " old process	17.6	17.7	3.8	5.5	1.6	1.3	34.67
H. G. Dried Distillery Grains	14.8	24.5	8.2	4.9	0.8	0.2	30.75
Buckwheat Middlings	15.1	21.1	4.0	4.6	2.7	1.4	32.00
Gluten Feed, Globe	15.0	32.4	1.5	4.4	0.6	0.1	31.17
Malt Sprouts	17.2	27.4	1.1	4.3	1.6	1.8	25.08
Dried Brewers' Grains	15.1	20.0	4.5	4.3	1.0	0.1	29.00
Gluten Feed, Warner's	13.2	32.4	1.7	3.9	0.3	0.1	32.00
" " Hubinger's	13.1	33.2	1.3	3.9	0.6*	0.2*	32.00
" " Buffalo	13.1	33.9	1.5	3.9	1.2	0.6	31.40
" " Queen	12.3	32.8	1.3	3.8	0.4	0.0	33.00
Union Grains, Biles Ready Ration	----	----	----	3.8	1.5	0.8	31.00
A1 Distillers' Grains	10.1	31.4	6.5	3.5	1.5	0.8	31.00
Gluten Feed, Union	11.7	36.0	2.7	3.4	0.6*	0.2*	31.00
" " Illinois	11.4	36.1	1.7	3.3	0.6*	0.2*	31.00
Buffalo Creamery Feed	----	----	----	3.3	1.4	1.0	35.00
Gluten Feed, Michigan	10.4	34.8	3.0	3.1	0.3	0.1	32.00
" " Bay State	9.8	35.3	3.8	3.0	0.6*	0.2*	32.00
Daisy Dairy Feed	----	----	----	2.9	----	----	30.00
Sucrene Dairy Feed	7.2	28.3	2.8	2.9	0.8	1.9	30.00
Flax Feed	----	----	----	2.8	----	----	26.67
Rye Middlings	----	----	----	2.8	----	----	33.00
Wheat Middlings, Spring	8.1	27.6	2.9	2.8	1.4	0.7	32.69
Molac Dairy Feed	----	----	----	2.7	----	----	30.00
Wheat Middlings, Winter	8.1	28.4	2.7	2.7	1.4	0.7	32.18
Wheat Mixed Feed, Spring	7.9	28.7	2.7	2.7	2.0	0.5	32.36
" " " Winter	8.0	29.9	2.7	2.6	2.0	0.5	31.12
Wheat Bran, Winter	7.8	26.5	1.8	2.5	2.9	1.6	31.25
" " Spring	7.6	26.7	2.0	2.4	2.9	1.6	30.68
Molasses Grains	----	----	----	2.4	----	----	28.00
Hammond Dairy Feed	----	----	----	2.4	0.9	2.1	24.00
Rye Feed	7.7	37.3	1.6	2.3	1.6	1.1	30.00
Husted Horse Feed	----	----	----	2.1	----	----	34.00
Quaker Dairy Feed	6.1	26.7	1.8	2.1	1.0	0.9	30.00
Sucrene Horse Feed	----	----	----	2.1	0.6	1.7	31.00
Buffalo Horse Feed	----	----	----	2.1	1.0	0.7	36.00
Molac Molasses Horse Feed	----	----	----	2.0	----	----	26.00
Rye Bran	----	----	----	1.9	1.3	0.8	27.00
Sterling Stock Feed	----	----	----	1.8	0.8	0.7	34.00
Hominy Feed	4.3	19.0	4.6	1.7	1.3	0.7	31.84
Corn, Oats and Barley	----	----	----	1.7	0.8	0.6	33.00
Matchless Stock Feed	----	----	----	1.6	----	----	35.00
Wirthmore Stock Feed	----	----	----	1.5	----	----	36.00
Wheat and Corn Cob	4.1	31.6	1.7	1.5	2.2	1.4	28.50
Corn and Oat Feeds	3.8	34.7	2.3	1.4	0.5	0.7	33.30
Buffalo Stock Feed	----	----	----	1.4	0.9	0.6	33.00
Star Feed	3.5	41.5	3.0	1.3	---	----	31.00
Ground Rice	----	----	----	1.3	----	----	30.00

* Average of other brands of gluten feed.

Table IV.—Analyses of Commercial Feeds Sampled in 1907.

Station No.	Brand.	Retail Dealer.	Analyses. Water.	Ash.	Protein. (N x 6.25.)	Fiber.	Nitrogen-free Extract. (Starch, gum, etc.)	Ether Extract. (Fat.)	Price per ton.
	Oil Seed Products. *Cotton Seed Meal.*								
19870	Little Rock, Ark., Mill, American Cotton Oil Co., N. Y.	*Granby:* Latham & Chittenden	9.60	6.86	42.69	6.60	24.58	9.67	$32.00
19711	Owl Brand. F. W. Brode & Co., Memphis, Tenn.	*Southington:* South. Lumber & Feed Co.	9.67	7.50	38.56	8.72	25.70	9.85	32.00
19853	" " " " " "	*Thompsonville:* H. K. Brainard	8.86	7.59	37.69	8.26	27.63	9.97	33.00
19701	Eastern Cotton Oil Co., Hertford, N. C.	*New Haven:* R. G. Davis	9.78	7.35	38.00	8.02	27.14	9.71	31.00
19771	" " " " "	*New Britain:* C. W. Lines & Co.	10.15	7.35	36.81	8.15	28.17	9.37	33.00
19827	Humphreys, Godwin & Co., Memphis, Tenn.	*Moosup:* T. E. Main & Sons	7.96	6.86	41.00	8.92	24.84	10.42	32.00
19856	" " " " "	*Suffield:* Spencer Bros.	7.96	6.18	40.75	8.03	21.86	15.22	30.00
19760	Prime. The Hunter Bros. Mill. Co., St. Louis, Mo.	*Hartford:* Smith, Northam & Co.	9.98	7.00	41.13	9.98	23.26	8.65	35.00
19774	" " " " " "	*New Britain:* Hugh Reynolds	10.40	6.39	37.75	10.09	28.17	7.20	33.00
19795	" " " " " "	*New Haven:* Abner Hendee	10.00	6.21	34.75	11.79	30.32	6.93	33.00
19838	" " " " " "	*Willimantic:* H. A. Bugbee	9.45	6.31	38.69	8.46	27.99	9.10	32.00
		Average guaranty	----	----	39.00	----	----	7.73	
		Average of these 11 analyses	**9.44**	**6.87**	**38.89**	**8.82**	**26.34**	**9.64**	**32.36**
		Average digestible	----	----	**32.5**	**3.1**	**20.5**	**9.1**	
	Linseed Meal, New Process.								
19698	Linseed Oil Meal. Amer. Linseed Co., Chicago	*New Haven:* R. G. Davis	11.01	6.02	37.38	8.60	33.95	3.04	32.00
19756	" " " " "	*Meriden:* Meriden Grain & Feed Co.	10.92	6.42	36.00	8.32	35.27	3.07	35.00
		Guaranty	----	----	36.00	----	----	1.00	
		Average of these 2 analyses	**10.97**	**6.22**	**36.69**	**8.46**	**34.60**	**3.06**	**33.50**
		Average digestible	----	----	**30.8**	**6.3**	**27.7**	**2.7**	
	Linseed Meal, Old Process.								
19794	Oil Meal. American Linseed Co., N. Y.	*New Haven:* Abner Hendee	11.04	5.36	34.94	6.86	34.65	7.15	33.00
19777	" The Mann Bros. Co., Buffalo, N. Y.	*Bridgeport:* Berkshire Mills	11.72	5.32	35.75	6.93	32.74	7.54	35.00
19759	" The Metzger Seed & Oil Co., Toledo, Ohio	*Hartford:* Smith, Northam & Co.	11.22	5.48	32.50	6.83	35.97	8.00	36.00
		Average guaranty	----	----	32.67	----	----	5.33	
		Average of these 3 analyses	**11.33**	**5.39**	**34.40**	**6.87**	**34.45**	**7.56**	**34.67**
		Average digestible	----	----	**30.6**	**3.9**	**26.9**	**6.7**	
	Wheat Products. *Bran from Winter Wheat.*								
19783	Ballard's Bran. Ballard & Ballard Co., Louisville, Ky.	*Stamford:* Scofield & Miller	10.54	6.85	14.87	7.99	55.05	4.70	32.00
19810	Bowersock Mills & Prov. Co., Lawrence, Kas.	*New London:* P. Schwartz	10.57	7.66	15.37	9.85	51.87	4.68	32.00
19804	Newport Bran. Chas. M. Cox Co., Boston*	*Guilford:* G. F. Walter	11.17	6.83	17.25	7.64	52.46	4.65	30.00
19798	The Hunter Bros. Mill Co., St. Louis	*Derby:* Peterson-Hendee Co.	10.22	7.00	14.25	7.57	56.34	4.62	32.00
19816	Climax Bran. Kansas Mill. Co., Wichita, Kas.	*Norwich:* Norwich Grain Co.	11.10	6.50	16.50	8.35	53.24	4.31	30.00
19801	K.C.K. Bran. Southwestern Mill. Co., Kansas City	*Ansonia:* Ansonia Flour & Grain Co.	11.07	7.05	15.94	8.27	53.36	4.31	31.00
19745	Voigt Milling Co., Grand Rapids, Mich.	*Wallingford:* E. E. Hall	12.08	5.92	15.40	6.27	56.08	4.25	31.00
19875	H. B. Tuttle, Naugatuck, Conn.*	*Middlebury:* L. Abbott & Son	11.32	7.39	16.31	9.00	51.90	4.08	32.00
		Average of these 8 analyses	**11.01**	**6.90**	**15.74**	**8.12**	**53.78**	**4.45**	**31.25**
		Average digestible	----	----	**12.1**	**3.2**	**38.2**	**2.8**	
	Bran from Spring Wheat.								
19833	Atlas Bran. Atlas Flour Mills, Milwaukee, Wis.	*Danielson:* Young Bros. Co.	12.76	6.12	15.00	9.53	51.70	4.89	31.00
19836	Commander Bran. Commander Mills, Minneapolis	*Putnam:* F. M. Cole	10.82	7.00	14.25	10.67	52.66	4.60	34.00
19832	Coarse Bran. Wm. G. Crocker, Minneapolis	*Danielson:* Quinebaug Mills	12.33	6.55	15.12	9.66	51.34	5.00	32.00
19882	J. G. Davis Co., Rochester, N. Y.	*Torrington:* E. H. Talcott Est.	10.77	6.39	15.75	9.13	52.74	5.22	31.00

* Statement of Dealer.

Table IV.—Analyses of Commercial Feeds Sampled in 1907—*Continued.*

Station No.	Brand.	Retail Dealer.	Analyses.						Price per ton.
			Water.	Ash.	Protein. (N x 6.25.)	Fiber.	Nitrogen-free Extract. (Starch, gum, etc.)	Ether Extract. (Fat.)	
	Wheat Products—*Continued.* *Bran from Spring Wheat.*								
19849	Imperial Bran. Duluth Superior Mill Co., Duluth, Minn.	*Rockville:* Rockville Milling Co.	10.90	5.83	16.25	8.62	53.36	5.04	$31.00
19776	Clover Leaf Bran. Gardner Mill, Seymour Carter, Hastings, Minn.	*New Britain:* M. D. Stanley	11.79	6.08	13.06	10.47	53.78	4.82	30.00
19843	Harvey Milling Co., Harvey, No. Dak.	*Stafford Springs:* Geo. L. Dennis	10.80	6.46	15.94	8.69	52.85	5.26	31.00
19823	Ben Hur Coarse Bran. Hennepin Mill Co., E. W. Bailey & Co., Agt., Montpelier, Vt.	*Yantic:* A. R. Manning	10.87	6.62	14.62	10.64	52.61	4.64	30.00
19743	W. J. Jennison Co., Minneapolis	*Branford:* S. V. Osborn	11.57	7.01	15.94	8.68	52.02	4.78	29.00
19788	Go-Far Bran. New Prague Flour Mill Co., New Prague, Minn.	*Norwalk:* Brower & Malone	10.82	6.50	15.12	10.47	52.22	4.87	30.00
19780	Independence Blended Bran. N. Y. City Milling Co., N. Y.	*Bridgeport:* The W. M. Terry Co.	10.50	6.32	15.25	9.31	53.35	5.27	30.00
19706	The Northwestern Cons. Mill. Co., Minneapolis	*Plantsville:* T. B. Atwater	11.07	6.55	15.63	8.82	52.78	5.15	30.00
19762	" " " "	*Hartford:* Smith, Northam & Co.	11.60	7.14	15.00	9.38	51.81	5.07	32.00
19730	Pillsbury's Bran, Minneapolis	*Plainville:* G. W. Eaton Est.	11.86	6.55	14.75	9.79	52.04	5.01	30.00
19883	Russell-Miller Mill. Co., Minneapolis	*Torrington:* E. H. Talcott Est.	10.61	6.44	15.62	7.98	53.82	5.53	31.00
19729	Big Diamond Bran. Sheffield Mill & Elev. Co., Minneapolis	*Plainville:* G. W. Eaton Est.	11.21	6.42	15.81	8.78	52.72	5.06	30.00
19854	Star & Crescent Mill. Co., Chicago	*Thompsonville:* H. K. Brainard	10.84	7.28	15.25	9.24	52.47	4.92	30.00
19866	Fancy Bran. Geo. Tileston Mill. Co., St. Cloud, Minn.	*Shelton:* Taylor & Morse	10.47	6.46	14.37	9.52	54.53	4.65	31.00
19708	Coarse Bran. Washburn-Crosby Co., Minneapolis	*Southington:* South. Lumber & Feed Co.	11.41	6.75	15.25	9.15	52.28	5.16	30.00
		Average of these 19 analyses	**11.21**	**6.55**	**15.16**	**9.40**	**52.68**	**5.00**	**30.68**
		Average digestible	----	----	**11.7**	**3.7**	**37.4**	**3.2**	
	Middlings from Winter Wheat.								
19811	Pure Wheat Shorts. Bowersock Mills & Prov. Co., Lawrence, Kas.	*New London:* P. Schwartz	11.70	3.48	16.69	3.34	60.23	4.56	32.00
19731	E. & S. M. Chas. M. Cox Co., Boston*	*Plainville:* G. W. Eaton Est.	11.78	4.42	16.38	5.90	56.62	4.90	33.00
19718	Eckhart & Swan Mill. Co., Chicago	*Bristol:* G. W. Eaton Est.	11.62	4.80	16.38	6.41	55.79	5.00	31.00
19714	Isaac Harter Mill. Co., Toledo, O.	*Bristol:* W. O. Goodsell	12.45	4.17	17.69	2.78	58.18	4.73	32.00
19742	M. Middlings. Hecker-Jones-Jewell Mill. Co., N. Y.	*North Haven:* Coöperative Feed Co.	10.32	5.39	16.69	6.35	56.19	5.06	31.00
19796	H. Middlings. Hecker-Jones-Jewell Mill. Co., N. Y.	*New Haven:* Abner Hendee	10.47	5.35	16.69	8.48	53.27	5.74	31.00
19786	The Hunter Bros. Mill. Co., St. Louis	*Norwalk:* Brower & Malone	12.54	4.10	15.81	3.80	59.13	4.62	34.00
19719	Snowflake. Lawrenceburg Roller Mill. Co., Lawrenceburg, Ind.	*Bristol:* G. W. Eaton Est.	12.40	3.69	19.38	3.64	55.68	5.21	33.00
19767	Manhattan Blended. N. Y. City Mill. Co., N. Y.	*Hartford:* L. C. Daniels Grain Co.	11.46	4.17	16.88	5.95	56.34	5.20	32.00
19837	Taylor's. The Northwestern Elev. & Mill. Co., Londonville, O.	*Putnam:* Bosworth Bros.	11.45	4.79	18.25	4.76	56.10	4.65	32.00
19732	F. W. Stock & Sons, Hillsdale, Mich.	*New Haven:* J. T. Benham Est.	12.70	4.10	16.38	4.60	57.49	4.73	33.00
		Average of these 11 analyses	**11.72**	**4.41**	**17.02**	**5.09**	**56.81**	**4.95**	**32.18**
		Average digestible	----	----	**13.1**	**1.5**	**44.3**	**4.4**	
	Middlings from Spring Wheat.								
19886	Flour Middlings. Banner Mill. Co., Buffalo, N. Y.	*Winsted:* F. Woodruff & Sons	10.03	4.10	17.37	5.72	57.06	5.72	34.00
19800	Bay State Mill. Co., Winona, Minn.	*Ansonia:* Ansonia Flour & Grain Co.	10.67	5.03	17.81	7.43	53.25	5.81	32.00
19841	Gopher. Brooks Elevator Co., Minneapolis	*Willimantic:* E. A. Buck & Co.	11.91	4.69	16.00	8.42	53.22	5.76	31.00

* Statement of Dealer.

Table IV.—Analyses of Commercial Feeds Sampled in 1907—*Continued.*

Station No.	Brand.	Retail Dealer.	Analyses. Water.	Ash.	Protein. (N x 6.25.)	Fiber.	Nitrogen-free Extract. (Starch, gum, etc.)	Ether Extract. (Fat.)	Price per ton.
	Wheat Products—*Continued.*								
	Middlings from Spring Wheat.								
19835	Commander. Commander Mills, Minneapolis	*Putnam:* F. M. Cole	11.93	4.71	17.19	5.51	55.43	5.23	$34.00
19831	Standard. Wm. G. Crocker, Minneapolis	*Danielson:* Quinebaug Mills	12.07	4.84	17.62	6.58	53.55	5.34	33.00
19880	Choice. J. G. Davis, Rochester, N. Y.	*Torrington:* E. H. Talcott Est.	10.01	4.20	16.87	4.66	58.48	5.78	34.00
19819	<s>. Duluth Superior Mill. Co., Duluth, Minn.	*Norwich:* Charles Slosberg	12.88	4.00	17.31	4.91	56.26	4.64	32.00
19872	Universal. Duluth Universal Mill. Co., Duluth, Minn.	*Waterbury:* I. A. Spencer	12.26	3.23	18.06	3.30	57.94	5.21	34.00
19891	Shorts. Missouri Valley Mill Co., Bismarck, No. Dak.	*Winsted:* E. Manchester & Son	11.43	4.85	17.37	6.07	54.37	5.91	31.00
19707	The Northwestern Cons. Mill. Co., Minneapolis	*Plainville:* T. B. Atwater	11.82	4.85	16.31	8.81	52.76	5.45	31.00
19716	B. Middlings. Pillsbury, Minneapolis	*Bristol:* W. O. Goodsell	12.04	5.25	16.81	8.53	52.00	5.37	31.00
19747	A. Middlings. " "	*Wallingford:* E. E. Hall	12.21	3.98	17.63	4.26	57.07	4.85	33.00
19848	Daisy XX. " "	*Rockville:* Rockville Mill. Co.	11.87	3.11	17.62	1.92	61.15	4.33	35.00
19868	Fancy. Geo. Tileston Mill. Co., St. Cloud, Minn.	*Shelton:* Taylor & Morse	11.55	4.53	17.87	5.11	55.53	5.41	33.00
19826	Geo. Urban Mill. Co., Buffalo, N. Y.	*Jewett City:* George Labonne, Jr.	11.08	3.91	16.37	5.03	59.48	4.13	34.00
19709	Standard. Washburn-Crosby Co., Minneapolis	*Southington:* South. Lumber & Feed Co.	11.87	4.76	17.94	7.41	52.06	5.96	31.00
		Average of these 16 analyses	**11.60**	**4.38**	**17.26**	**5.85**	**55.60**	**5.31**	**32.69**
		Average digestible	----	----	13.3	1.8	43.4	4.7	
	Mixed Feed from Winter Wheat.								
19723	Acme. Acme Mill. Co., Indianapolis, Ind.	*Bristol:* G.W.Eaton Est.	12.02	5.66	16.19	6.46	55.20	4.47	32.00
19734	Buckeye. American Cereal Co., Chicago	*New Haven:* J. T. Benham Est.	11.28	4.92	16.50	6.78	55.11	5.41	30.00
19850	Erie. Chapin & Co., St. Louis	*Manchester:* Little & McKinney	10.18	6.68	16.25	6.75	55.16	4.98	31.00
19844	Adrian. Detroit Mill. Co., Detroit, Mich.	*Stafford Springs:* Geo L. Dennis	10.73	5.13	16.56	7.73	54.18	5.67	32.00
19815	Pure. Eldred Mill. Co., Jackson, Mich,	*Norwich:* Norwich Grain Co.	11.28	5.35	16.25	6.35	56.00	4.77	32.00
19713	The Isaac Harter Mill. Co., Toledo, O.	*Bristol:* W. O. Goodsell	12.10	5.73	16.81	6.73	54.06	4.57	31.00
19739	Manhattan. Hecker-Jones-Jewell Mill. Co., N. Y.	*North Haven:* Coöperative Feed Co.	11.21	5.78	16.25	7.67	54.26	4.83	30.00
19699	Queen. " " " " "	*New Haven:* R. G. Davis	11.67	6 33	15.75	8.11	53.26	4.88	30.00
19775	Sunshine. Hunter Bros., St. Louis	*New Britain:* M. D. Stanley	12.08	6.21	16.12	6.67	54.23	4.69	32.00
19740	Kehlor's. Kehlor Flour Mill Co., St. Louis	*North Haven:* Coöperative Feed Co.	12.13	6.25	15.63	6.99	54.38	4.62	29.00
19806	Rex. " " " "	*Guilford:* Morse & Landon	11.98	5.69	15.25	7.16	55.32	4.60	31.00
19724	Try-Me. Sparks Mill. Co., Alton, Ill.	*Plainville:* G. W. Eaton Est.	12.21	5.38	16.50	5.94	55.63	4.34	32.00
19735	Monarch. F. W. Stock & Sons, Hillsdale, Mich.	*New Haven:* J. T. Benham Est.	11.24	5.60	16.06	7.71	53.61	5.78	31.00
19862	Joy. R. C. Stone Mill. Co., Springfield, Mo.	*East Haven:* F. A. Forbes	11.57	6.87	16.50	6.83	53.54	4.69	31.00
19871	Vimco Mixed Cow Feed. Valley City Mill. Co., Grand Rapids, Mich.	*Waterbury:* I. A. Spencer	11.65	5.40	15.06	6.93	56.54	4.42	32.00
19753	Waggoner & Gates Mill. Co., Independence, Mo.	*Meriden:* Meriden Grain & Feed Co.	11.17	5.60	15.88	6.75	56.08	4.52	30.00
19879	" " " " "	*Thomaston:* L. E. Blackmer	11.16	5.81	15.69	6.21	56.70	4.43	33.00
		Average of these 17 analyses	**11.51**	**5.79**	**16.07**	**6.93**	**54.90**	**4.80**	**31.12**
		Average digestible	----	----	12.5	4.3	42.3	4.2	
	Mixed Feed from Spring Wheat.								
19834	Commander. Commander Mills, Minneapolis	*Putnam:* F. M. Cole	11.17	5.55	15.37	7.14	55.85	4.92	33.00
19857	Columbia. Chas. M. Cox Co., Boston*	*Suffield:* Spencer Bros.	11.19	4.85	16.19	7.31	56.12	4.34	30.00
19773	Boston. Duluth Imperial Mill. Co., Duluth, Minn.	*New Britain:* C. W. Lines & Co.	11.65	5.05	16.62	7.79	53.87	5.02	32.00
19765	Huron Fancy. Flint Mill Co., Milwaukee, Wis.	*Hartford:* G. M. White & Co.	11.40	5.84	16.75	6.23	54.46	5.32	32.00
19820	Vermont. " " " "	*Yantic:* A. R. Manning	11.10	5.45	17.12	6.96	54.27	5.10	33.00
19858	" " " " "	*Suffield:* Spencer Bros.	10.72	5.39	17.31	6.31	55.09	5.18	33.00
19715	Fancy. Pillsbury, Minneapolis	*Bristol:* W. O. Goodsell	12.26	4.76	16.88	5.32	56.02	4.76	33.00
19822	"Regular." Henry Russell, Albany, N. Y.	*Yantic:* A. R. Manning	10.96	5.16	17.62	7.25	53.49	5.52	33.00

* Statement of Dealer.

Table IV.—Analyses of Commercial Feeds Sampled in 1907—*Continued.*

Station No.	Brand.	Retail Dealer.	Analyses.						Price per ton.
			Water.	Ash.	Protein. (N x 6.25.)	Fiber.	Nitrogen-free Extract. (Starch, gum, etc.)	Ether Extract. (Fat.)	
	Wheat Products—*Continued.* *Mixed Feed from Spring Wheat.*								
19803	Gold Mine. Sheffield King Mill. Co., Minneapolis	*Ansonia:* Ansonia Flour & Grain Co.	11.05	4.70	16.31	6.61	56.44	4.89	$33.00
19867	Fancy. Geo. Tileston Mill. Co., St. Cloud, Minn.	*Shelton:* Taylor & Morse	10.70	5.62	15.62	7.62	55.52	4.92	32.00
19825	Geo. Urban Mill. Co., Buffalo, N. Y.	*Jewett City:* Geo. Labonne, Jr.	12.61	5.62	16.12	7.79	52.85	5.01	32.00
		Average of these 11 analyses	11.35	5.27	16.54	6.94	54.90	5.00	32.36
		Average digestible	----	----	12.9	4.3	42.2	4.4	
	Maize Products. *Gluten Feed.*								
19768	Bay State Gluten Feed. J. E. Soper & Co., Boston	*Hartford:* L. C. Daniels Grain Co.	8.87	0.91	18.50	5.50	58.80	7.42	32.00
		Guaranty	----	----	24.00	----	----	3.00	
		Digestible	----	----	15.7	4.2	52.3	6.2	
19710	Buffalo Gluten Feed. Corn Products Mfg. Co., Chicago	*Southington:* South. Lumber & Feed Co.	10.42	1.48	24.75	7.41	53.25	2.69	30.00
19720	Buffalo Gluten Feed. Corn Products Mfg. Co., Chicago	*Bristol:* G. W. Eaton Est.	9.52	1.57	24.50	8.00	53.23	3.18	32.00
19737	Buffalo Gluten Feed, Corn Products Mfg. Co., Chicago*	*New Haven:* J. T. Benham Est.	9.75	1.85	23.75	5.86	55.93	2.86	31.00
19748	Buffalo Gluten Feed. Corn Products Mfg. Co., Chicago†	*Wallingford:* E. E. Hall	10.26	1.78	23.75	5.93	55.45	2.83	31.00
19757	Buffalo Gluten Feed. Corn Products Mfg. Co., Chicago	*Hartford:* Daniels Mill Co.	9.71	3.48	25.00	6.49	52.52	2.80	33.00
		Average guaranty	----	----	23.60	----	----	2.50	
		Average of these 5 analyses	9.93	2.03	24.35	6.74	54.08	2.87	31.40
		Average digestible			20.7	5.1	48.1	2.4	
19700	Globe Gluten Feed. Corn Products Refining Co., N. Y.	*New Haven:* R. G. Davis	9.12	3.26	27.06	6.84	51.06	2.66	30.00
19741	Globe Gluten Feed. Corn Products Refining Co., N. Y.*	*North Haven:* Coöperative Feed Co.	9.06	2.95	26.75	6.73	50.98	3.53	30.00
19763	Globe Gluten Feed. Corn Products Refining Co., N. Y.	*East Hartford:* G. M. White & Co.	9.03	3.46	27.98	6.80	48.98	3.75	33.00
19802	Globe Gluten Feed. Corn Products Refining Co., N. Y.	*Ansonia:* Ansonia Flour & Grain Co.	8.16	3.60	27.75	6.37	51.56	2.56	32.00
19807	Globe Gluten Feed. Corn Products Refining Co., N. Y.*	*Guilford:* Morse & Landon	8.58	3.23	27.19	6.12	51.96	2.92	31.00
19839	Globe Gluten Feed. Corn Products Refining Co., N. Y.*	*Willimantic:* H. A. Bugbee	7.75	3.42	26.94	6.36	53.07	2.46	31.00
		Average guaranty	----	----	25.20	----	----	2.50	
		Average of these 6 analyses	8.62	3.32	27.28	6.54	51.26	2.98	31.17
		Average digestible	----	----	23.2	5.0	45.6	2.5	
19792	Gluten Feed. J. C. Hubinger Bros. Co., Keokuk, Ia.	*New Haven:* Abner Hendee	11.19	1.05	24.62	7.26	53.31	2.57	32.00
		Guaranty	----	----	27.00		----	2.50	
		Digestible	----	----	20.9	5.5	47.4	2.1	
19893	Illinois Gluten Feed. M. G. Rankin & Co., Milwaukee, Wis.*	*Winsted:* E. Manchester & Son	11.22	0.97	20.87	6.47	57.38	3.09	31.00
		Guaranty	----	----	25.00		----	3.00	
		Digestible	----	----	17.7	4.9	51.1	2.6	

* Statement of Dealer. † From Chas. M. Cox Co., Boston. Statement of Dealer.

TABLE IV.—ANALYSES OF COMMERCIAL FEEDS SAMPLED IN 1907—*Continued.*

Station No.	Brand.	Retail Dealer.	Analyses. Water.	Ash.	Protein. (N x 6.25.)	Fiber.	Nitrogen-free Extract. (Starch, gum, etc.)	Ether Extract. (Fat.)	Price per ton.
	MAIZE PRODUCTS—*Continued.* *Gluten Feed.*								
19887	Michigan Gluten Feed. Michigan Starch Co., Traverse City, Mich.	*Winsted:* Platt & Coe	10.25	0.90	19.50	5.97	57.48	5.90	$32.00
		Guaranty	----	----	25.00	----	----	3.00	
		Digestible	----	----	16.6	4.5	51.2	4.9	
19865	Queen Gluten Feed. Corn Products Refining Co., N. Y.	*Shelton:* Taylor & Morse	9.96	1.83	23.87	6.14	55.52	2.68	33.00
		Guaranty	----	----	20.00	----	----	2.00	
		Digestible	----	----	20.3	4.7	49.4	2.2	
19842	Gluten Feed. Union Starch & Refining Co., Edinburg, Ind.	*Willimantic:* E. A. Buck & Co.	9.13	0.69	21.37	6.69	56.98	5.14	31.00
		Guaranty	----	----	24.00	----	-	3.00	
		Digestible	----	----	18.2	5.1	50.7	4.3	
19725	Warner's Gluten Feed. Corn Products Refining Co., Chicago	*Plainville:* G. W. Eaton Est.	10.47	1.62	24.00	6.75	53.72	3.44	33.00
19821	Warner's Gluten Feed. Corn Products Refining Co., N. Y.	*Yantic:* A. R. Manning	11.12	1.99	25.75	6.48	51.11	3.55	32.00
19851	Warner's Gluten Feed. Corn Products Refining Co., Chicago	*Manchester:* G. W. Kuhney	10.18	1.68	24.69	7.63	52.60	3.22	31.00
		Average guaranty	----	----	23.67	----	----	2.50	
		Average of these 3 analyses	10.59	1.76	24.81	6.95	52.49	3.40	32.00
		Average digestible	----	----	21.1	5.3	46.7	2.8	
	Hominy Feed.								
19751	Hominy Feed. Buffalo Cereal Co., Buffalo, N.Y.*	*Meriden:* A. H. Cashen	11.22	2.34	10.50	3.35	65.14	7.45	32.00
19790	" " " " "	*Norwalk:* Holmes, Keeler & Selleck	10.93	2.47	10.69	3.42	64.98	7.51	32.00
		Guaranty	----	----	10.25	----	----	8.00	
		Average of these 2 analyses	11.08	2.41	10 60	3.38	65.11	7.42	32.00
		Average digestible	----	----	6.9	2.3	57.9	6.8	
19787	Chase Grain Co., Norwalk, Conn.*	*Norwalk:* Brower & Malone	9.67	2.05	8.00	11.06	64.07	5.15	32.00
19738	Fine White Hominy. Chas. M. Cox Co., Boston*	*North Haven:* Coöperative Feed Co.	9.50	2.59	10.56	3.59	65.20	8.56	30.00
19828	Hominy. " " " *	*Moosup:* T. E. Main & Sons	10.74	2.75	10.50	3.90	63.46	8.65	31.50
19758	Wirthmore Hominy. " " "	*Hartford:* Smith, Northam Co.	11.82	2.07	10.50	1.89	66.96	6.76	34.00
19840	" " " " " *	*Willimantic:* H. A. Bugbee	9.15	2.86	10.62	4.86	63.78	8.73	31.00
		Guaranty	----	----	10.50	----	----	7.00	
		Average of these 2 analyses	10.48	2.47	10.56	3.38	65.36	7.75	32.50
		Average digestible	----	----	6.9	2.3	58.2	7.1	
19892	Evans Milling Co., Indianapolis, Ind.*	*Winsted:* E. Manchester & Son	10.35	3.03	11.12	4.78	61.35	9.37	31.00
19733	Steam-Cooked Hominy Feed. Miner-Hillard Mill. Co., Wilkesbarre, Pa.	*New Haven:* J. T. Benham Est.	11.71	2.42	10.81	3.16	63.86	8.04	31.00
19772	Steam-Cooked Hominy Feed. Miner-Hillard Mill. Co., Wilkesbarre, Pa.	*New Britain:* C. W. Lines & Co.	11.52	2.57	10.62	3.57	63.51	8.21	32.00
19859	Steam-Cooked Hominy Feed. Miner-Hillard Mill. Co., Wilkesbarre, Pa.	*East Hampton:* R. H. Hall	9.12	2.88	10.62	3.85	64.82	8.71	32.00
		Guaranty	----	----	10.00	----	----	7.50	
		Average of these 3 samples	10.78	2.62	10.68	3.53	64.07	8.32	31.67
		Average digestible	----	----	6.9	2.4	57.0	7.7	
19705	W. H. Payne & Son, Harlem River, N. Y.*	*New Haven:* R. G. Davis	10.87	2.18	10.63	3.32	65.94	7.06	31.00
19781	Wm. E. Payne, N. Y.*	*Stamford:* Scofield & Miller	9.23	2.44	10.62	3.20	66.67	7.84	32.00

* Statement of Dealer.

TABLE IV.—ANALYSES OF COMMERCIAL FEEDS SAMPLED IN 1907—*Continued.*

Station No.	Brand.	Retail Dealer.	Analyses. Water.	Ash.	Protein. (N x 6.25.)	Fiber.	Nitrogen-free Extract. (Starch, gum, etc.)	Ether Extract. (Fat.)	Price per ton.
	MAIZE PRODUCTS—*Continued.* *Hominy Feed.*								
19764	A. B. Porter, Philadelphia.*	*East Hartford:* G. M. White & Co.	10.00	2.40	11.00	3.62	64.98	8.00	$34.00
19869	Fine Hominy. A. B. Porter, Philadelphia.*	*Granby:* Latham & Chittenden	8.79	2.83	10.37	6.63	62.28	9.10	32.00
19813	Blue Ribbon. J. E. Soper & Co., Boston	*New London:* Beebe & Bragaw	9.02	3.00	10.87	4.21	63.89	9.01	32.00
		Average guaranty	----	----	9.97	----	----	7.28	
		Average of all (16) analyses	10.23	2.56	10.50	4.28	64.43	8.00	31.84
		Average digestible	----	----	6.8	2.9	57.3	7.4	
19809	Star Feed. The Toledo Elevator Co., Toledo, O.	*New London:* E. H. Caulkins	10.50	2.04	8.25	9.02	65.09	5.10	30.00
19881	" " " "	*Torrington:* E. H. Talcott Est.	9.32	2.25	8.06	9.04	66.06	5.27	32.00
19888	" " " " *	*Winsted:* Platt & Coe	10.07	2.20	8.50	9.93	64.28	5.02	31.00
		Guaranty	----	----	7.00	----	----	6.50	
		Average of these 3 analyses	9.96	2.16	8.27	9.33	65.15	5.13	31.00
		Average digestible	----	----	5.4	6.3	58.0	4.7	
	RYE PRODUCTS.								
19808	Rye Bran	*Guilford:* Morse & Landon	12.50	2.52	11.87	1.93	68.81	2.37	27.00
19770	Rye Middlings. Miner-Hillard Mill. Co., Wilkesbarre, Pa.	*New Britain:* C. W. Lines & Co.	12.51	2.93	17.25	2.84	61.80	2.67	33.00
19749	Rye Feed. Miner-Hillard Mill. Co., Wilkesbarre, Pa.	*Wallingford:* E. E. Hall	12.32	3.80	14.50	2.97	63.66	2.75	30.00
	BUCKWHEAT PRODUCTS.								
19830	Buckwheat Middlings	*Danielson:* Quinebaug Mills	17.27	3.94	28.37	3.34	39.94	7.14	32.00
		Digestible	----	----	24.1	0.6	33.2	6.4	
	RICE PRODUCTS.								
19846	Ground Rice. Quaker Oats Co., Chicago	*Colchester:* Colchester Grain Co.	9.30	0.63	7.87	0.06	81.79	0.35	30.00
		Guaranty	----	----	9.61	----	----	0.38	
	BARLEY PRODUCTS. *Malt Sprouts.*								
19797	Malt Sprouts. Amer. Malting Co., Buffalo, N. Y.	*New Haven:* Abner Hendee	10.12	5.55	28.25	11.36	43.20	1.52	27.50
19805	" " " "	*Guilford:* Morse & Landon	10.07	5.50	27.37	12.13	43.51	1.42	25.00
19704	" " " N. Y.*	*New Haven:* R. G. Davis	8.76	5.47	26.38	12.58	45.36	1.45	25.00
19769	" " Milling Co., Syracuse, N. Y.	*New Britain:* C. W. Lines & Co.	10.54	6.25	27.62	11.97	42.30	1.32	25.00
19744	" Chas. M. Cox Co., Boston*	*Branford:* S. V. Osborn	10.85	5.40	25.63	9.86	46.54	1.72	22.00
19863	" Francis Duhne, Jr., Milwaukee, Wis.	*East Haven:* F. A. Forbes	8.49	7.56	27.00	11.78	43.96	1.21	26.00
		Guaranty	----	----	25.00	----	----	2.00	
		Average of these 6 analyses	9.80	5.96	27.04	11.61	44.15	1.44	25.08
		Average digestible	----	----	21.6	3.9	30.5	1.4	
	Distillers' Grains.								
19722	Ajax Flakes. Ajax Milling & Feed Co., N. Y.	*Bristol:* G. W. Eaton Est.	8.79	1.51	31.75	14.10	29.78	14.07	33.00
19845	" Flint Mill Co., Milwaukee, Wis.	*Colchester:* Case Bros.	7.98	2.19	31.62	11.90	34.01	12.30	27.00
		Average guaranty	----	----	32.50	----	----	12.00	
		Average of these 2 analyses	8.38	1.85	31.69	13.00	31.89	13.19	30.00
19824	Fourex Grains. The J. W. Biles Co., Cincinnati, O.	*Yantic:* A. R. Manning	8.86	2.93	31.94	12.84	28.68	14.75	32.00
19889	A1 Distillers' Grains. The J. W. Biles Co., Cincinnati, O.*	*Winsted:* E. Manchester & Son	7.55	2.18	21.56	11.66	46.43	10.62	31.00
19861	Continental Gluten Feed. Continental Cereal Co.; Peoria, Ill.*	*Middletown:* Meech & Stoddard	6.61	4.95	29.56	8.34	38.34	12.20	31.00
		Average guaranty	----	----	31.40	----	----	11.80	
		Average of these 5 analyses	7.96	2.75	29.29	11.77	35.44	12.79	30.80
		Average digestible		----	21.4	11.2	29.7	12.2	

* Statement of Dealer.

Table IV.—Analyses of Commercial Feeds Sampled in 1907—*Continued.*

Station No.	Brand.	Retail Dealer.	Water.	Ash.	Protein. (N x 6.25.)	Fiber.	Nitrogen-free Extract. (Starch, gum, etc.)	Ether Extract. (Fat.)	Price per ton.
	Dried Brewers' Grains.								
19791	Farmers' Feed Co., N. Y.	*Norwalk:* Holmes, Keeler & Selleck	9.64	3.39	27.00	11.42	41.29	7.26	$29.00
		Guaranty	----	----	26.30	----	---	7.60	
		Digestible	----	----	21.9	5.6	23.5	6.5	
	Mixed Feeds. *Corn and Oat Feeds.*								
19750	Corn and Oat Chop. Buffalo Cereal Co., Buffalo, N. Y.	*Meriden:* A. H. Cashen	11.35	2.31	7.75	6.28	67.81	4.50	33.00
19878	Corn and Oat Chop. Buffalo Cereal Co., Buffalo, N. Y.	*Thomaston:* L. E. Blackmer	10.62	2.72	8.87	6.11	67.44	4.24	34.00
		Guaranty	----	----	7.50	----	---	3.50	
		Average of these 2 analyses	10.98	2.52	8.31	6.19	67.63	4.37	33.50
		Digestible	----	----	5.9	3.0	56.1	3.8	
19884	Provender. Buffalo Cereal Co., Buffalo, N. Y.*	*Torrington:* F. Wadhams	12.15	1.83	9.37	3.45	69.38	3.82	36.00
		Digestible	----	----	6.7	1.6	57.6	3.3	
19818	Pearl Cooked Horse and Cow Feed. Flint Mill Co., Milwaukee	*Norwich:* Chas. Slosberg	10.47	2.65	10.25	4.69	65.29	6.65	34.00
		Guaranty	----	----	9.00	----	----	6.00	
		Digestible	----	----	7.3	2.3	54.2	5.8	
19782	Boss Chop Feed. The Great Western Cereal Co., Chicago	*Stamford:* Scofield & Miller	10.40	4.06	9.87	7.64	63.06	4.97	32.00
		Guaranty	----	----	10.00	----	----	5.00	
		Digestible	----	----	7.0	3.7	52.3	4.3	
19746	Excelsior Chop Feed. The Great Western Cereal Co., Chicago	*Wallingford:* E. E. Hall	10.92	4.07	8.00	8.97	63.09	4.95	32.00
		Guaranty	----	----	8.00	----	---	3.50	
		Digestible	----	----	5.7	4.3	52.4	4.3	
19864	Monarch Chop Feed. Husted Mill. & Elev. Co., Buffalo, N. Y.	*Shelton:* Taylor & Morse	11.47	2.60	9.19	5.30	67.09	4.35	32.00
		Guaranty	----	----	7.50			3.50	
		Digestible	----	----	6.5	2.5	55.7	3.8	
19829	Corn and Oat Feed. T. E. Main & Sons, Moosup, Conn.	Manufacturer	13.05	1.65	8.94	2.58	69.90	3.88	32.50
		Digestible	----	----	6.3	1.2	58.0	3.4	
19789	Eclipse Feed. W. H. Payne & Son, N. Y.	*Norwalk:* Holmes, Keeler & Selleck	11.14	3.15	9.87	7.72	63.56	4.56	35.00
		Guaranty	----	----	9.00	----		4.00	
		Digestible	----	----	7.0	3.7	52.8	4.0	
19736	Victor Feed. Quaker Oats Co., Chicago	*New Haven:* J. T. Benham Est.	11.92	3.22	7.75	10.85	64.06	3.20	32.50
		Guaranty	----	----	7.50	----	----	3.00	
		Digestible	----	----	5.5	5.2	53.2	2.8	
		Average all Corn & Oat Feeds (10)	11.25	2.83	8.99	6.36	66.06	4.51	33.30
		Digestible		----	6.4	3.1	54.8	3.9	

* Statement of Dealer.

Table IV.—Analyses of Commercial Feeds Sampled in 1907—*Continued.*

Station No.	Brand.	Retail Dealer.	Analyses. Water.	Ash.	Protein. (N x 6.25.)	Fiber.	Nitrogen-free Extract. (Starch, gum, etc.)	Ether Extract. (Fat.)	Price per ton.
	Mixed Feeds—*Continued.* *Wheat and Corn Cob Feeds.*								
19793	Blue Grass Mixed Feed. A. Waller & Co., Henderson, Ky.	*New Haven:* Abner Hendee	10.22	3.30	9.62	14.77	59.37	2.72	$29.00
		Guaranty	----	----	10.00	----	----	2.50	
19754	Jersey Mixed Feed. Indiana Mill. Co., Terre Haute, Ind.	*Meriden:* Meriden Grain & Feed Co.	10.29	5.47	8.69	18.53	54.44	2.58	28.00
		Guaranty	----	----	10.00	----	----	2.00	
	Corn, Oats and Barley.								
19712	Schumacher's Stock Feed. Quaker Oats Co., Chicago	*Bristol:* W. O. Goodsell	10.64	4.02	10.50	10.14	60.60	4.10	33.00
		Guaranty	---	----	10.00	----	----	4.00	
	Molasses Grains.								
19874	E. P. Mueller, Milwaukee, Wis.	*Waterbury:* I. A. Spencer	15.48	6.48	14.87	10.61	50.30	2.26	28.00
		Guaranty	----	----	17.00	----	----	2.50	
	Flax Feed.								
19703	H. J. Flax Feed. J. E. Soper & Co., Boston*	*New Haven:* R. G. Davis	9.45	7.39	17.88	10.16	35.57	19.55	25.00
19761	" " H. Jennings	*Hartford:* Smith, Northam & Co.	10.20	6.60	16.75	11.09	40.43	14.93	28.00
		Guaranty	----	----	17.34	----	----	17.37	
19717	Ground Flax Flakes. C. R. Lull, N. Y.	*Bristol:* G. W. Eaton Est.	9.48	6.77	18.00	9.93	37.05	18.77	27.00
		Guaranty	----	----	14.00	----	----	15.00	
		Average of these 3 analyses	**9.71**	**6.92**	**17.54**	**10.39**	**37.69**	**17.75**	**26.67**
	Proprietary Horse Feeds.								
19876	Sucrene Horse Feed. American Milling Co., Chicago	*Thomaston:* L. E. Blackmer	11.83	7.27	13.12	8.69	55.51	3.58	31.00
		Guaranty	----	----	13.50	----	----	3.50	
19702	Horse Feed. Buffalo Cereal Co., Buffalo, N. Y.	*New Haven:* R. G. Davis	11.67	2.70	13.13	5.89	61.19	5.42	36.00
19766	" " " " "	*Hartford:* L. C. Daniels Grain Co.	11.03	2.81	12.88	6.01	62.20	5.07	36.00
		Guaranty	----	---	12.00	----	----	4.50	
		Average of these 2 analyses	**11.35**	**2.76**	**13.01**	**5.95**	**61.68**	**5.25**	**36.00**
19784	Husted Horse Feed. Husted Mill. Co., Buffalo, N. Y.	*Stamford:* Scofield & Miller	9.95	3.00	13.25	5.79	62.67	5.34	34.00
19855	Molac Molasses Horse Feed. Quaker Oats Co., Chicago	*Thompsonville:* H. K. Brainard	10.52	6.04	12.50	14.00	53.64	3.30	26.00
		Guaranty	----	----	11.00	----	-- -	3.00	
	Proprietary Dairy and Stock Feeds.								
19877	Sucrene Dairy Feed. American Mill. Co., Chicago	*Thomaston:* L. E. Blackmer	11.56	7.82	17.75	10.06	48.39	4.42	30.00
		Guaranty	----	----	16.50	----	----	3.50	
		Digestible	----	----	10.8	7.2	35.3	4.2	
19785	Union Grains, Ready Rations. The J. W. Biles Co., Cincinnati, O.	*New Canaan:* C. H. Fairty	8.65	6.92	23.75	8.61	44.65	7.42	30.00
19817	Union Grains, Ready Rations. The J. W. Biles Co., Cincinnati, O.	*Norwich:* Norwich Grain Co.	8.92	5.76	23.44	9.88	43.99	8.01	32.00
19890	Union Grains, Ready Rations. The J. W. Biles Co., Cincinnati, O.*	*Winsted:* E. Manchester & Son	9.12	6.30	23.12	8.99	44.83	7.64	31.00
		Guaranty	...	----	24.00	----	----	7.00	
		Average of these 3 analyses	**8.90**	**6.33**	**23.44**	**9.16**	**44.48**	**7.69**	**31.00**
19728	Calf Meal. Blatchford's Calf Meal Fact., Waukegan, Ill.	*Plainville:* G. W. Eaton Est.	11.73	4.65	27.63	4.48	46.86	4.65	55.00
		Guaranty	----	----	25.00	----	----	5.00	

* Statement of Dealer.

TABLE IV.—ANALYSES OF COMMERCIAL FEEDS SAMPLED IN 1907—*Concluded.*

Station No.	Brand.	Retail Dealer.	Analyses.						Price per ton.
			Water.	Ash.	Protein. (N x 6.25.)	Fiber.	Nitrogen-free Extract. (Starch, gum, etc.)	Ether Extract. (Fat.)	
	MIXED FEEDS—*Continued.* *Proprietary Dairy and Stock Feeds.*								
19779	Creamery Feed. Buffalo Cereal Co., Buffalo, N. Y.	*Bridgeport:* Berkshire Mills	9.51	4.38	20.62	10.91	49.91	4.67	$35.00
		Guaranty	----	----	**20.00**	----	----	**5.00**	
19778	Buf-Ce-Co Stock Feed. Buffalo Cereal Co., Buffalo, N. Y.	*Bridgeport:* Berkshire Mills	10.89	2.55	8.75	7.29	65.84	4.68	33.00
		Guaranty	----	----	**9.00**	----	----	**4.50**	
19814	Wirthmore Stock Feed. Chas. M. Cox Co., Boston	*New London:* Beebe & Bragaw	9.62	3.46	9.69	8.16	61.89	7.18	36.00
		Guaranty	----	----	**10.00**	----	----	**4.00**	
19727	Daisy Dairy Feed. The Great Western Cereal Co., Chicago	*Plainville:* G. W. Eaton Est.	10.01	7.94	17.94	8.80	51.81	3.50	30.00
		Guaranty	----	----	**16.00**	----	----	**3.00**	
19726	Sterling Stock Feed. The Great Western Cereal Co., Chicago	*Plainville:* G. W. Eaton Est.	12.05	3.54	11.00	6.46	63.15	3.80	34.00
		Guaranty	----	----	**11.00**	----	----	**4.00**	
19752	Matchless Stock Feed. Meriden Feed & Grain Co., Meriden, Conn.	Manufacturer	9.55	4.12	9.75	10.49	58.97	7.12	35.00
		Guaranty	----	----	**10.00**	----	----	**4.00**	
19847	Molac Dairy Feed. Quaker Oats Co., Chicago	*Colchester:* Colchester Grain Co.	9.75	5.97	16.37	11.37	51.51	5.03	29.00
19860	" " " " "	*East Hampton:* R. H. Hall	10.48	5.98	17.75	11.03	50.69	4.07	31.00
		Guaranty	----	----	**16.00**	----	----	**3.00**	
		Average of these 2 analyses	**10.11**	**5.98**	**17.06**	**11.20**	**51.10**	**4.55**	**30.00**
19852	Quaker Dairy Feed. Quaker Oats Co., Chicago	*Thompsonville:* H. K. Brainard	8.40	5.71	13.19	16.29	52.79	3.62	30.00
		Guaranty	----	----	**12.00**	----	----	**3.00**	
19799	Schumacher's Calf Meal. Quaker Oats Co., Chicago	*Derby:* Peterson-Hendee Co.	9.05	3.09	21.87	2.46	55.18	8.35	70.00*
		Guaranty	----	----	**19.00**	----	----	**8.00**	
19873	Hammond Dairy Feed. Western Grain Products Co., Milwaukee	*Waterbury:* I. A. Spencer	8.82	7.54	15.00	10.30	55.01	3.33	24.00
		Guaranty	----	----	**17.00**	----	----	**3.50**	
	Proprietary Poultry Feeds.								
19755	Poultry Feed. Buffalo Cereal Co., Buffalo, N. Y.	*Meriden:* Meriden Grain & Feed Co.	11.71	2.82	15.25	3.96	61.63	4.63	38.00
		Guaranty	----	----	**17.00**	----	----	**5.00**	
19885	Husted's Poultry Feed. Husted Mill. & Elev. Co., Buffalo, N. Y.	*Torrington:* F. Wadhams	10.37	3.84	13.12	7.20	60.46	5.01	42.00
		Guaranty	----	----	**12.00**	----	----	**4.00**	
19812	American Poultry Feed. Quaker Oats Co., Chicago	*New London:* P. Schwartz	10.74	2.96	13.19	4.32	62.92	5.87	38.00
		Guaranty	----	----	**12.00**	----	----	**3.50**	
19721	Alfalfa Meal. Ralston Purina Mills, St. Louis	*Bristol:* G. W. Eaton Est.	10.56	8.90	14.25	31.58	33.44	1.27	38.00
		Guaranty	----	----	**16.00**	----	----	**2.40**	
	Meat Scrap.								
19894	Beef Scrap. C. M. Shay Fertilizer Co., Groton, Conn.*	*Winsted:* E. Manchester & Son	6.84	33.24	43.25	----	4.10	12.57	48.00

* Statement of Dealer.

* In small lots.

PART IV.

Forestry Publication No. 4.

ANNUAL REPORT OF THE FORESTER

AUSTIN F. HAWES, M.F.

FOREST PLANTATIONS.

The statement that comes from the United States Forest Service that the present supplies of timber in the country will be exhausted in twenty years, the rapid increase within the past few years of the price of lumber, and the abundance of cheap land suitable for forest raising, have combined to bring forest planting into prominence within the past few years, especially in New England.

In advocating investments which must necessarily be for a long period of years, in a new kind of industry, it is imperative that all the information obtainable should be gathered and presented to the public. For the purpose of having definite data upon which it could rely, this station started in 1901 a series of experiments in forest planting, which will be more and more interesting and valuable as years pass, if the plantations can be protected from fire.

The purpose of the present report is primarily to preserve a record of the experiments that have been made, but it also aims to give the results so far as there have yet been results. Besides the discussion of these experiments is included an account of other plantations which have been made in Connecticut both recently and in the past. From these older plantations one may gain some idea of what may be expected in the future, though it is to be hoped that the new plantations will receive more intelligent care than have the old ones. Plantations which have been made by enthusiastic owners have usually passed into the hands of others who have often neglected them. By keeping a record of all forest plantations it is hoped that the State Forester may be able to influence the owners to properly manage their tracts.

At the end of the bulletin are several yield tables for normal forests of different species in Europe. While conditions of growth are somewhat different in this country, it may be presumed that the tables will apply fairly well to Southern New England and therefore indicate what may be expected from plantations of such trees as Scotch pine and Norway spruce.

The great increase in forest planting in the last two years shows that business men are beginning to realize the chance for a good profit from such investments. It is not necessary to wait for the timber to mature, for plantations ten years old have a sale value much greater than that of waste land unplanted.

For a short-time investment of this character the raising of Christmas trees commends itself. While this has not yet been done, there seems to be every reason for its being a profitable undertaking. Christmas trees retail at from one to two dollars apiece in the large cities. It should be possible to raise fifteen hundred of the smaller size spruce or fir per acre, in ten years; or one thousand of the larger size in fifteen years. These species are only suited to fairly moist situations. Pine is little used for this purpose, but it seems as if a market might be developed.

Briefly stated, the results thus far evident from the experiments at Rainbow and the other plantations are as follows:

1. The best trees for planting on sandy land are pines: white, Scotch, Norway and pitch.

2. Of the deciduous species those best adapted for planting on sandy land are chestnut, red oak and black locust.

3. As to the character of the plant material, we recommend:

For the pines: Three-year-old transplants when they can be procured for $5.50 per thousand or less, otherwise two-year-old transplants or seedlings may be used satisfactorily.

For chestnut and black locust, one-year-old seedlings are recommended.

For red oak: acorns, but preferably one-year-old seedlings.

4. Experience at Union has shown that fairly open land can be planted with two-year-old pines with mattocks at $1.70 per thousand trees.

5. Experience at Rainbow has shown that when the plantations have been seriously threatened by field and forest fires, proper supervision and fire lines furnished adequate protection.

6. The older plantations of white pine indicate that with a reasonable expenditure for purchase of land and planting, at least five per cent. compound interest may be made from such investments, figuring the value of lumber at present prices. With cheap planting and greater future prices of lumber the profit will probably be much larger than that indicated.

DESCRIPTION OF FOREST PLANTING EXPERIMENTS MADE AT WINDSOR.

See map opposite page 228.

1.* Lockwood Field, A 1 and 2; about 2 acres, April 17, 1901.—White pine seed was broadcast at the rate of 2, 3, 4, and 5 pounds per acre respectively on four quarter-acre plots of uncultivated open sandy land bearing only scattered tufts of grass.

Not more than two dozen seedlings were ever found on the entire two acres as a result of this sowing. Germination tests previous to sowing showed that 23 per cent. of the seed was viable.

2.* Lockwood, B 1, 2, 3, 4; about 2 acres, April 19, 1901.—White birch seed gathered in the neighborhood. It was intended to raise the birch as a nurse for pine. Germination tests proved the seed to be worthless.

3.* Lockwood, parts of A 3, 4, 5; about 3 acres, April 19, 1901.—Black birch seed intended as a nurse for white pine. Subsequent germination tests proved the seed to be worthless.

4.* Lockwood, parts of B 1 and 2; about 1-14 acre, April 26, 1901.—325 cottonwood cuttings from the west, of one and two years old wood, 5 to 11 inches long, were pushed into the soil 2½ x 4 feet. (See Report 1901, p. 358.) Very few of these are now living.

5.* Lockwood, A 5; ½ acre, Sept. 27, 1901.—White oak seed 3 x 4 feet. Planted with garden hoe, 3 acorns in a hole, being 37 quarts per acre; 18 hours were required for this planting. (See Exp. 30, Results.)

* Indicates that the experiment was discontinued and the land used for later experiments.

6.* Lockwood, A 8, *a, b, c;* ¾ acre, March 7, 1902.—White pine seed was broadcast on the uncultivated sand plain land at the rate of 1, 2, 3, and 4 pounds per acre on the various parts of the plot among the tufts of plains grass. Although germination tests showed the seed was good, only about a dozen seedlings resulted from this sowing.

7.* Lockwood, under the birches, across fire line from plots A 12 and 13; ½ acre, March 7, 1902.—White pine seed was broadcast on the uncultivated sandy surface, under a dense growth of white or gray birch fifteen feet high at the rate of 1 and 2 pounds per acre on different parts of the plot.

Although germination tests showed that the seed was good, not over a dozen seedlings were ever found as a result of this sowing.

8* and 9.* Mundy Hollow near the road at top of the hill; ¼ acre, March 14, 1902.—White pine seed broadcast on the uncultivated sandy surface under a medium dense growth of white birch and coppice of oak and chestnut 5 feet high, at the rate of 2 pounds per acre.

No seedlings were found as the result of this sowing although germination tests showed that the seed was fair.

10. Lockwood, A 3; 1 acre, April 5, 1902.—Pitch pine seed broadcast on cultivated strips 1½ feet broad, 4 feet apart. One half plot at rate of 1 pound seed per acre, and one half at rate of 2 pounds. Seed was lightly brushed in.

Results. For an average length of 250 feet of row, 2 pounds produced 264 seedlings, and 1 pound 60 seedlings in September 1902; and 97 per cent. of these were alive in April 1903.

In August 1906 there were 5,054 trees on this plot with heights ranging from 12 to 36 inches; average 26. The trees are more or less bunched, some places being rather open.

NOTE.—In the spring of 1907 many of these trees were covered with staminate flowers and with a few pistillate flowers. A few trees bore cones the previous fall.

11.* Lockwood, B 1, 2, 3, 4; 2 acres, April 2, 1902.—Gray birch seed, intended as a nurse for white pine, was broadcast on cultivated strips, at the rate of 1 pound per acre, and was lightly brushed in.

Although a test showed that the seed was fair no seedlings appeared.

12. Lockwood, A 7; 2 acres April 25, 1902.—Chestnut seed planted 1 x 5½ feet, one nut in a hole made by garden hoe. This was at the rate of 42 quarts per acre.

Squirrels and other rodents destroyed many nuts, nevertheless the plot became well stocked.

Number alive July 1902, 5,874; spring 1903, 5,146; August 1903, 4,324; August 1906, 3,717. In August 1906, the heights ranged from 5 to 33 inches; average 14.3 inches.

13.* Lockwood, A 4; ⅕ acre, April 23, 1902.—538 pitch pine seedlings 8 to 18 inches high, collected from the woods, planted with mattock 4 x 4 feet. The stock was much larger than was ordered and was received in very poor condition because of poor packing so that many trees died within a few days.

Number living July 1902, 213. The trees were removed in April 1903.

14. Lockwood, A 6, *a;* ½ acre, April 24, 1902.—1,900 cottonwood nursery seedlings 10 to 12 inches high, planted in furrows made by a plow; covered by returning along the row with the plow. A man followed the plow straightening the seedlings and giving them a little additional setting whenever necessary. The experiment was to test rapid planting with cheap material.

Number living August 1902, 1,029; August 1903, 820; August 1906, 181. Heights, August 1906, ranged from 8 to 40 inches; average 25 inches.

15. Lockwood, B, C 1; 1-17 acre, May 7, 1902.—104 spruce nursery seedlings 10 to 12 inches high, imported from France for Norway spruce, but apparently another species, were planted 5 x 5 feet.

Number living July 1902, and 1903, 72; and July 1907, 31. Many of these trees were killed by a fire in the spring of 1905. Heights in the fall of 1906 ranged from 8 to 18 inches, average 14.4 inches.

16.* Lockwood, B 4; 1-25 acre, May 1, 1902.—52 red cedar nursery seedlings 6 to 12 inches high, planted 6 x 6 feet.

Number living July 1902, 38; spring 1903, none.

17. Lockwood, B 5; ⅗ acre, April 28, 1902.—1,268 white pine seedlings, 3 years old, roots not pruned, planted 4 x 5 feet. All of the failed places were filled with nursery transplants in the spring of 1904 and a few in 1905.

Number living July 1902, 1,235; spring 1903, 1219; August 1906. (See Exp. 19.) Heights ranged in August 1906 from 13 to 48 inches, average 28 inches.

NOTE.—The east end of this plot was manured in the spring of 1907 to ascertain if an increased growth would result.

18. Lockwood, B 5; ½ acre, April 30, 1902.—White pine and tulip, 4 x 5 feet, every fifth tree a tulip. 880 pine, nursery transplants 4 years old, roots pruned; 135 tulip nursery seedlings 24 inches high. The vacancies were filled in the springs of 1904 and 1905.

Number living July 1902, 878 white pine, 121 tulip; spring 1903, 863 white pine, 104 tulip; August 1906, pine (see Exp. 19), no tulip. Heights in fall of 1906 ranged from 29 to 67 inches; average 40 inches.

NOTE.—The east end of this plot was divided into halves in the spring of 1907. Half was cultivated and half was manured.

19 and 20. Lockwood, B 5; ½ acre, May 1902.—1,134 white pine nursery seedlings and transplants four years old, planted 4½ x 5 feet. 520 seedlings forming the five northern rows were imported from France. Vacancies were refilled in springs of 1904 and 1905.

Number living July 1902, 1,076; spring 1903, 1,046; August 1906 on B 5, as the result of Exp. Nos. 17, 18, 19, 20, 3,218. Average height, fall 1904, 26.2 inches; fall 1906, 37 inches.

NOTE.—The east end of this lot was cultivated in spring of 1907. 6 per cent. of the trees of B 5 have been affected by the white pine weevil, which kills the leading shoot. These leaders have been cut off and destroyed to hinder the spread of the insect as much as possible.

21. Lockwood, A 9, northwest side; ⅖ acre, April 23, 1902.—725 white pine three-year-old nursery seedlings planted 5 x 5 feet under a dense growth of birch 15 to 20 feet high. In the spring of 1904 the failed places were filled with three-year-old nursery transplants.

Number living July 1902, 683; spring 1903, 670; spring 1907, 735. Height ranged in fall of 1906 from 18 to 42 inches. Average height fall 1903, 4.7 inches; fall 1904, 7.9 inches; fall 1906, 27 inches.

22. Lockwood, B 8; 5-6 acre, April 29, 1902.—1,493 white pine seedlings collected from woods of Granby 8 to 18 inches high, planted 4½ x 5½ feet.

A small strip on east end was not planted at first but was planted to similar stock, as well as the failed places through the plot, in the springs of 1904 and 1905. The seedlings arrived in poor condition as the result of poor packing, hence many died within a few days. Some of the failed places were filled with hardwoods. (See Exp. 49.)

Number living July 1902, 1,145; spring 1903, 1,075; fall 1903, 1,074; fall 1906, 1,243. Average height fall of 1903, 15 inches; 1904, 25 inches; 1905, 34 inches; 1906, 42 inches.

NOTE.—5.5 per cent. of these trees have been affected by the white pine weevil.

23. Lockwood, part of B 9; 1 acre, April 28, 1902.—815 red or Norway pine nursery seedlings four years old, planted 4½ x 5 feet.

Number living July 1902, 811; spring 1903 and August 1906, 798. Average height fall 1903, 8 inches; 1904, 16 inches; 1905, 22 inches; 1906, 29 inches. In the spring of 1905, 52 white pines were planted at the east end of the lot.

24. Lockwood, B 10; ½ acre April 28, 1902.—969 Scotch pine nursery seedlings three years old planted 4 x 5 feet. A strip at the east end and a few failed places were filled in the spring of 1904 with two-year-old nursery transplants of Scotch pine.

Number living July 1902, 924; spring 1903, 892; August 1906, 1,068. Average height fall 1904, 19 inches; 1905, 31 inches; 1906, 50 inches. In the fall of 1906 these heights ranged from 20 to 70 inches.

NOTE.—In the spring of 1907 there were many staminate and some pistillate flowers on these trees, as on the pitch pines of Exp. 10. There is a species of fungus on some of these trees with an orange mycelium which retards the growth. Dr. Clinton, the botanist, identifies this as *Peridermium pyriforme*.

25. Lockwood, B 11; 5-6 acre, May 1, 1902, and spring 1904.—1,479 red or Norway pine four-year-old nursery transplants planted 4½ x 5 feet to compare effect with similar material not transplanted.

Number living July 1902, 1,453; August 1903, 1,438; August 1906, 1529, and 96 white pine. Average height fall 1904, 19 inches; 1905, 28 inches; 1906, 35 inches.

NOTE.—A species of scale, called by Dr. Britton, the state entomologist, the Pine Leaf Scale, *Chionaspis pinifoliæ*, infests a few of these trees and is killing the foliage. He advises spraying with a soap solution soon after the eggs hatch. In the spring of 1907 some of these trees were full of staminate flowers, but no pistillate flowers were found.

26. Lockwood, south part of B 9; 1-20 acre, April 28, 1902.—98 Austrian pine four-year-old nursery seedlings planted 4 x 5 feet.

Number living July 1902, 98; spring 1903, 87; August 1903, 82; August 1906, 82. Average height fall 1904, 22 inches; 1906, 29 inches.

27* and 28.* Mundy Hollow; ½ acre, May 12, 1902.—388 white pine, 315 red pine, 54 tulip planted 5 x 6 feet.

Number living July 1902, white pine, 381; red pine, 300; tulip, 48. The plantation was burned over in the spring of 1904, and nearly every tree was killed.

29.* Mundy Hollow; ⅖ acre, May 12, 1902.—Norway spruce nursery transplants 10 to 12 inches high planted 5 x 6 feet. Number planted: Shade grown seedlings 318, not shade grown, 284.

Number living, July 1902, shade grown 309; not shade grown 279; spring 1903, shade grown 302; not shade grown 272. The plantation was burned over in the spring of 1904 and nearly every tree was killed.

30. Lockwood, part of A 7; ½ acre, Oct. 13, 1902.—White oak seed planted 4 x 5½ feet with a hoe, and covered 1½ to 2 inches. Three acorns planted per hole at the rate of 20 quarts per acre. It was a poor seed year and the acorns were bad. In June 1907 there were several oak seedlings on this plot, which were left although the area had been replanted with another experiment.

31. Lockwood, A 2; ½ acre, Oct. 7, 1902.—White oak seed planted on three plots as follows: 1, four acorns per hole at the rate of 23 quarts per acre, holes 5 x 5 feet. 2, two acorns per hole at the rate of 15 quarts per acre, holes 4 x 5 feet. 3, one acorn per hole, at the rate of 29 quarts per acre, holes 1 x 5 feet.

The acorns were very poor and only a few seedlings appeared. Number living August 1903, 437; June 1907, 212. Average height, fall 1906, 6 inches.

32. Lockwood, A 2; ½ acre, Oct. 14, 1902.—Red oak seed planted with hoe 4 x 5½ feet, covered 1 to 2 inches deep. Three acorns per hole, being at the rate of 42 quarts per acre. The acorns were good and the number living August 1903 was 708.

33.* Lockwood, C 4, 5; 1-17 acre, Oct. 18, 1902.—64 yellow or black locust one-year-old nursery seedlings planted with mattock 6 x 6½ feet.

Number living spring 1903, 57. These trees were heavily top and root pruned when planted. The trees were removed later to make way for another experiment.

34.* Lockwood, B 1; ½ acre, Oct. 18, 1902.—795 pitch pine nursery seedlings and transplants two years old planted with a hoe 5 x 6 feet.

Number living spring 1903, 617. The plantation was made to test the practicability of fall planting of seedlings and transplants and was fairly successful.

35.* Lockwood, B 12; 1⅖ acres, October 1902 and April 1903.—273 white pine, two-year-old nursery seedlings and transplants, red oak seed planted in 275 holes October 1902, and 1,750 sugar maples, collected seedlings 4 to 10 inches, planted April 1903. Acorns were planted three in a hole.

Fall planting of white pine was only partially successful, as only 190 were living in the spring of 1903. As the oak and maple did not do well all the trees were removed and another experiment started. (See Exp. 70.)

36.* Lockwood, B 13; 1⅖ acres.—294 white pine two-year-old nursery seedlings and transplants, and red oak seed planted in 300 holes Oct. 15, 1902; 1,800 beech, collected seedlings 6 to 18 inches high planted April 18, 1903. Acorns were planted three in a hole.

Fall planting of white pine was only partially successful as only 205 were living in the spring of 1903; as the oak and beech did not do well all the trees were removed and another experiment started. (See Exp. 71.)

37. Lockwood, C 2; 2⅓ acres, Oct. 15, 1902.—White oak seed, which was very poor, planted three acorns per hole, 1,100 holes; 1,768 chestnut nursery seedlings one year old; April 28, 1903, white pine two-year-old nursery transplants. These were planted 4½ x 5 feet, in mixed groups each containing three to ten trees of one species. The failed places in the white oak were

refilled in the fall of 1903; and of the white pine in the spring of 1904.

Fall planting of chestnuts was only moderately successful as many were heaved out by frosts.

Number living August 1903, chestnut, 1,269; white oak, 445; white pine, 1,251; total, 2,965. August 1906, chestnut, 1,053; white oak, 324; white pine, 1,218; total, 2,595. Average height August 1906, of white pine, 19 inches; chestnut, 12 inches.

38 and 39. Lockwood, A 7; ½ acre, October 1902.—Chestnut, nursery seedlings and seed. 672 seedlings one year old planted 5 x 5½ feet; seed one in a hole, holes 1 x 5½ feet, being at the rate of 42 quarts per acre.

Number living August 1903, of the seedlings 849; from seed, 620.

NOTE.—It required one man three and one-quarter hours to plant one peck of chestnuts, in this way.

40. Lockwood, B 4; 1-50 acre, April 1903.—26 red cedar nursery transplants 12 to 15 inches high, planted 6 x 6 feet.

Number living June 1907, 15. Average height 16 inches.

41. Lockwood, A 5; 1¾ acres, April 1903.—Hardy catalpa nursery seedlings 10 to 15 inches high, planted in three sections: 4 x 4; 5 x 5; 6 x 6 feet. In the spring of 1904 the failed places were filled with seedlings.

Number living August 1903, 3,526; August 1906, 1,641.

42. Lockwood, A 6; 2¾ acres, April 1, 1903.—3,350 cottonwood cuttings, 10 inches long, pushed into the ground 6 x 6 feet. The failed places were replaced in the spring of 1904 with similar cuttings.

Number living August 1903, 2,429; June 1907, 100. Average height, 12 inches.

43, 44, 45. Lockwood, A 8, *a;* 3 acres, April 6, 1903.—1,567 chestnut one-year-old nursery seedlings planted 5 x 5 feet; 1,170, 6 x 6; 825, 7 x 7. The failed places were replaced in the spring of 1904.

Number living August 1903, 2,859. Average height August 1907, 16 inches. (See Exp. 12.)

46. Lockwood, A 7; 1-50 acre, April 29, 1903.—Chestnut seed planted with a hoe 1 x 5½ feet, one nut per hole, being at the rate of 42 quarts per acre.

Number living August 1903, 67. This was to compare spring sowing of stratified seed with fall sowing of seed from the same

source in Exp. 39. (See also Exp. 12, the seed for which was, however, from a different source.)

47. Lockwood, B 1; ¾ acre. Green ash (A), April 29, 1903; Scotch pine (S), spring 1904. Arrangement:—

S	S	S	S
S	A	S	A
S	S	S	S

324 green ash nursery seedlings one year old; 700 pine nursery seedlings two years old; planted 5 x 5 feet.

Number living August 1903, 293 ash; August 1906, pine, 461; ash, 88; total, 549. Average height August 1907, pine, 39 inches; ash, 10 inches. Several of the pines are affected by the same fungus as that mentioned in Exp. 24.

48. Lockwood, B 7; 1 acre, April 27, 1903.—2,281 white pine nursery transplants two years old planted in three sections as follows: 504, 6 x 6; 720, 5 x 5; 1,057, 4 x 4. The failed places were filled in the spring of 1904 with three-year transplants.

Number living August 1903, 2,153; August 1907, 2,135. Average height August 1907, 34 inches.

49. Lockwood, B 8; 5-6 acre, April 9, 1903.—White and green ash, nursery seedlings one year old; basswood and tulip collected seedlings 4—6 inches high planted in the failed places among the white pine of Exp. 22. Total number, 450.

Number living August 1906, white pine, 1,243; ash, 229; basswood, 20; tulip, 4; total, 1,496. Average height August 1907, basswood, 8 inches; ash, 14 inches.

50. Lockwood, E 3; 1 acre, April 18, 1903.—819 chestnut nursery seedlings one year old; 825 beech collected seedlings 6 to 15 inches high planted 5 x 5 feet. The missing trees were replaced with similar stock in the spring of 1904.

Number living August 1903, chestnut, 755; beech not counted. Average height August 1907, chestnut, 8 inches; beech, 11 inches.

51. Lockwood, C 1; 1 acre, April 9, 1903.—822 chestnut nursery seedlings one year old; 813 sugar maple collected seedlings 4 to 8 inches high, planted 5 x 5 feet according to diagram.

C	M	C
M	C	M
C	M	C
M	C	M

The missing trees were replaced with similar stock in the spring of 1904. Number living August 1903, sugar maple, 502; chestnut, 726; August 1907, sugar maple, 32; chestnut, 589. Average height August 1907, maple, 5 inches; chestnut, 13 inches.

52 and 53. Lockwood, C 3, 4; 2 acres, April 1903.—900 white pine nursery transplants two years old; 1,500 sugar maple collected seedlings 4—10 inches high, planted 6 x 6 feet. The missing trees were replaced with similar stock in the spring of 1904. In August 1906, there were only about 300 maples remaining alive, and the average height was 5 inches while that of the pines was 29 inches.

54.* Lockwood, D 1; 1 acre, April 27, 1903.—1,128 sugar maple nursery seedlings 6 to 9 inches high planted 5 x 5 feet. In August 1903 there were 995 alive. In the spring of 1904 the missing trees were replaced, but in August 1907 practically all were dead.

55* and 56. Lockwood, D 3, 4; 2 acres, April 2, 1903.—Pitch pine planted 5 x 5 feet, 1,823 nursery seedlings two years old, 1,907 nursery transplants two years old.

Number living August 1903, seedlings, 1,789; transplants, 1,869. As seedlings and transplants did equally well the former were removed so that D 3 could be utilized for another experiment. In August 1906 there were 1,689 of these transplants alive. Their average height in August 1907 was 53 inches. Many of them bore cones their third year.

57 and 58. Lockwood, E 1, 2; 2 acres, April 24, 1903.—800 white pine two-year-old nursery seedlings from Maine, very poor stock; 1,400 beech collected seedlings from Tennessee 6—15 inches high, very poor; planted alternately 6 x 6 feet.

Number living August 1903, white pine, 681; beech, 1,071. The missing places were refilled with similar material in the spring of 1904. Average height August 1907, pine, 25 inches; beech, 11 inches.

59. Lockwood, E 4; 1 acre, April 25, 1903.—1,748 yellow or black locust, nursery seedlings one year old planted as follows: 804, 4 x 4; 542, 5 x 5; 402, 6 x 6.

Number living August 1903, 1,683; August 1906, 1,137. In August 1907 the heights ranged from 3 to 12 feet; average 7.5 feet. Almost all the trees bore seeds in 1907 and many did so in 1905. The large mortality was caused by rabbits girdling the trees in winter.

60. Lockwood, E 5; 1 acre.—550 white pine nursery transplants two years old, planted April 29, 1903; 325 white pine transplants three years old, and 875 black birch nursery seedlings 8 to 12 inches high planted May 21, 1904; all planted alternately 5 x 5 feet.

Number living August 1903, pine, 549; August 1906, pine, 800; birch, 83. Average height August 1907, pine, 40 inches; birch, 19 inches.

61.* Lockwood, B 6; 1 acre, April 10, 1903.—Black birch seed broadcast on cultivated strips. No seedlings appeared as the result of this experiment although the seed was fairly good.

62. Lockwood, C 6; 1 acre, April 29, 1903.—Red oak seed planted as follows: in the northeast section one acorn per hole, holes 5 x 5 feet, being at the rate of 13 quarts per acre; in the southeast section, two acorns per hole, holes 6 x 6 feet, being at the rate of 18 quarts per acre.

Number living August 1903, 539. The failed places were refilled in the spring of 1904. Number living August 1907 was 753 and the average height was 16 inches.

63.* Mundy Hollow; 14 acres on both slopes of the main valley through the central part of the property, April 1903.—16,000 chestnut nursery seedlings one year old planted 6 x 6 feet under a medium dense chestnut and oak coppice. Because of the difficulty of making accurate counts in the thicket, no definite counts were made; but it is certain that a large proportion of the trees were alive in the fall of 1903. In the spring of 1904 a fire killed practically all of them.

64.* Mundy Hollow; 1½ acres along the ridge on the other side of the main central valley from the highway, April 30, 1903.—Red fir, basswood, tulip, white and green ash. Each species planted pure among the sprouts, 6 x 6 feet as nearly as possible. Fir, nursery seedlings 6 to 9 inches high; basswood and tulip, collected seedlings 4 to 10 inches high; ash, nursery seedlings one year old. Total number 1,800. No definite counts could be made on account of the brush, but it is probable that most of the ash and fir were living in the fall of 1903 while few basswoods or tulip survived. A fire swept over the property in the spring of 1904 and killed most of the trees.

65. Lockwood, C 4, 5; 1⅕ acres, April 25, 1903.—Sugar maple, white pine, red fir, tulip, basswood, white and green ash

planted 5 x 5 feet, and mixed, but never more than three species in one portion of the plot. Number planted: 800 maple; 600 pine; 325 ash; 300 fir; 55 tulip; 20 basswood. The missing maples were replaced in May 1904 with maple and pine.

Number living August 1907, C 4: pine, 515; maple, 113; total, 628. C 5: pine, 455; maple, 235; ash, 241; fir, 183; total, 1,114. On both lots 1,742.

66. Lockwood, D 6; 1 acre, April 25, 1903.—Chestnut, red fir, white and green ash, basswood and tulip, planted 5 x 5 feet, mixed but never more than three species in any one portion of the plot. The total number planted was about 1,750, of which about 1,000 were chestnut, and the remainder distributed among the other species about equally. The stock consisted of collected seedlings, nursery seedlings and transplants of various ages.

Number living August 1907, chestnut, 323; ash, 63; fir, 68; basswood, 12; total, 466.

67 and 68. Lockwood, D 2, 5; 2 acres, spring 1904.—Red oak nursery seedlings one year old, white pine nursery seedlings two years old planted 6 x 6 feet.

D 5, planted with 800 oak and 400 pine as follows: four rows, all oak; then two rows, all pine, etc. Number living August 1907, oak, 759; pine, 296.

D 2, planted with 800 oak and 400 pine as follows: two rows all oak; then one row all pine, etc. Number living August 1907, oak, 734; pine, 309.

69. Lockwood, B 6; 1 acre, spring 1904.—600 chestnut one-year seedlings and 600 white pine two-year seedlings planted 6 x 6 feet; two rows of one, then two rows of the other.

Number living August 1907, pine, 451; chestnut, 361.

70. Lockwood, B 12; 1⅖ acres, spring 1904.—300 white pine two-year nursery seedlings; red oak seed, in 300 holes; 1,800 sugar maple nursery seedlings 8 to 12 inches, planted 5 x 5 feet; solid rows of maple, the oak and pine alternate in rows.

Number living August 1907, pine, 256; oak, 271; maple, 201. (See Exp. 35.)

71. Lockwood, B 13; 1⅖ acres, spring 1904.—300 white pine two-year nursery seedlings; red oak seed in 300 holes; 1,800 beech nursery seedlings 4 to 8 inches high, planted 5 x 5 feet.

Number living August 1907, pine, 271; oak, 325; beech, 598. (See Exp. 36.)

72. Lockwood, D 3; 1 acre, spring 1904.—1,200 red oak nursery seedlings one year old planted 6 x 6 feet. Experiments 32, 62, 72 are from seed gathered at the same time from the same trees. Number living August 1907, 1,092.

73. Lockwood, A 4; 1 acre, spring 1904.—Red oak acorns, three in a hole, and white pine nursery seedlings two years old planted 6 x 6 feet. Arrangement:

R	P	R
R	R	R
R	P	R

Number living August 1907, pine, 256; oak, 553.

74. Mundy Hollow, in a strip parallel to and adjoining the highway, extending from about half way up the hill toward Wilson's Station nearly to the boundary; spring 1904.—White pine, Scotch pine, red oak, each species planted pure 8 x 8 feet as nearly as possible among the sprouts. Beginning on the Wilson's Station side, the planting was as follows: 26 rows Scotch pine nursery seedlings 2 years old, 2,075; 10¾ rows white pine nursery seedlings 2 years old, 775; 6¾ rows white pine nursery transplants 2 years old, 575; 31½ rows Scotch pine nursery transplants 2 years old, 2,400; 38 rows white pine nursery seedlings 2 years old, 2,400; 10 rows red oak seed, two acorns per hole, 700; total number planted about 8,925.

75.† Lockwood, F 1; 1 acre, Oct. 7, 1904.—White oak and bitternut hickory seeds planted in alternate holes 6 x 6 feet with a hoe; acorns three in a hole; nuts two in a hole.

Number living August 1907, oak, 25; hickory, 211; being a very small percentage of the number planted.

76. Mundy Hollow, southwest corner, road to brook; 1 acre, October 1904.—White oak acorns, planted 6 x 6 feet, three in a hole, with a hoe, 36 quarts.

77 and 78. Clark Field, F 4 and E 7; 11 acres, April 1905.—Chestnut seed collected in locality. Furrows were made across the field 6 feet apart, northwest to southeast. Nuts were planted 3 feet apart in furrows with a hoe. Two nuts in a hole part of

† All the experiments up to this point are made under the direction of the first forester, Mr. Walter Mulford. The remaining experiments were made under the direction of the writer.

way; 3 nuts in a hole nearest East Granby highway, 3 bushels of nuts. Average cost per acre, material and planting, $5.

Number living August 1907, ten trees in every 100 feet of furrow, equivalent to a spacing of 6 x 10 feet.

79. Clark, E 6; 7 acres, May 9, 1905.—White pine planted 5 x 5 or 6 x 6 feet. Part of these were three-year transplants raised in our nursery, part were two-year seedlings raised by the Yale Forest School, and part were native stock pulled from the woods in Stafford. Many of the furrows made for Exp. 78 ran over into this area, and some of the pines were planted in these furrows and some on the hills between.

Results. In August 1907 of the three-year transplants 98 per cent. were alive; of the Stafford trees 60 per cent. and of the two-year seedlings 83 per cent. The average heights were: Two-year seedlings, 13 inches; three-year transplants in furrows, 34 inches; on ridge, 25 inches; in gravel pit, 19 inches; and of the Stafford trees, 15 inches.

80. Lockwood, F 2; 4 acres, May 15, 1905.—7,000 white pine and Norway spruce two-year seedlings raised by the Yale Forest School planted 5 x 5 feet alternately.

Results. In August 1907 of the white pine there were 95 per cent. alive; and of the spruce 64 per cent. Average height, pine, 17 inches; spruce, 11 inches.

81. Lockwood, B C 1; 1½ acres, May 17, 1905.—Norway spruce two-year seedlings raised by the Yale Forest School, planted 5 x 5 feet with dibble and spade. The object of this experiment was to see how Norway spruce would do in this dry situation under pitch pine. This had just been burned over.

82. Lockwood, B C 2; 1½ acres, May 25, 1905.—2,733 white pine two-year seedlings raised in our Poquonock nursery, planted 5 x 5 feet. The idea is to see how two-year-old white pine will do under a medium dense stand of pitch pine thirty feet high.

83. Lockwood and Clark, D 7; 10 acres, April 21, 1906.—8,100 white pine two-year seedlings purchased from D. Hill at $3.75 per thousand; 7,300 Norway spruce two-year seedlings purchased from the Evergreen Nursery Company, at $3 per thousand; 950 sugar maple home-raised seedlings three years old. All planted 5 x 6 feet, alternate rows of pine and spruce as long as the spruce lasted, then pine and maple. Cost: Plants, $56.40; labor, $43.35; express, $10; total, $109.75; average cost per acre, $10.97.

Results. Partial count August 1, 1906, showed two-year white pines, 68 per cent. alive; three-year white pines, 90 per cent. alive; maple, 75 per cent.; spruce, 89 per cent.

The pines purchased from the west arrived in poor condition, and the long dry spell after planting proved too much for them. In August 1907, 60 per cent. of the pines were alive, 72 per cent. of the spruces.

84. Mundy Hollow; 2 acres, May 10, 1906.—2,800 white pine two-year seedlings purchased from D. Hill, at $3.75, planted 5 x 6 feet. Cost: Plants, $10.50; labor, $9.50; express, $2; average cost per acre, $11.

85. Mundy Hollow; 1 acre, May 11, 1906.—115 black or yellow locust, one-year-old seedlings, home-raised, planted with a hoe 5 x 6 feet. Cost: Plants, $3; labor, $8; total, $11.

86. Mundy Hollow; 1 acre, May 12, 1906.—1,300 chestnut one-year seedlings planted 5 x 6 feet. Cost: Plants, $4; labor, $4; total, $8.

87. Clark, B 15; 1 acre near new nursery, May 12, 1906.—1,360 white pine three-year seedlings, home-raised, planted 5 x 6 feet.

88, 89, 90. Mundy Hollow; 7 acres, April 1907.—I. 1,800 Norway spruce, two-year seedlings planted, 6 x 6 feet on two acres. Cost: Plants, $5; time five men one day, $7.50; total, $12.50.

II. 2,800 balsam firs two-year seedlings planted 6 x 6 feet on three acres. Cost: Plants, $9; time five men one day, $7.50; total, $16.50.

These seedlings were very small. It would have been better to have transplanted them for a year.

III. 2,500 arbor-vitæ two-year seedlings planted 6 x 6 feet on two acres. Cost, $17.

91. Lockwood, A 1; 1 acre, April 6, 1907.—Part I, in corner of lot nearest road. 600 Austrian pine, two-year seedlings raised in our Poquonock nursery, planted 5 x 5 feet.

II. 125 European larch two-year seedlings from same source, planted 5 x 5 feet.

III. 630 Scotch pine two-year seedlings from same source, planted as follows: 5 x 5 feet, 500; 6 x 6 feet, 130.

92. Lockwood, B 14; ¾ acre, May 1, 1907.—1,041 black locust, one-year-old seedlings planted 5 x 5 feet.

93. Lockwood, A 2; 1 acre, May 1, 1907.—White pine, two-year seedlings raised in our Poquonock nursery planted as follows: 6 x 6 feet, 300; 5 x 5 feet, 330; 4 x 4 feet, 500; 3 x 3 feet, 600; total, 1,730.

94. Clark, F 5; 6 acres, May 8, 1907.—10,792 white pine two-year seedlings raised in our Poquonock nursery, planted 5 x 5 feet. Cost: Trees, $40; labor, $30; total, $70; cost per acre, $11.60.

95. Lockwood, B 2, 3, 4; 2 acres, Sept. 28, 1907.—3,000 white pine three-year transplants planted 5 x 5 feet. The purpose of this experiment was to test fall planting of pine compared to spring planting.

GUIDE FOR VISITORS TO THE PLANTATIONS.

See map on opposite page.

In this portion of the report L. F. stands for Lockwood Field; and M. H. for Mundy Hollow. These are both in the town of Windsor, and can best be reached by taking the Rainbow trolley from Hartford or Windsor. Mundy Hollow is three-quarters of a mile east of Poquonock; and Lockwood Field is half a mile north of the end of the Rainbow trolley line. Carriages may be procured for visiting the latter at the Case Livery Stable near the end of the line. Mr. Judson S. Leonard, local superintendent, is always glad to show visitors either of these plantations. His house is opposite the Rainbow post office, and engagements can be made either by mail or telephone. (See F. M. Case in directory.)

Lockwood Field is divided into blocks of irregular sizes by fire lines which intersect each other at right angles. These fire lines are also used as roads. An idea of the size of the blocks can be obtained from Lot A 3, which is covered with pitch pine, and is approximately one acre. The blocks are lettered in series, beginning at the south; and each series is numbered, beginning at the east, so that A 1 is the lot in the extreme southeast corner of the field on the Tariffville highway, and F 5 is in the extreme northwest corner, on the East Granby highway.

Mundy Hollow is not regularly divided.

Lockwood Field:

A 1. White pine, Exp. 1; European larch, Scotch pine, Austrian pine, 91.
A 2. White pine, Exp. 1, 93; white oak, 31; red oak, 32.

A 3. Pitch pine, Exp. 10; black birch, 3.
A 4. Black birch, Exp. 3; white pine, red oak, 73.
A 5. Catalpa, Exp. 41; white oak, 5.
A 6. Cottonwood, Exp. 14, 42.
A 7. Chestnut, Exp. 12, 38, 39, 46; white oak, 30.
A 8. Chestnut, Exp. 43, 44, 45; white pine, 6.
A 9. White pine, Exp. 21.

B 1. Gray birch, Exp. 2, 11; cottonwood, 4; green ash, 47; pitch pine, 34; Scotch pine, 47.
B 2. Cottonwood, Exp. 4; gray birch, 2, 11; white oak, 47; white pine, 95.
B 3. Gray birch, Exp. 2, 11; white oak, 47; white pine, 95.
B 4. White oak, Exp. 47; white pine, 95; red cedar, 16.
B 5. White pine, Exp. 17, 18, 19, 20; tulip, 18.
B 6. Chestnut, white pine, Exp. 69; black birch, 61.
B 7. White pine, Exp. 48.
B 8. White pine, Exp. 22; green and white ash, basswood, tulip, 49.
B 9. Austrian pine, Exp. 26; red pine, 23.
B 10. Scotch pine, Exp. 24.
B 11. Red pine, Exp. 25.
B 12. White pine, red oak, sugar maple, Exp. 35, 70.
B 13. White pine, red oak, beech, Exp. 36, 71.
B 14. Black locust, Exp. 92.
B 15. White pine, Exp. 87.

B C 1. Norway spruce, Exp. 81; white spruce, 15.
B C 2. White pine, Exp. 82.
C 1. Chestnut, sugar maple, Exp. 51.
C 2. White oak, chestnut, white pine, Exp. 37.
C 3. White pine, sugar maple, Exp. 53.
C 4 and 5. Sugar maple, Exp. 52, 65; tulip, white and green ash, basswood, red fir, 65; white pine, 52, 65.
C 6. Red oak, Exp. 62.

D 1. Sugar maple, Exp. 54.
D 2. Red oak, white pine, Exp. 68.
D 3. Red oak, Exp. 72; pitch pine, 56.
D 4. Pitch pine, Exp. 56.
D 5. White pine, red oak, Exp. 67.
D 6. White and green ash, red fir, basswood, chestnut, tulip, Exp. 66.
D 7. Norway spruce, sugar maple, white pine, Exp. 83.

E 1 and 2. White pine, Exp. 57, 58; beech, 57, 58.
E 3. Beech, chestnut, Exp. 50.
E 4. Black locust, Exp. 59.
E 5. White pine, black birch, Exp. 60.
E 6. White pine, Exp. 79.
E 7. Chestnut, Exp. 78.

F 1. Hickory, white oak, Exp. 75.
F 2. White pine, Norway spruce, Exp. 80.
F 4. Chestnut, Exp. 77.
F 5. White pine, Exp. 94.

MUNDY HOLLOW:

White pine, Exp. 8, 9, 27, 74, 84; green ash, white ash, basswood, red fir, 64; red oak, 74; red pine, 27, 28; white oak, 76;, balsam, 89; arbor-vitæ, 90; Scotch pine, 74; tulip, 27, 28, 64; Norway spruce, 29, 88; black locust, 85; chestnut, 63, 86.

SUMMARY OF EXPERIMENTS.

According to Species.

WHITE PINE *Pinus strobus.*

Seeding.

Exps. 1, 7, 8, 9. These experiments with seed have all been made in the spring on sandy uncultivated land. Although seed was sown in Exp. 1 at the rate of 2, 3, 4 and 5 pounds per acre on the plain land, only a few trees resulted. Exps. 7 and 8 were made under a birch cover, and Exp. 9 under the cover of an oak and chestnut coppice. They were all equally unsatisfactory.

Planting.

Exps. 17, 18, 19, 20, 21, 22, 27, 28, 35, 36, 48, 52, 53, 57, 58, 60, 65, 67, 68, 69, 70, 71, 73, 74, 79, 80, 82, 83, 84, 87, 93, 94, 95. A large number of these experiments have been made to test the relative merits of different distances of spacing; and another group to test mixtures of pine with other species. It will require many years to obtain any information on these points from the experiments. Those, however, which illustrate the value of different kinds of stock, of time of planting, method of planting and the suitability of the soil, are already instructive; as well as the later ones which have been made on a larger scale to test the expense of planting.

As all the experiments in planting with the exception of 35, 36, and 95 have been made in the spring, the most important deduction to be made is as to the relative value of stock of different ages. Of the trees planted in the fall in Exps. 35 and 36 only 70 per cent. were alive the next spring.

Two-year seedlings were used in Exps. 57, 58, 67, 68, 69, 70, 71, 73, 79, 80, 82, 83, 84, 93, 94.

The criterion for judging of the success of seedlings is the percentage that live, and the height attained in a definite period. Two-year seedlings and transplants stand about 3 inches above the ground when planted, three-year stock 6 inches, and four-year stock 10 inches. The seedlings from the woods ranged from 3 to 12 inches. There is a great variation in two-year seedlings according to their origin.

With the two-year seedlings the following results have been obtained. The percentage of trees alive at the close of the first summer was as follows: Exp. 57, 75 per cent.; Exp. 58, 88 per cent.; Exps. 67, 68, 69, 75 per cent.; Exp. 70, 85 per cent.; Exp. 71, 90 per cent.; Exp. 79, 83 per cent.; Exp. 80, 95 per cent.; Exp. 83, 68 per cent.

The average height made by the trees of Exp. 57 in five years was 21 inches; and of Exps. 79 and 80 in three years 13 and 17 inches respectively.

These figures show that, while from 68 to 95 per cent. have lived, the indications are that 75 to 85 per cent. is a fair proportion to expect. In the above case the 68 per cent. was from seedlings imported from a Western nursery, while the 95 per cent. was from seedlings raised by the Yale Forest School in New Haven, illustrating forcibly the advantage of well-raised stock near at hand over that furnished by distant nurseries.

There are only a few experiments with two-year transplants; Exps. 48, 52, 53. Exp. 48 showed 94 per cent. alive at the end of the first summer, with an average height after five years of 34 inches. The average height of the trees of Exp. 52 after the same period was 29 inches.

The results from these experiments indicate that a greater number of the transplants lived than of the seedlings and that the height growth of the transplants is considerably better.

Three-year seedlings were used in Exps. 17, 21, 87.

Experiment No.	Per cent. alive at close of First Summer.	No. of Seasons' Growth.	Average Height in Inches.
17	98	5	28
21	94	5	27

These results indicate that two-year transplants and three-year seedlings are about equally good.

Three-year transplants were used in Exps. 60, 79, 95.

Experiment No.	Per cent. alive at close of First Summer.	No. of Seasons' Growth.	Average Height in Inches.
60	99.5	5	40
79	98	3	25

Four-year transplants were used in Exps. 18, 19, 20.

Experiment No.	Per cent. alive at close of First Summer.	No. of Seasons' Growth.	Average Height in Inches.
18	99.9	5	40
20	90	5	37

Exp. 20 was with pines imported from France. The larger percentage of loss is due to damage sustained during the long shipment.

Woods-grown stock was used in Exps. 22, 65, 79.

Experiment No.	Per cent. alive at close of First Summer.	No. of Seasons' Growth.	Average Height in Inches.
22	70	5	42
79	60	3	15

The most pronounced lesson from these experiments is that woods-grown seedlings can only be transplanted with considerable loss. This is because their roots are poor, and grown in the woods, they cannot stand the light and heat of the open land. In some localities, even with this high percentage of loss, it may be cheaper to collect native stock and plant 2,000 trees per acre than to purchase 1,500 trees. This is hardly the case, however, in any part of Connecticut, for there are few places in the state where pines can be collected at less than $3 per thousand at present prices of labor.

Next to the woods-grown stock it is evident that the biggest percentage of loss occurs in the use of two-year seedlings, while transplants of that age and the older trees suffer almost no loss.

HEIGHT OF WHITE PINE.

Character of Stock.	No. of Years from Seed.	Height, Inches.	No. Inches per Year.
2 yr. seedlings	5	15	3
2 yr. seedlings	7	21	3
2 yr. transplants	7	30	4.1
3 yr. seedlings	8	28	3.5
3 yr. transplants	6	25	4.1
3 yr. transplants	8	40	5
4 yr. transplants	9	40	4.4

Evidently from the standpoint of growth the transplants are superior, the two-year transplants giving better results than the three-year seedlings. The best results both in number living and in rate of growth have been obtained from three-year transplants, of which 98 per cent. lived and which have grown on an average five inches a year for the first eight years from seed.

As to the expense of planting pine, only a few of the later experiments have been made with a view of determining this.

Exp. 83 is one of the most instructive. The total cost of planting this area of ten acres was as follows:

16,350 trees	$56.40
Labor	43.35
Express on trees	10.00
Total	$109.75

When it is considered that nearly ten per cent. of this cost was for transportation, and that there was at least twenty per cent. more loss with these imported seedlings than in stock raised at home, the advantage of home-raised seedlings is evident.

The expense in Exp. 94 is about the same. Here six acres were planted.

10,792 trees	$40.00
Labor	30.00
Total	$70.00
Cost per acre	$11.60

Planting has been done on a larger scale on the state land in Union, Conn., for $8.70 an acre. On the arrival of the trees from a distance they should be at once heeled in near the place of planting, preferably in a shaded, well-drained situation. Not more than five hundred trees should be taken out at any one time for a crew of three planters. The bundles should be untied and the roots puddled in a thick mud. They should be protected in the basket with wet moss or cloths, and the roots should never be exposed to the air for a minute. A still, cloudy day early in spring when the ground is moist is most suitable for planting.

The method of planting found to be most efficient and economical is with crews of four men. Three men work abreast with mattocks, keeping straight lines by sighting on poles placed six feet apart at the other end of the field. One man or boy carries a basket with the trees and hands them to the planters as they are required. The sod should be somewhat scraped away by the mattock. The mattock is then struck down into the earth, the handle is raised and somewhat twisted, making a small hole just large enough for the little tree. The earth is then pressed firmly about the roots with the foot, the mattock not having been removed until the tree is set. A crew of four men in open pasture free from brush and stones can plant 4,000 trees a day without much trouble. In very stony or brushy land they may not plant over 2,000. It pays to hire good men at high wages for this work, as for everything else. The secret of the cheapness of the planting at Union is that nearly all the labor was done by native Americans who were interested in the work.

What is said here regarding methods of planting applies equally well to the other species.

Scotch Pine *Pinus sylvestris.*

Exps. 24, 47, 74, 91. This is a European tree noted for its adaptability to very poor, sandy soils. The experiments have borne out its reputation for rapid growth at first, but it is probable that the white pine will eventually go ahead of it. One advantage over the white pine is that it is rarely attacked by the weevil and seems to be freer from other enemies. At the end of the first summer Exp. 24 showed 95 per cent. alive.

The average height for these three-year seedlings was, at the end of three years' growth, 19 inches; four years' growth, 31 inches; five years' growth, 50 inches. The growth of the fourth year was 12 inches, and of the fifth year, 19 inches.

Seedlings of this species can be purchased at about the same prices as those of white pine, and the seed is considerably cheaper.

Red or Norway Pine *Pinus resinosa.*

Exps. 23, 25, 27, 28. This tree is a native of the northern part of the United States, but only a few specimens have been found wild in Connecticut.

Exps. 23 and 25 showed 99.5 per cent. alive at the end of the first season.

The height of the nursery seedlings four years old was, at the end of two years, 8 inches; three years, 16 inches; four years, 22 inches; five years, 29 inches.

While the growth was not as rapid as that of Scotch pine, it takes readily to the soil and is entirely free from enemies. The

height growth will undoubtedly eventually surpass that of the Scotch pine. The lumber is also superior to that of Scotch pine, and is largely classed in with white pine in the Lake States, where it reaches its best development. The seedlings are somewhat more expensive than those of the two previous species, and are not yet raised in large quantities.

Austrian Pine *Pinus Austriaca.*

Exps. 26, 91. Exp. 26 is the only one which has been made with this species long enough to indicate results. Of the 98 trees planted all were alive at the end of the first summer, while 11 died during the first winter. Usually the loss in the plantations is greater during the first dry season.

The average height of the four-year seedlings three years after planting was 22 inches, of the fourth year, 29 inches.

On the whole, there seems to be no argument in favor of this species, as there is for the three previous species. It is better adapted for loamy soils than for sand.

Pitch Pine *Pinus rigida.*

Exps. 10, 13, 34, 55, 56. This is our native pitch pine, locally called yellow pine, and is the only species with which seeding has given satisfactory results (see Exp. 10), and this ability to cover old waste sand barrens is one of its chief characteristics. The average height of these trees five years from seed was 26 inches.

Exp. 34 was made to test the practicability of fall planting. 795 two-year seedlings and transplants were set Oct. 18, 1902, and in the spring of 1903 there were 617 alive, or 77 per cent.

Exp. 55, spring planting of two-year seedlings, showed 98 per cent. alive at the end of the first summer, so spring planting seems better adapted even to this hardy species. The average height of these two-year seedlings at the end of their fifth year was 53 inches.

Average Height Growth of Best Plantations of Five Species of Pine.

Name.	No. of Years from Seed.	Height in Inches.	No. of Inches per Year.
White pine	8	40	5.0
Scotch pine	8	50	6.2
Red pine	8	22	2.7
Austrian pine	8	29	3.6
Pitch pine	7	53	7.5

NORWAY SPRUCE

Exps. 29, 80, 81, 83, 88. Exp. 29 was made with nursery transplants 10 to 12 inches high. The trees were eventually killed by fire, but a count at the end of the first year showed that 95 per cent. of the number planted were alive.

In Exp. 80 two-year seedlings raised by the Yale Forest School were used; and at the end of the third growing season only 64 per cent. were alive, as compared with 95 per cent. of the white pine from the same source. The average height of the spruce was 11 inches, compared with 17 inches for the pine at the end of the third growing season.

In Exp. 83 two-year seedlings from the west were used, and at the end of the first growing season 89 per cent. were alive as compared to 68 per cent. for similar white pine stock.

Spruce seedlings are not as large as those of pine of the same age, and it is evident that three-year transplants should be used. It is also pretty certain that the spruce is not adapted to such dry light soils.

RED FIR *Pseudotsuga taxifolia.*

Exps. 64, 65, 66. In Exp. 65 about 300 two-year seedlings were used and at the end of the fifth year's growth about two-thirds were alive. These trees have grown very little thus far, bearing out the general belief that while the Pacific coast tree has proved itself very valuable for European planting, it is not adapted for planting in the eastern United States. However, it is possible that if larger stock were used the results might be more satisfactory.

RED CEDAR *Juniperus virginiana.*

Exps. 16, 40. The first of these experiments was with seedlings 6 to 12 inches high, and was unsuccessful, as they all died within two years. Of the slightly larger trees planted in Exp. 40 about half were alive at the end of five years. Considering the natural adaptability of the species for such situations, it seems strange that it has not done better.

BALSAM *Abies balsamea* and
ARBOR-VITÆ *Thuya occidentalis.*

The experiment made with these species in the moister part of Mundy Hollow is too recent to have given any evidence at this date regarding the suitability of the species for planting.

EUROPEAN LARCH *Larix Europea.*

Exp. 91 with this species, also made in the spring of 1907, is not old enough to lend any light on the adaptability of the species for our planting.

CHESTNUT *Castanea dentata.*

The following experiments were made by planting the nuts in the permanent situation: 12, 39, 46, 77, 78. The object of Exps. 12 and 46 was to test spring sowing; and of 39, fall sowing.

The squirrels destroyed many nuts, but in July, after sowing, 5,874 seedlings were counted. By the end of the fifth season only 3,717 trees were alive. The heights at this time ranged from 5 to 33 inches. As the areas planted in these experiments were not separated from each other, it is impossible to judge whether spring or fall sowing was most successful.

In Exp. 77 ten acres were planted with three bushels of nuts, three nuts per hole in furrows. At the end of the third growing season there was found to be an average of ten trees in every one hundred feet of furrow, equivalent to a spacing of ten feet apart. The average height of the three-year seedlings was 5 inches.

Chestnut seedlings one year old were used in Exps. 37, 38, 43, 44, 45, 50, 51, 63, 66, 69, 86. Of the 1,768 chestnuts planted in Exp. 37, 72 per cent. were alive at the end of the first growing season, and 60 per cent. at the end of the fourth season. The average height at the last named date was twelve inches.

Many thousand trees planted in the other experiments showed at the end of the first season from 77 to 92 per cent. alive.

For example, of the 822 trees planted in Exp. 51, 90 per cent. were alive at the end of the first season; and 71 per cent. at the end of the fifth season. While the results from sowing are fairly satisfactory considering the cheapness of the method compared to planting, these experiments prove that planting is most satisfactory. It will be noticed that while a large proportion of the planted seedlings live through the first season, a considerable number die subsequently, so that probably not over 60 per cent. can be expected to grow up.

It is a question whether two-year seedlings might not give even better results. Planting of deciduous trees in Europe is largely of stock two or more years old.

WHITE OAK *Quercus alba.*

In Exps. 5, 30, 31, 37, 47, 75, 76, acorns were planted in the fall. In some of them the seed was poor, but even in those where the seed was good the results were very unsatisfactory. It is probable that planting seedlings would give much better results.

RED OAK *Quercus rubra.*

Exps. 32, 35, 36, 62, 73, 74 were made with red oak acorns. As the result of 21 quarts of seed used in Exp. 32, 708 seedlings were found at the end of the season. In Exp. 62, one acre was planted in the spring, half at the rate of 13 quarts per acre and the other half at the rate of 18 quarts per acre. The number of seedlings living on the whole acre three years after sowing was 753 and the average height was 16 inches.

In Exp. 73 one acre was planted with red oak acorns and white pine. Four years later there were 553 oaks as the result of this sowing which, taken with the 256 pines, made a satisfactory stand of 809 trees.

Exp. 72 was made with one-year seedlings. Of the 1,200 trees planted, 90 per cent. were alive at the end of the fourth growing season.

While these experiments indicate that red oak seed can be more successfully sowed than that of chestnut or white oak, it also shows that planting gives better results than sowing. Still, on account of the economy with which sowing can be done, it has a good deal to recommend it where the land is fairly open.

HICKORY *Hicoria minima.*

Although about one acre was sowed in Exp. 75 to white oak and hickory—nuts two in a hole and the holes six feet apart—after three years only 211 hickories could be found, and 25 white oaks. The results are therefore unsatisfactory, though more satisfactory for hickory than for white oak.

BEECH *Fagus atropunicea.*

Exps. 36, 50, 57, 58, 71. The beech collected seedlings used in Exp. 36 did not do well, so were pulled up.

Of the 900 beech collected seedlings used in Exp. 57, 78 per cent. were alive at the end of the first growing season, but the average height after five years' growth was only 11 inches. The growth seemed to be almost nothing.

Of the 509 beech planted in Exp. 58, 71 per cent. were alive at the end of the first growing season, while of the 1,800 beech planted in Exp. 71, only 33 per cent. were alive at the end of the fourth season's growth.

It is therefore apparent that, while 70 per cent. or more may get a rooting, a very large proportion die subsequently, and the growth is so slight that the species cannot be recommended for this kind of soil.

WHITE OR GRAY BIRCH *Betula populifolia.*

Exps. 2 and 11. Both of these experiments were made with seed. The natural reproduction of this birch in the vicinity is so good that it suggested the idea of sowing on cultivated strips to create a nurse growth for pine to be planted later. The utter failure of the experiment shows what an immense amount of seed must be used in nature to secure results. The experiments have shown, however, that a nurse is not needed for pine, and in fact that it grows better in the open than under shade. No experiments were made planting seedlings.

BLACK BIRCH *Betula lenta.*

Exps. 3, 60, 61. Exps. 3 and 60 made with seed gave the same utter failure as the experiments with gray birch seed.

Of the 875 birch planted in Exp. 60 only 83, or less than 10 per cent., were alive at the end of the third year, while the average height at the end of the fourth season was 19 inches, as compared to 40 inches for the white pine planted at the same time.

COTTONWOOD

Exps. 4 and 42 were made with cuttings which were pushed into the soil. Of the 325 used in Exp. 4 none survived more than three or four years; while of the 3,350 planted in Exp. 42 in April 1903, there were only 72 per cent. alive in August 1903. The failed places were replaced in the spring of 1904, and yet only about 3 per cent. of the whole number were left in June 1907.

Exp. 14 was made with seedlings 10 to 12 inches high, and of the 1,900 planted in the spring of 1902 nearly 50 per cent. had died before July; only 43 per cent. were alive in August 1903, and this dwindled to about 5 per cent. in the following three years.

It is evident, as might be expected, that this species is not suited to these dry sand plains.

CATALPA

In Exp. 41, 3,607 nursery seedlings 10 to 15 inches high were planted in April 1903, and 98 per cent. were alive in August of that year, showing that they secured a rooting and withstood the summer. There was a considerable loss the first winter, and all the failed places were replanted in the spring of 1904, and yet only 45 per cent. of the whole number were alive in August 1906, and these had not grown any. Almost all of the trees have been killed back each winter, showing conclusively that the species is not adapted to our climate any more than it is to this poor, light soil. The success of catalpas has been in the West on fairly good soil.

SUGAR MAPLE *Acer saccharum.*

Exps. 35, 51, 52, 53, 54, 65, 70, 83. Exp. 35 was not successful, so was discontinued. 813 maples were planted in Exp. 51, in April 1903, and of these only 61 per cent. were alive in August of the same year. The vacancies were replanted in the spring of 1904, but in August 1907 only 4 per cent. of the whole number were alive, and the average height of these was 5 inches, the same as when planted, four years earlier. All the other experiments have resulted as Exp. 35.

It is evident that the species is not adapted to this dry class of soils, and yet it is probable that by planting older, stronger stock more satisfactory results might be obtained. The forest schools in this country have so far been very faulty in their instruction regarding the planting of deciduous trees, especially of the light-seeded species. In Europe with such trees as maple and ash stock two to four feet high is used.

WHITE and GREEN ASH *Fraxinus Americana* and *lanceolata.*

These species are considered together, as it is thus far impossible to distinguish them.

Exps. 49, 64, 65, 66: 47. Of the 324 green ash planted in Exp. 47, in April 1903, fully 90 per cent. were alive in August 1903, while by August 1906, only 27 per cent. were alive, and the average height was 10 inches, the same as when planted. Of the 325 white and green ash planted in Exp. 65, about 75 per cent. were alive five years after planting, but as the exact number planted is unknown, this figure may not be exact.

All the ash planted in these various experiments were one-year seedlings. The statement made for sugar maple, that older stock should be used, applies equally to ash, though there is no question that this dry, sandy soil is exceedingly unfit for growing ash of whatever age.

BASSWOOD *Tilia Americana.*

Exps. 49, 64, 65, 66. No records were kept of the exact number of basswoods planted, all of which were collected seedlings. The results show, however, that the tree is not suited for planting on this class of land, and what has been said regarding maple and ash applies equally to this species.

TULIP *Liriodendron tulipifera.*

Exps. 18, 27, 28, 49, 64, 65, 66. Of the 135 tulips planted in Exp. 18, in April 1902, about 90 per cent. were alive in July 1902; about 80 per cent. in the spring of 1903; while by August 1906, all were dead, yet these were seedlings 24 inches high when planted. The other experiments showed about the same results, proving the species absolutely unfit for this kind of land.

BLACK OR YELLOW LOCUST *Robinia pseudocacia.*

Exps. 33, 59, 85, 92. Of the 1,748 trees planted in Exp. 59, April 1903, there were 95 per cent. alive in August 1903; 65 per cent. were alive in August 1906. These were nursery seedlings one year old or about 2 feet high when planted, and in August 1907 the heights ranged from 3 to 12 feet, the average being 7.5 feet.

These results indicate the black locust as by far the most rapid growing tree tried in this series of experiments and well adapted to this class of land. The only disadvantage of the species is its liability to be infested by borers, but there is a plantation seventy years old in West Hartford in which the trees have attained the height of 90 feet and are apparently free from this trouble.

From this series of experiments we feel justified in recommending certain species as suitable for planting on these sand plain lands. While other species are, no doubt, fitted for planting on the better soils of the state, or possibly might succeed on these poor soils if larger stock were used, we do not at present feel justified in recommending them for such poor land. The trees that the experiments show most worthy of trial are, of the conifers: Scotch, white, Norway and pitch pines; and of the deciduous trees: Chestnut, red oak, and black or yellow locust. For the conifers, three-year transplants are the most satisfactory and for these three deciduous species, one-year seedlings are recommended, although a seeding of red oak or even of chestnut may give satisfactory results.

The experiments above described throw important light on the kinds of trees adapted for planting on the sand plains of southern New England and upon the methods of planting. Later on they will show also what mixtures are advisable, and what distances of spacing give the best results. They will also offer numerous opportunities for experiments in different methods of thinning, and will furnish the first reliable data on the growth of even-aged forests of different species in this part of the country.

RECENT PLANTATIONS THROUGHOUT CONNECTICUT.

Within the last five years, as the result of better protection from forest fires, better knowledge about forest planting, availability of planting stock, and especially on account of the rise of prices of lumber, many forest plantations have been made in different parts of the state. As most of those made thus far have been either under the direction of this office, or have been known to it, we publish here a record of such recent plantations, and we will be obliged if land owners who have made plantations not here recorded will call our attention to their experiments.

PLANTATIONS IN THE STATE FORESTS.

UNION.

The most extensive planting done by the state on a commercial scale is at Union, where the state owns three hundred acres of land, about one hundred of which is open. In the spring of 1906 about fifteen acres of the old mowings were planted with 20,000 two-year-old white pines 5 x 6 feet. With labor at $1.75 per day the average cost of planting 1,000 trees was $1.66. In other words, a man could plant a little over 1,000 trees a day on the

average. This planting was done early in April, when the ground was still very wet, and as the trees arrived in excellent condition the plantation was a success, although of course the trees did not make any growth the first year. Eighty to eighty-five per cent. of them were alive at the end of the first year.

In the spring of 1907 there were planted on similar land consisting of old mowings and pastures 50,000 two-year-old white pines, 2,000 Scotch pines, 2,000 Norway spruce. The Scotch pines were from D. Hill of Dundee, Ill., purchased at $3.75 per thousand.

The Norway spruce were from the Evergreen Nursery Company of Sturgeon Bay, Wis., purchased at $3 per thousand. The white pines were from the following sources: 25,000 from R. Douglas' Sons, Waukegan, Ill., purchased at $3.85 per thousand; 10,000 from the state forester of New York, at $1.50; 16,000 transplants raised in our nursery on the land, and purchased the year before at $2.50 per thousand. Twenty thousand one-year seedlings were purchased in 1906 of Dr. Schenck, forester of the Vanderbilt estate, Biltmore, N. C., at $2.50. They were set out in nursery drills at $1.27. The transportation and weeding cost fully fifty cents a thousand, and as nearly three thousand died, the 17,000 remaining cost about $5.00 per thousand. They proved themselves well worth the difference, for of the 16,000 set out fully 97 per cent. were alive at the end of the severe summer drouth, as against 85 per cent. of the other trees.

The total number of trees thus far planted in the Union forest is 74,000, covering about fifty acres.

PORTLAND.

The land which the state owns in Portland is largely covered with a sprout growth of chestnuts and hardwoods, not requiring planting. There are, however, one or two old pastures more or less grown up to brush which will be planted.

In the spring of 1906 five small areas were planted with chestnuts. The nuts were planted three in a hole, the holes being made in the sod with a hoe about five feet apart. The cost of such planting, including the price of the nuts and the labor, amounted to between $5 and $6 an acre. The squirrels ate many of these nuts, so that there are trees in about 25 per cent. of the holes planted.

In the spring of 1907 there were planted on similar land 5,000 two-year white pines, purchased from R. Douglas' Sons at $3.85 per thousand, and 3,000 Norway spruce two-year seedlings, purchased from the Evergreen Nursery Company at $3. Most of these trees withstood the summer drouth well.

PLANTING OF WATER SHEDS.

Middletown Water Company.

Mr. Mulford, the previous forester, made a working plan for the Higby Mountain Reservoir tract, under the control of the board of water commissioners of the city of Middletown. This plan called for the planting of 168 acres. Up to the present time the board has expended on this work $1,662.50, and has planted from 1903 to 1906 about 121,000 trees, as follows: Red oak, 20,993; yellow oak, 18,000; white oak, 7,575; swamp white oak, 13,575; catalpa, 3,500; chestnut, 15,425; Italian chestnut, 124; red pine, 1,250; white pine, 34,770; white ash, 5,000; tulip, 1,000; English walnut, 80; total, 121,292.

The total area completely planted is 57.75 acres, and partly planted, 59.25 acres. This plantation, which is under the direction of Mr. Bywater, the superintendent, is all made on good agricultural land, very much better than the Rainbow land. The original plan called for extensive planting of pine and sugar maple in alternate rows, which at that time was considered an advisable mixture. The pines have been planted and are doing well, but the maples have not yet been put in. The result is that the pines are too far apart on these areas to form a good stand and have so much start that unless interplanted by very rapid growing trees they would entirely suppress them. The only species that could be safely planted between these rows now is the Scotch pine, which is rapid growing and tolerant enough to withstand the crowding of the older white pines. The white pines were planted when three years old and 95 per cent. are alive, the heights ranging from 2 to 4 feet. Many showed a growth last year of two feet. Some have been attacked by the weevil, and a few were killed back by last summer's drouth.

Of the 1,250 red pines which were purchased from the west hardly a dozen are now alive. The stock arrived in very poor condition.

The results with chestnut have been the same as those at Rainbow, showing that the planting of seed on the land cannot be successful, while one-year seedlings give very satisfactory results. One plantation made with such stock 10 inches high has 95 per cent. of the trees alive three years after planting, with heights 3 to 5 feet.

Red and black oak two-year-old seedlings were planted together and 86 per cent. are alive. The trees have an average height of eight inches, with a maximum of 18 inches and are now six years old from seed.

White oak seeding gave the same unsatisfactory results as at Rainbow, for from the 7,575 acorns planted, scarcely a single tree was found.

Swamp white oak one-year-old seedlings were planted on a slope near the lake and were severely thrown by frost the first winter. They were reset in the spring and 84 per cent. were alive after three years.

Tulip two-year-old seedlings were planted on a hill slope in mixture with oak; 90 per cent. are alive and the average height after three years' growth is 8 inches. Tulip is better adapted to moist soils.

White ash one-year-old seedlings were planted on a dry hillside in mixture with white pine; 85 per cent. are alive and the average height after three years' growth is 8 inches. White ash should also only be planted on moist soils and for both ash and tulip older stock is necessary.

Catalpa one-year-old seedlings were planted on good upland soil; 88 per cent. are alive, but as they have been killed back each winter by frosts they have made no growth.

Hartford Water Company.

Mr. L. W. Goodrich, superintendent of the Hartford Water Company, has given me the following account of the plantations made on their lands. About 150 acres have been planted as follows:

Spring of 1903, 30 acres with 21,500 white pine two-year seedlings; 3½ bushels red oak acorns; ½ bushel black oak; ⅛ bushel swamp oak; 2½ bushels hickory; 3½ bushels chestnuts. Cost: Plowing double furrows across field, $60; planting pines, $32; planting seed, $48; collecting seed, $12.70; seedlings, $86.43 (purchased from nurseries). Average cost per acre, $7.97.

Fall of 1903, 8 acres with 4 bushels white oak acorns. Cost: Plowing furrows, $11.55; planting, $8.64; collecting acorns, $8.88. Average cost per acre, $3.63.

Spring and fall of 1904, 25 acres with 5 bushels pignut hickory nuts; 3,000 sugar maple three-year-old seedlings; 3 bushels red oak; 20,000 white pine seedlings; 3 bushels shell bark hickory nuts; 2 bushels chestnuts; 4 bushels white oak. Cost about $7.30 acre.

Spring of 1905, 22 acres planted with 10,000 white pines; 3,500 white ash; 2½ bushels chestnuts; ½ bushel swamp oak acorns; ¼ bushel shell bark hickory. Average cost per acre, $7.

Spring of 1906, 47 acres planted with 42,100 white pines; 23,500 white ash; 10,000 sugar maple. Cost: Plowing, $52.39; planting, $162.75; seed, $11.25; nursery, $68.60. Average cost per acre, $6.27.

Spring of 1907, 24 acres planted with 31,200 white ash; 21,000 white pine; 1,600 maple; 300 tulip; 800 wild cherry.

The average cost per acre has been reduced from $7.97 in 1903 to $6.27 in 1906, chiefly by the use of home-raised seedlings and by the substitution of single for double furrows.

The white pine has thus far given the most satisfactory results, the growth last year being about 2 feet. Those planted in 1903 were about 4½ feet high in the fall of 1907. The sugar maple is second best (note that three-year seedlings were used). The chestnuts and oaks are growing fairly well and the white ash has started finely. The soil of these plantations is good.

EDUCATIONAL INSTITUTIONS.

Loomis Institute.

The Loomis Institute of Windsor owns about forty acres of sand plain land on the edge of Bloomfield, which is covered with a poor growth of oak brush which has been badly damaged by fire. As the land has been bringing in no income, the trustees have decided to plant it to forest trees, and to experiment with four or more species of conifers best adapted to such sandy situations in order that the plantation may serve for demonstration purposes, as it is possible that the rudiments of forestry may eventually be taught by the Institute.

In the spring of 1907 the following trees were planted: 10,800 three-year white pine transplants from Europe, purchased at $5.45 through Kelsey; 10,000 two-year white pine seedlings, purchased from the state forester of New York at $1.50; 10,000 two-year Scotch pines, purchased from D. Hill at $3.75.

The land is so thickly covered with brush that for three or four years it will be impossible to make any accurate statement as to the success of these plantations, but the indications are that at least 75 per cent. of the trees withstood the summer's drouth.

Yale Forest School.

Prof. James Toumey, who has had charge of all the plantations made by the Yale Forest School, made the following report Dec. 7, 1907.

The planting that has been done by the Forest School as to acreage is as follows:

12 acres, Norway spruce, two-year-old seedlings and four-year-old transplant stock. This stock was used in underplanting a mixed forest of hardwoods of from .6 to .7 density. The plantings were made four and five years ago next spring. In fair condition, 60 to 80 per cent. living.

16 acres, white pine two-year-old seedling stock. This stock was used in underplanting a mixed hardwood forest from .7 to .3 density. The plantations were made six to three years ago. All of these plantings are in excellent condition, showing at the present time a stand of from 80 to 90 per cent.

10 acres, white pine two-year-old seedling stock used in planting old fields. These trees were planted from seven to five years ago. The plantation has been practically destroyed by fire.

4 acres, European larch two-year-old seedling stock planted on old fields, grown up to juniper and brambles. Recently all destroyed by fire.

4 acres, white pine two-year-old seedling stock and three-year-old transplants. Planted on recently cut-over upland, three to four years ago. This plantation is practically complete, the loss being less than 2 per cent.

All of the above plantings are at Maltby Lakes.

At Ansonia the following plantations were made two years ago on the land of the Water Company.

8 acres, two-year-old white pine seedling stock planted on old fields growing up to white birch and sumach. Stock poor when planted. Loss about 25 per cent.

2 acres planted in seed spots to red oak and black walnut on a fairly rich bottomland in open field. About 30 per cent. of the seed spots now vacant.

Last year about 12 acres were planted to white pine on the Winchester Powder Farm. Stock two-year-old seedlings and three-year-old transplants. This is all in excellent shape at the present time. Also about 3 acres were seeded to black walnut in seed spots. About 40 per cent. of vacant spots show at present.

PRIVATE PLANTATIONS.

The only private plantations of any extent have been made during the past two years, since this station undertook to find seedlings for planters at reasonable rates.

Two men made extensive plantations in the spring of 1907, and intend to continue the work until a large area is forested.

Mr. Albert B. Wells of Southbridge, Mass., planted in Union, Conn., 75,000 two-year-old white pines, purchased at $3.85 per thousand; 1,000 two-year-old Scotch pines, at $3.75; 1,000 two-year-old Norway spruce, at $3. The land planted by Mr. Wells was a rough piece formerly covered with pine and hardwoods, and recently cut over. The piles of tops and other brush made it impossible to plant with any regularity, so that Mr. George Towne of Union, who had charge of the work as well as that for the state, was unable to estimate exactly the number of trees living after the summer drouth. It is probable, however, that some 20 to 30 per cent. have died. Undoubtedly for such brushy land three-year transplants would be preferable if they could be obtained at fair prices.

Mr. Harris Whittemore of Naugatuck planted on his farm in Middlebury, 77,500 white pines and 2,000 Norway spruce. 2,500 of the pines were three-year transplants, purchased at $5.45 per thousand, and the rest were two-year seedlings, purchased at $3.85. They were all imported from Europe through Frederick Kelsey of 150 Broadway, New York.

This was run-out farm land, most of it having been in mowing until it was planted. Over the greater part of the area the soil is a loamy sand, but there are two or three sand knolls. There are a few acres of rich, moist land. The wettest part was planted to spruce, but the pine in the moist situations did remarkably well the first year. On the sand ridge a considerable proportion died, but averaging all the land together, 90 per cent. of the pines were alive at the end of the summer's drouth.

BRIDGEPORT. Mr. James W. Thompson planted 1,000 white pine in 1906.

BROOKLYN. Mr. William Ingalls planted 6,000 white pine in 1907.

CANTON. Mr. Benjamin F. Case planted 3,000 white pine in 1907.

ELLINGTON. Mr. J. P. McKnight planted 2,000 white pine in 1906, and 1,100 more in 1907.

FARMINGTON. The Vine Hill Farm Company of West Hartford began planting its waste lands in the spring of 1906 under a working plan published in our Annual Report of that year. The land thus far planted by the company is on the trap ridge northeast of Farmington village. In 1906 the following trees were planted: Chestnut, 2,500; white pine, 15,000; Scotch pine, 3,000; Norway spruce, 1,000.

In 1907 the following were planted: 14,000 two-year white pine seedlings, at $3.85; 5,900 three-year white pine transplants, at $5.45.

Almost every one of the chestnuts, which were one-year seedlings, have lived. Of the conifers, the Scotch pines have done somewhat the best.

Adjoining the land of the Vine Hill Farm Company on the north, Mr. Bennett planted in 1906 the following: 4,000 white pine; 2,000 Scotch pine; 1,000 balsam fir; 500 Norway spruce.

GRANBY. Mr. Stanley Edwards planted 3,000 white pine in 1907.

GREENWICH. H. F. Schwarz planted 2,000 white pine in 1906. These proved unsatisfactory on account of poor packing.

HAMDEN. At the foot of Mount Carmel, Mr. J. Edward Heaton planted 20,000 white pine in the spring of 1906. Owing to poor packing about 20 per cent. failed, and this number was replaced by D. Hill free, in the spring of 1907. The junior class of the Yale Forest School did the planting in both cases.

In the spring of 1907, Gen. Phelps Montgomery planted 1,500 three-year transplants, white pine.

HAMPTON. Mr. W. G. Holman planted 4,000 white pine in 1907.

HARWINTON. Mr. Newman Hungerford planted in 1906 in Harwinton, 500 catalpa; 300 white oaks; 500 chestnuts; 500 black locusts; 1,500 white pines. In 1907 he planted 1,100 white pines, three-year transplants; 1,000 Norway spruce, two-year seedlings.

MANSFIELD. The Connecticut Agricultural College planted 1,000 white pine in 1906.

MIDDLEBURY. Mr. E. E. Stevens planted 1,500 white pine in 1907.

NEW HAVEN. Mr. John C. North planted 1,000 white pine in 1906.

NORFOLK. Mr. Ellicott D. Curtis had 45 acres planted by the H. L. Frost Company of Boston. This company furnished the seedlings and did the planting at the contract price of $12.50 per acre for pine and $15 for ash. Twenty acres of pasture and rough fields and 20 acres of young second growth hardwood land were planted with two-year white pine seedlings; and five acres of sprout land were underplanted with white ash.

The planting in the open was six feet apart and the same distances were kept in the woods as nearly as possible.

PUTNAM. Mr. Chester Child planted 3,000 white pine in 1906. Mr. John M. Paine planted 1,000 white pine in 1906, and 4,000 white pine three-year transplants in 1907.

SALISBURY. The Hotchkiss School in Lakeville planted 1,000 white pine in 1906.

SOMERS. Mr. Edwin Davis planted 1,000 white pine in 1906.

STONINGTON. In the spring of 1906 Dr. Charles Williams and Miss Mary Dreier planted 6,000 two-year white pines.

TORRINGTON. Mr. L. E. Dayton planted 1,500 white pine in 1907.

UNION. Mr. George Towne planted 1,500 white pine in 1907.

WATERTOWN. Mr. Charles Atwood in 1906 planted 1,500 white pine, and in 1907 another 1,500 of the same.

WESTPORT. Miss Kate A. Wilcox planted 1,000 white pine in 1906.

WETHERSFIELD. Mr. F. A. Griswold planted 3,000 white pine and 1,000 Norway spruce in 1907.

WINCHESTER. Mr. Elliott Bronson planted 5,000 white pine in 1907.

WOODBURY. Dr. William Sage planted 2,000 white pine in 1906.

WOODSTOCK. Mr. O. A. Hiscox planted 4,000 white pine in 1907.

It is impossible to estimate accurately the amount of planting which has been done in the state, but from the above accounts it is evident that private owners have planted during the past two years fully 350,000 trees; that water companies and similar concerns have planted 200,000; and the state has planted 85,000, making a total planted for forestry purposes throughout Connecticut of 635,000 trees.

OLDER FOREST PLANTATIONS IN CONNECTICUT.

In considering all these experimental plantations in Windsor and the commercial plantations recently made in different parts of the state, it may occur to many that if we simply had a few old plantations we could judge better what to expect from these new ones. Fortunately we have in this state several such plantations and there are many others in the neighboring states. As accounts of most of those in other parts of New England have been published elsewhere, we give here a brief account of the most interesting plantations in Connecticut.

GREENFIELD HILL PLANTATIONS.

The youngest of these is a plantation at Greenfield Hill, between Bridgeport and South Norwalk, covering about 10 acres. This was made twenty-two years ago and is partly pure white pine and partly a mixture of white pine and European larch. The trees were planted 4 or 5 feet apart.

An examination of this grove was made in the spring of 1907 and the quarter acre here given was measured. This plot was taken in an average part of the plantation in which both pine and larch were present.

SAMPLE PLOT—¼ ACRE—GREENFIELD HILL PLANTATION—AGE 22 YRS.

Diameter Breast High. Inches.	Number of Trees per ¼ acre. White Pine.	Number of Trees per ¼ acre. European Larch.	Number of Trees per ¼ acre. Hard Woods.	Volume of Pine and Larch. Per Tree. Feet, Board Measure.	Per Tree. Cubic Feet.	Per Tree. Cords.	Total. Feet, Board Measure.	Total. Cubic Feet.	Total. Cords.
2	5	15	6	--	--	--	--	--	--
3	27	45	6	--	--	--	--	--	--
4	42	40	5	5	1.9	.02	410	155.8	1.64
5	43	41	5	10	2.5	.03	840	210.	2.52
6	28	12	--	20	4.1	.04	800	164.	1.60
7	12	8	--	30	5.3	.05	600	106.	1.00
8	6	2	--	40	7.8	.08	320	62.4	.64
9	2	--	--	50	9.8	.10	100	19.6	.20
--	165	163	22	--	--	--	3,070	717.8	7.60

Total number of trees per acre (pine and larch), 1,312.

Total volume per acre, feet B. M. 12,280
" " " " cubic feet 2,871
" " " " cords 30.4
Mean annual growth per acre, feet B. M. 558
" " " " " cubic feet 130
" " " " " cords 1.4

The volume of the pine and larch were obtained from volume tables compiled for white pine by Mr. Ralph Hawley.

It is difficult to estimate the value of such a stand because while there is considerable lumber, most of it is too small to saw and the price for it would be low compared to the price for the same amount of lumber of larger dimensions. In Windsor white pine lumber recently sold at $6 per thousand stumpage, and cord wood at $1.25. At these prices the value of the plantation as wood would be $37.50 and as lumber $73 per acre. Probably the actual sale value at present would be nearer the former price, but the interesting fact to note is that the mean annual growth for the first twenty-two years has been 558 board feet or 1.4 cords. At this rate of growth during the first quarter of a century we may expect far greater results during the next twenty years. At the present price of lumber this means that the plantation is producing a net annual income of $3 per acre.

SHAKER PLANTATION.

Perhaps the most famous forest plantation in Connecticut is that made by the Shaker community of Enfield in 1874-76. This plantation, extending over about one hundred acres, was made by sowing pine seed on land that had been previously plowed and harrowed. Two quarter-acre plots were laid off in different parts of the plantation, which gave practically the same results.

SAMPLE QUARTER ACRE—SHAKER PLANTATION—AGE 31 YRS.

Diameter Breast High. Inches.	Number of Trees per ¼ acre. White Pine.	Volume. Per Tree. Feet, Board Measure.	Per Tree. Cords.	Total. Feet, Board Measure.	Total. Cords.
3	56	--	--	---	---
4	92	8	.02	736.	1.84
5	68	15	.03	1,020.	2.04
6	42	20	.04	840.	1.68
7	19	30	.05	570.	.95
8	10	35	.07	350.	.70
9	1	52	.09	52.	.09
10	3	65	.11	195.	.33
--	291	--	--	3,763.	7.63

Total number of live trees per acre, 1,164.

There were fully 800 dead trees per acre still standing, so the total stand per acre at the age of 31 was about 2,000 trees. Evidently there must have been over 3,000 trees per acre originally, as hundreds must have died during the first three decades.

Total volume per acre of live trees—feet B. M. 15,052
" " " " " " " —cords 30.5
Mean annual growth per acre—feet B. M. 486
" " " " " —cords .... .98

Average height of trees five inches and over in diameter is 40 feet. The soil is a loamy sand.

The other quarter acre was measured in a part of the plantation from which all dead trees had been removed. The number of trees per acre remaining was 1,168 and the volume per acre in feet board measure was 14,524. The measurements of these two plots indicate that while the mean annual growth is somewhat less than in the Greenfield Hill plantation, the difference in board measure, at least, is slight. This difference may be partly due to the fact that the soil of the former plantation is better, but is also due to the fact that the trees of the Shaker plantation have been too much crowded to produce the best results. That there is less proportionate difference between the yields in board measure than in cords is no doubt due to the fact that between the ages of twenty-two and thirty-one there is a greater proportionate production of lumber than during the earlier stage.

The oldest known plantation of white pine in Connecticut, if not in New England, is one covering about four acres in the extreme northwest corner of the town of Stafford. The trees were planted in furrows about six feet apart, the rows being perfectly straight. It is situated on a knoll of poor sandy soil. The old man who plowed the furrows is still living (1906) and estimates that the plantation was made seventy years ago. The whorls would indicate that this is about correct. The heights of the trees range from 65 to 80 feet. As they have never been thinned their tops have long been too much crowded so that they are spindling, their diameters being much too small for their age. The result is that the growth has not been as great as it should have been under proper treatment. Mr. Edwin C. Davis of Somers said that the plantation was made by his father.

SAMPLE QUARTER ACRE—DAVIS PLANTATION—WHITE PINE—AGE 70 YRS.

Diameter Breast High. Inches.	Number of Trees per ¼ acre.		Volume of Living Trees.			
			Per Tree.		Total.	
	Alive.	Dead.	Feet, B. M.	Cords.	Feet, B. M.	Cords.
4	--	3	10	.03	---	--
5	3	5	20	.04	60.	.12
6	7	9	30	.05	210.	.35
7	18	4	50	.07	900.	1.26
8	21	1	75	.10	1,575.	2.10
9	28	--	115	.16	3,220.	4.48
10	22	--	145	.20	3,190.	4.40
11	20	--	170	.26	3,400.	5.20
12	9	--	200	.29	1,800.	2.61
13	2	--	235	.36	470.	.72
14	1	--	265	.41	265.	.41
--	131	22	---	--	15,090.	21.65

Number of trees per acre alive 524
" " " " " dead 88

Total number of trees per acre 612

Total volume per acre of live trees—feet B. M. 60,360
" " " " " " " —cords 86.6
Mean annual growth per acre—feet B. M. 862
" " " " " —cords 1.24

As might be expected the mean annual growth per acre of this old, overcrowded forest has not been as great as that of the twenty-two-year-old plantation. But it will be seen that the annual production of lumber per acre has risen in this older forest to the very high figure of 862 board feet, not including the many trees that have died during the period. That under proper treatment the mean increment would have been 1,000 feet there can be no doubt, which means that at present prices the annual income would have amounted to $6 an acre for seventy years.

In connection with these plantations of white pine twenty-two, thirty-one and seventy years old, it may be of value to describe a natural grove of the same species in Windsor about 50 years old. While the results from a natural grove are never as large as those from a plantation owing to the irregular distribution of the trees, the fact that the age of this eight-acre grove lies between the younger and older plantations above described, makes it interesting. While many dead trees had been removed from time to time by the owners, there were at the time of measurement many dead trees, some standing and some which had been blown over on account of their bad root conditions. The height of the trees in this grove range from 65 to 80 feet.

SAMPLE QUARTER ACRE—HAYDEN PINE GROVE, WINDSOR—AGE 50 YRS.

Diameter Breast High. Inches.	Number of Trees per ¼ acre.		Volume of Living Trees.			
			Per Tree.		Total.	
	Alive.	Dead.	Feet, B. M.	Cords.	Feet, B. M.	Cords.
6	2	3	30	.05	60	.10
7	6	6	50	.07	300	.42
8	5	2	65	.10	325	.50
9	11	--	100	.13	1,100	1.43
10	8	--	110	.16	880	1.28
11	6	2	140	.23	840	1.38
12	7	1	165	.27	1,035	1.89
13	6	--	190	.31	1,140	1.86
14	6	--	215	.35	1,290	2.10
15	4	--	245	.42	980	1.68
16	4	--	270	.50	1,080	2.00
17	2	--	300	.52	600	1.04
18	--	--	---	--	----	---
19	2	--	400	.65	800	1.30
--	69	14	---	--	10,430	16.98

Number of live trees per acre	276
Number of dead trees per acre	56
Total	332

Total volume per acre of live trees—feet B. M.	41,720
" " " " " " " —cords	67.92
Mean annual growth per acre—feet B. M.	834
" " " " " —cords	1.36

The mean annual increment of this grove, considering the many trees that have died, has been equal to that of the first plantation described, while the increment in lumber has been nearly equal to that of the seventy-year-old plantation. It is equally probable that under good management the mean increment of this grove would have been 1,000 feet.

The above was the best of the three plots measured in this grove. Below is a summary of the other two plots.

Plot. No. 2. Number of trees alive per acre	200
Total volume per acre—feet B. M.	36,080
Mean annual growth per acre	720
Plot No. 3. Number of trees alive per acre	268
Total volume per acre—feet B. M.	28,540
Mean annual growth per acre, feet B. M.	571

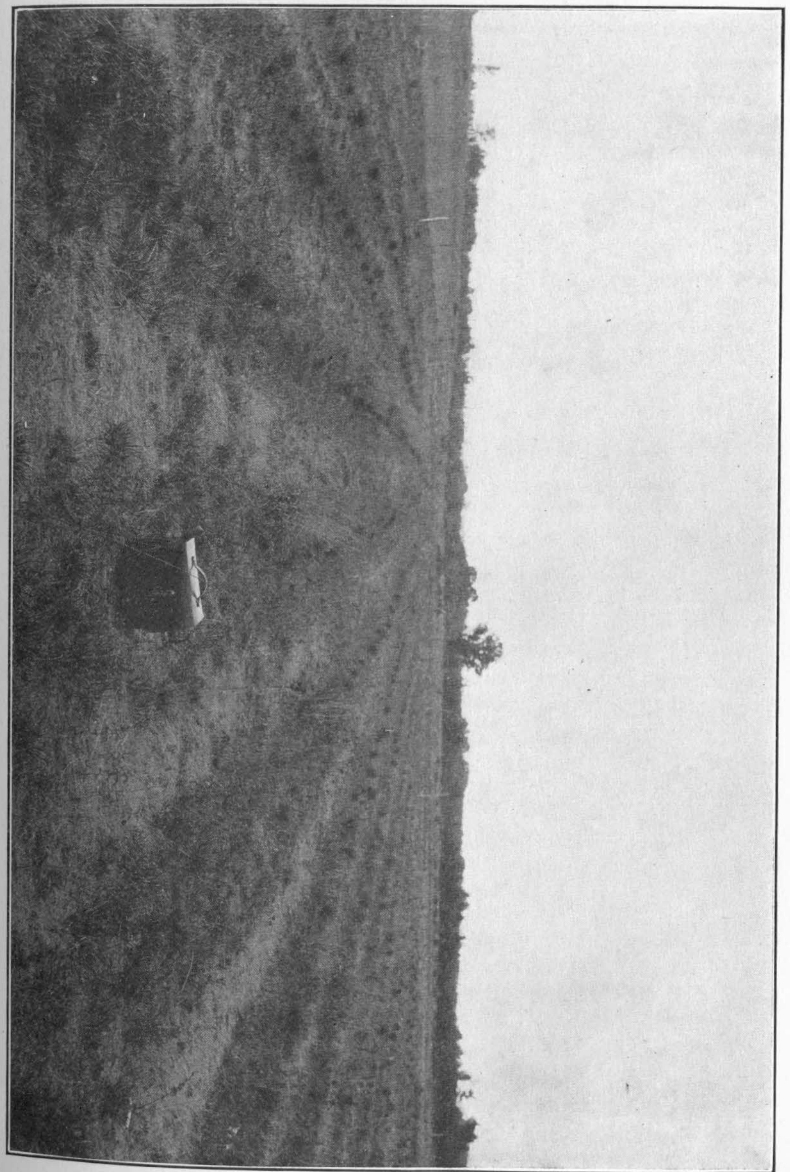
From the above three plots taken in various parts of the grove it appears that the average number of trees per acre for the whole grove is 248; that the average yield is 35,447 feet and the mean annual growth is therefore 709 feet.

Altogether these three plantations of white pine and one natural grove are most encouraging. The following table summarizes the results of the four forests.

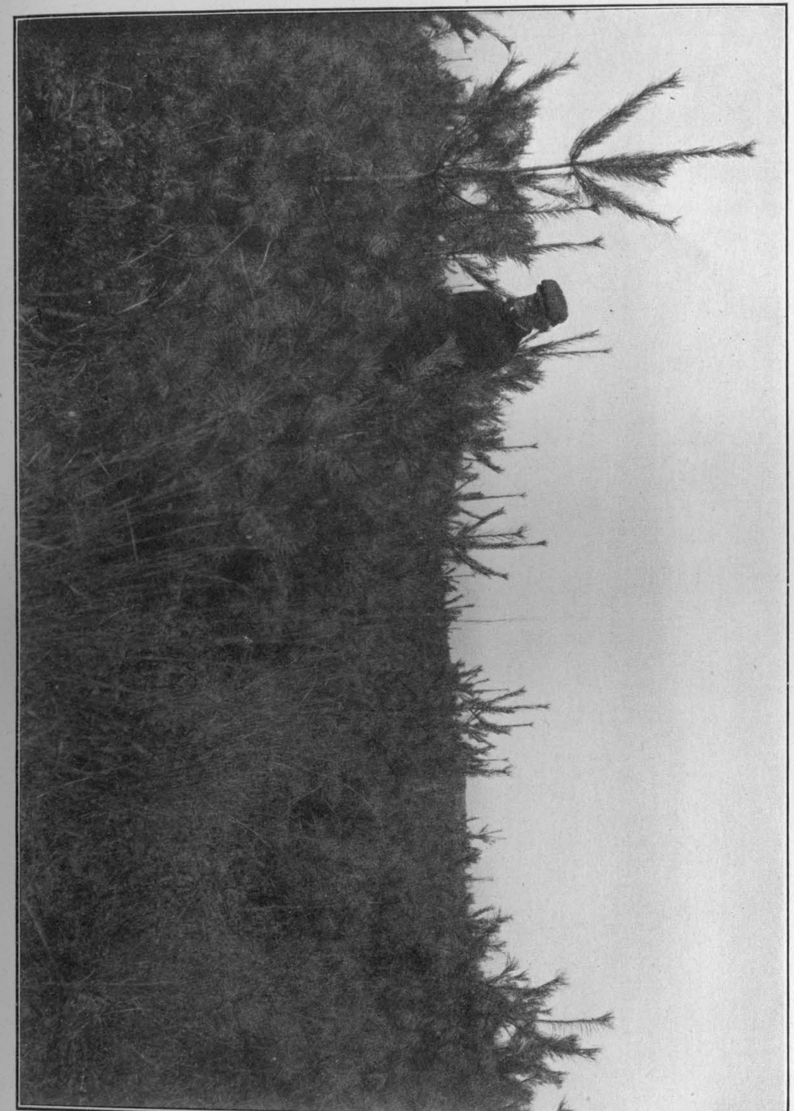
Name.	Age, Years.	Approximate area. Acres.	Number of live trees per acre.	Total yield per acre. Feet, B. M.	Mean annual growth. Feet, B. M.	Value stands per acre.
Greenfield Hill	22	10	1,312	12,280	558.	$ 61.50
Shakers	31	100	1,164	15,052	486.	75.25
Windsor	50	8	276	41,720	834.	291.70
Davis	70	4	524	60,360	862.	422.80

The values are based on the supposition that the stumpage of the first two forests is worth $5 because of the small size, and of the others $7.

PLATE I.



WHITE PINE, ONE YEAR AFTER PLANTING, RAINBOW, CONN. (See Exp. 19, p. 216.)



THE SAME PLANTATION AS SHOWN IN PLATE 1—FIVE YEARS LATER. (See Exp. 19, p. 216.)

PLATE IV.

FOREST NURSERY, RAINBOW, CONN.

A WHITE PINE GROVE 50 YEARS OLD, WINDSOR, CONN.

(See p. 255.)

A PLANTATION OF HARDWOODS 100 YEARS OLD, LITCHFIELD, CONN.

(See p. 260.)

While with the present practice of lumbermen of securing woodlots much under value it is improbable that the above prices could be realized in a sale, they furnish a valuable index of the future value of the plantations now being started, only we must remember that lumber prices, which have risen rapidly in the past five years, cannot fail to rise much higher in the next half century.

We have shown that with trees at $3.75 per thousand, land can be planted with 1,500 trees per acre, which is sufficient, for $8.50. In some cases, however, where the land is covered with brush, and especially if three-year stock is used, the cost may be $10 or $12. Below is a summary of two investments, the one including the purchase of land at $5 and planting at $12, as a maximum; the other a case where the owner already has land which is not being used, and which does not therefore represent an investment. In the latter case we also suppose that two-year-old trees are secured at $3 per thousand, and that the land is easy to plant, reducing the cost of planting to $7.50 per acre. These two sets of figures give maximum and minimum outlays.

	Investment I.	Investment II.
Purchase of land	$5.00	
Cost of planting	12.00	$7.50
Amount to which capital accumulates in 20 years at 5%	45.05	19.87
Taxes 10 years at 2%	1.00	1.00
Total investment at end of 20th year	46.05	20.87
Total investment at the end of 30th year	75.06	34.02
Amount to which the capital accumulates in 50th year	198.90	90.15
Probable taxes and interest on same 20 years	30.00	30.00
(Assessing at $50 for 10 years and at $70 for 10 years.)		
Total investment at the end of 50th year	228.90	120.15
Amount to which this capital accumulates in 70th year	606.60	318.40
Probable taxes and interest on same 20 years	45.50	45.50
(Assessing at $80 for 10 years, at $100 for 10 years.)		
Total investment at end of the 70th year	652.10	363.90

These figures call attention to several facts, first the enormous rapidity with which a moderate investment at compound interest assumes large proportions and the consequent necessity for making our plantations as cheaply as possible. While the original investment of $17 amounted in seventy years to $652 the investment of $7.50 only amounted to $364 in the same length of time. The figures are also very illuminative of the evils of the present method of forest taxation. To be sure forest plantations are exempt from taxation for a period of twenty years after the trees have reached an average height of 6 feet, but this is while the taxes would be light anyway. The taxation for the later periods in the above calculations have not in any case been figured on as high assessed value as their real value, yet the sum of the taxes for the fifty taxable years of the seventy-year period amount to $76.50, which on the sum of $652 amounts to 12 per cent. and on $364 to 21 per cent. Supposing the value of the crop to be exactly equal to the amount of these investments at 5 per cent. It goes without saying that the forest crop is the only one on which a tax of from 12 per cent. to 21 per cent. is levied. Obviously a tax on the annual growth such as that proposed by Mr. Akerman in his able report to the Massachusetts Legislature would do much to remedy this trouble.

When we come to compare the estimated values of the pine plantations above described with those two investments at different periods, further interesting results are manifest which are shown in the following table.

Name of forest.	Profit or Loss over 5 per cent. investment. Investment No. 1.	Investment No. 2.
Shakers, 31 years	± 0	+ 41.00
Greenfield Hill, 22 years	+$15.45	+$40.63
Windsor, 50 years	+ 62.80	+171.55
Davis, 70 years	—229.30	+ 58.90

By these figures it is apparent that a small investment as $7.50 to $10 cannot fail to give a good return over and above the 5 per cent. interest whether grown for twenty, thirty, fifty or seventy years, though the best results are indicated by the Windsor grove fifty years old. The results from an investment amounting to $15, however, are more questionable. While there is a good profit on the plantation twenty years old and on the grove fifty years, the Shaker plantation, if the land had cost $5 and planting $12, would have simply produced 5 per cent. compound interest on the investment, which should be sufficiently satisfactory. The Davis plantation, on the other hand, indicates that

a plantation representing such a large initial outlay cannot be profitable for such a long period as seventy years. However, it is impossible to estimate what supplies might have been removed from this plantation during the period, under proper management, and what would in that case be now standing. The probabilities are that the value of such products put at interest at 5 per cent. from the time of marketing would have brought the present value of the plantation to fully $652 an acre.

Unfortunately the plantations of other trees in Connecticut are scarce and less instructive than those of white pine.

There is, however, a plantation in West Hartford seventy years old containing chestnut, black locust, red maple, hickory, white and red oak, beech, elm, black birch, dogwood and blue beech. It is probable that such trees as the maple, birch, elm, beech, dogwood and blue beech seeded in naturally. The plantation covers about four acres and belongs to the Vine Hill Farm Company of West Hartford. The nuts and seeds were planted in 1837 with an agricultural crop. The soil is a good loam, suitable for farm purposes and therefore too good for forestry. Below is a survey of one quarter acre.

Sample Quarter Acre—Beach Plantation, West Hartford. Age 70 Years.

Diameter breast high. Inches.	Number of Trees.					Volume per tree. Feet, B. M.	Total Volume.		
	Chestnut.	Black Locust.	Red Maple.	Hickory.	White and Red Oak.		Chestnut.	Locust.	All Others.
2	--	--	--	--	--	--	--	--	--
3	--	--	3	1	1	--	--	--	--
4	1	--	5	2	2	--	--	--	--
5	--	--	4	--	--	--	--	--	--
6	--	1	1	--	--	--	--	--	--
7	--	1	1	--	1	12	--	12	24
8	--	--	--	--	2	22	--	--	44
9	2	--	1	--	1	35	70	--	70
10	--	2	--	--	--	47	--	94	--
11	1	1	--	--	--	60	60	60	--
12	1	--	--	--	--	75	75	--	--
13	1	2	--	--	--	91	91	182	--
14	7	2	--	--	--	110	770	220	--
15	2	1	--	1	--	131	262	131	131
16	1	1	--	--	--	155	155	155	--
17	1	--	--	--	--	180	180	--	--
18	2	--	--	--	--	206	412	--	--
Total	19	11	15	4	7		2,075	854	269

Total number of trees per acre, 224. As seven large chestnuts were recently cut from the plot this would bring the total number before cutting up to 252.

Total volume per acre .... 12,792 feet B. M.
Mean annual growth per acre .... 183 feet B. M.

In the other quarter acre measured in the same plantation there were 320 trees per acre. It is probable that at the age of fifty years the mean annual growth was much better than at present.

The oldest known forest plantation in the state is one in Litchfield, about one mile north of the village, belonging to Dr. Buel. The original piece consisting of 23 acres is said to have been planted in 1812. Aside from the traditions of the locality there is little proof that this woodland was planted, especially as many of the trees when cut proved to be considerably over one hundred years old. There is the more reason to doubt the authenticity of these stories because 7 out of the 18 chestnuts measured on this quarter acre were sprouts instead of seedlings. However, it is possible that it was an open pasture with a few scattered trees at the time of planting. A quarter acre survey is given below.

Both of these plantations of mixed hard woods indicate that the results to be expected from such plantations are much less than those from pine plantings. The chief argument in favor of planting chestnut is for railroad companies desiring ties or for other companies requiring these woods for special purposes.

Sample Quarter Acre—Litchfield Plantation—93 Years Old.

Diameter, breast high. Inches.	Number of Trees.					Volume feet, B. M. per tree.	Total Volume.	
	Chestnut.	Hemlock.	Beech.	Red Oak.	Others.		Chestnut.	All others
3	--	--	4	--	2	--	--	--
4	--	--	1	--	2	--	--	--
5	--	--	1	--	5	--	--	--
6	--	--	--	--	3	--	--	--
7	--	--	2	--	1	12	--	36
8	--	--	2	--	--	22	--	22
9	--	--	--	--	--	--	--	--
10	1	--	--	--	--	47	47	--
11	--	--	--	--	--	--	--	--
12	2	1	--	--	--	75	150	75
13	1	--	--	1	--	91	91	91
14	--	1	--	--	--	110	--	110
15	2	1	--	--	--	131	262	131
16	3	--	--	--	--	155	465	--
17	3	--	--	--	--	180	540	--
18	1	--	--	1	--	206	206	206
19	1	--	--	1	--	235	235	235
20	3	--	--	--	--	266	798	--
21	--	--	--	--	--	--	--	--
22	1	--	--	--	--	335	335	--
Total	18	3	10	3	13	----	3,129	906

Total number of trees per acre, 188.

Total volume per acre .... 16,140 feet B. M.
Mean annual growth per acre .... 173 feet B. M.

These two plantations of deciduous trees are not as instructive as those of pine. In order to form a better idea of the possible results of such plantations properly managed a careful study of the most important species, the chestnut, has been made. The results as far as they influenced the treatment of the woodlot, were published in Bulletin 154 of the station. Most of our woodlots are composed chiefly of sprout chestnuts and their growth is quite different from that of seedlings. In a study of some 400 chestnut trees cut by lumbermen in various parts of the state, about 150 trees had grown from seed and it is the growth of the best of these that gives us the best indication of what may be expected from chestnut plantations on a fairly good soil as a fresh loamy sand. The following table gives the volume in board and cubic feet of the best trees measured of various ages.

Volume of Individual Chestnut Trees Grown from Seed.

Age, Years.	Feet, B. M.	Cubic feet.	Age, Years.	Feet, B. M.	Cubic feet.
26	75	25	65	315	85
41	98	32	67	358	82
42	153	42	69	602	163
43	120	26	70	412	134
45	262	85	75	775	194
46	159	48	76	666	170
47	206	60	85	537	142
48	194	58	90	623	143
50	314	75	95	640	163
52	237	62	98	696	167
53	203	52	100	763	194
55	550	142	103	662	170
58	364	123	119	511	100
64	609	182	124	1,026	190

It will readily be seen, however, that these figures in themselves are no indication of the results which might be expected from chestnut plantations. It is also necessary to know how many trees of the different ages could be grown to the acre. These trees above enumerated were all dominant and therefore occupied a large growing space. These spaces in the case of a few trees were measured and were found to vary from 700 to 1,400 square feet. The tree fifty-five years old which produced

550 board feet grew in the open and probably occupied over 1,400 square feet. The tree which produced 609 feet in sixty-four years occupied 1,400 feet, while the tree that produced 662 feet in one hundred and three years only occupied 900 square feet. The results prove that for extraordinary yields very large tops are necessary and that therefore fewer trees can be raised per acre. Upon these data is based the following table giving estimates of the number of trees which might be possible per acre and the total yield per acre.

YIELD TABLE—CHESTNUT PLANTATIONS BASED ON THE MEASUREMENT OF INDIVIDUAL TREES.

Age, Years.	Volume per tree. Feet, B. M.	Number of trees per acre.	Total Volume per acre. Feet, B. M.	Mean Annual Growth per acre. Feet, B. M.
25	50	180	9,800	360
30	70	165	11,550	385
35	100	150	15,000	428
40	150	135	20,250	506
45	175	120	21,000	470
50	220	105	23,100	462
55	260	95	24,700	450
60	310	85	26,350	438
65	360	75	27,000	415
70	430	70	30,100	430
75	500	65	32,500	433

While this table cannot be taken as conclusive proof that such results can be obtained from chestnut plantations, we believe that they are at least conservative for the average forest soils of Connecticut where chestnut would be planted. Such results could not be obtained on the sand plains of Rainbow.

YIELD TABLES OF EVEN AGED FORESTS IN EUROPE.

The following normal yield tables taken from Prof. Graves' "Forest Mensuration" are suggestive, if not convincing, of what we may expect to produce by forest plantations. They are based on the measurement of numerous even aged stands which are common throughout Europe, but hardly to be found at present in this country. A glance at the tables brings out several interesting points:

1. In forests of one species, of the same age, on different classes of soil there are always more trees on the poorer soils; while the

average height and diameter is less than on the good soils. That these two facts should go together seems natural when we realize that the greater the growth the severer must be the struggle for existence and consequently the higher the rate of mortality.

2. There is a much greater number of trees in the youngest of these forests than we recommend planting. Nature's methods are always lavish and a well-protected and reproduced forest presents the appearance of a mat of seedlings. Europeans copied Nature's practice in planting many thousand trees per acre for years, but are now adopting a more open spacing. They generally recommend even now, however, from 1,700 to 3,500 trees per acre. Nursery stock in Europe is cheap enough so that they can afford it.

3. The number of trees per acre diminishes rapidly from decade to decade. The trees are not allowed to die and fall to the ground as in our virgin forests, but are removed in a series of thinnings so that the vitality of the remaining trees is not injured by the struggle as is the case in Nature's method. The original tables give the amount of these thinnings for each ten-year period, which, if added to the final yield, would considerably increase the amounts given in the following tables.

4. The younger forests of Scotch pine and Norway spruce produce about the same amount of wood, much more than the beech. The spruce soon surpasses the pine and in the long run the pine is also surpassed by the beech. We must remember, however, that the best quality of soil in the various beech forests measured is probably much better than the best quality on which Scotch pine is growing, and the same relation exists between the other qualities. It is therefore impossible to say how the yields of beech and pine would compare on the same soil.

Normal Yield Table for Scotch Pine.

Quality I.

Age, Years.	Number of Trees per acre.	Average Height, feet.	Diameter of Average tree, inches.	Yield per acre, cords.
20	1,696	29.	3.4	10.7
30	1,076	44.	4.9	25.0
40	696	55.	6.5	39.9
50	464	65.	8.2	51.4
60	328	73.	10.1	60.9
70	256	80.	11.7	69.2
80	218	86.	12.8	76.2
90	196	91.	13.7	81.9
100	179	96.	14.4	87.7
110	166	100.	15.2	90.6
120	154	103.	15.9	94.3

Quality III.

20	2,600	17.	2.2	3.7
30	1,784	30.	3.2	13.4
40	1,228	39.	4.3	23.2
50	848	46.	5.4	31.6
60	596	52.	6.6	38.6
70	440	57.	7.9	44.3
80	348	62.	9.0	49.0
90	292	67.	9.9	53.0
100	255	72.	10.8	56.0
110	228	76.	11.5	59.0
120	205	79.	12.1	61.0

Quality V.

30	3,200	15.	1.9	2.0
40	2,256	21.	2.6	6.5
50	1,588	26.	3.3	11.8
60	1,152	30.	4.0	15.9
70	828	34.	4.8	19.5
80	640	38.	5.5	22.2
90	520	41.	6.1	24.0
100	428	44.	6.8	25.5

Normal Yield Table for Norway Spruce.

Quality I.

Age, Years.	Number of Trees per acre.	Average Height, feet.	Diameter of Average tree, inches.	Yield per acre, cords.
20	2,940	20.	2.6	7.8
30	1,780	35.	4.2	32.5
40	1,120	51.	5.8	61.9
50	716	65.	7.6	86.4
60	500	76.	9.4	106.5
70	380	85.	11.0	123.0
80	308	93.	12.4	147.8
90	256	99.	13.9	147.4*
100	220	104.	15.2	159.0
110	200	109.	16.1	168.7
120	189	112.	16.7	177.4

* There is an error in the original table from which this is copied.

Quality III.

30	3,300	19.	2.4	7.5
40	1,924	30.	3.7	23.6
50	1,216	42.	4.9	41.0
60	840	52.	6.2	56.5
70	624	61.	7.4	70.0
80	500	69.	8.5	81.7
90	424	74.	9.5	91.7
100	380	78.	10.2	100.0
110	346	82.	10.9	107.5
120	320	85.	11.8	114.2

Quality V.

40	3,920	15.	2.0	3.8
50	2,128	22.	3.0	10.7
60	1,356	29.	4.1	20.9
70	988	37.	5.0	30.8
80	800	43.	5.7	39.4
90	696	47.	6.3	46.2
100	640	51.	6.7	51.7

Normal Yield Table for Beech.

Quality I.

Age, Years.	Number of Trees per acre.	Average Height, feet.	Diameter of Average tree, inches.	Yield per acre, cords.
20	2,524	18.	1.7	----
30	1,526	31.	3.0	7.7
40	934	45.	4.5	21.7
50	598	56.	6.3	37.2
60	423	67.	7.9	51.3
70	327	76.	9.4	64.7
80	269	85.	10.7	77.0
90	228	92.	11.9	88.2
100	196	97.	13.0	98.9
110	174	102.	14.0	108.6
120	157	106.	15.0	117.4

Quality V.

40	1,976	20.	2.3	4.5
50	1,496	28.	3.1	10.4
60	1,192	34.	3.8	17.1
70	984	39.	4.4	22.8
80	824	44.	5.0	27.0
90	696	47.	5.1	29.8
100	600	50.	6.0	31.9
110	524	52.	6.4	33.3
120	464	54.	6.7	34.3

PART V.

SEVENTH REPORT

OF THE

STATE ENTOMOLOGIST OF CONNECTICUT

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

I hereby transmit my seventh report as state entomologist, according to Section 4387 of the General Statutes. As all state reports are to be published biennially hereafter instead of annually, technically this is Part V. of the biennial report. The financial and other administrative details are herein omitted, but will be published at the end of the biennial period.

Respectfully submitted,

W. E. BRITTON,
State Entomologist.

During the calendar year of 1907 the members of the office force have made thirty-one nursery inspections, thirty-one inspections of orchards, gardens and greenhouses, have written 1,156 letters regarding matters pertaining to the work of the department, sent out sixty-eight packages by mail and express, and have given eight addresses and lectures at agricultural and scientific meetings.

The state entomologist has been ably assisted throughout the year by Mr. B. H. Walden as general assistant, who has been in charge of the office in the absence of the entomologist; by Mr. George H. Hollister as local superintendent in charge of gypsy moth work at Stonington; and by Miss Elizabeth B. Whittlesey, who has worked as stenographer for half of each day.

ENTOMOLOGICAL FEATURES OF 1907.

Entomologically, the most interesting feature of the season was the outbreak of the peach sawfly in an orchard at Yalesville. This insect proved to be a new species, which has been described as *Pamphilius persicum* by Dr. A. D. MacGillivray, and was so abundant as to threaten the defoliation of a large number of trees. Consequently the owners sprayed between four and five thousand trees with lead arsenate, with satisfactory results. Mr. Walden has made a careful study of this insect, an account of which appears elsewhere in this report.

Good progress has been made in controlling the gypsy moth, which was discovered in Stonington last year. (See Report for 1906, p. 235.) Over 13,000 trees were banded in 1907 as against 1,300 the previous season, and though twice as many men were employed and much scouting done, only 2,936 caterpillars were found in 1907 where 10,000 were taken in 1906. The work was also strengthened and supported by an act of the legislature giving authority and making an appropriation. This entire matter is treated in detail on another page of this report.

The fall canker worm, *Anisopteryx pometaria* Harris, was more abundant at the station than since 1900, and the large number of males clustering on the trunks of trees on warm days in November and December indicate that this species will be even more abundant and destructive in 1908.

The spiny elm caterpillar, *Euvanessa antiopa* Linn., and the apple leaf miner, *Tischeria malifoliella* Clem., which were so common in 1906, did little damage in 1907.

The apple aphis, *Aphis pomi* DeGeer, was quite injurious, especially to nursery and newly set orchard trees, and in several cases spraying was necessary to prevent a marked checking of the growth.

The hickory tussock moth, *Halisidota caryae* Harris, was more abundant than for several years, and the caterpillars were found feeding upon apple, hickory and a number of other trees. A separate illustrated article treating of this insect is printed on a later page of this report.

In spite of an extreme drought extending through July and August, mosquitoes were exceedingly abundant and annoying in certain localities, and many complaints were received regarding them. In compliance with a request, the region about Niantic and Crescent Beach was examined for breeding places, and the report is published on a subsequent page of this pamphlet.

The grape vine flea beetle, *Haltica chalybea* Ill., was received from several localities, where it was reported as eating holes in the buds of the grape vine before the leaves unfold.

The winter of 1906-1907 was more severe than the preceding winter, consequently a smaller proportion of San José scales survived. While the increase and spread of this insect was less marked than in 1906, nevertheless it multiplied rapidly late in the season of 1907.

NURSERY INSPECTION.

This work was commenced the first week in September and was nearly completed November 1st, the last inspection being made November 8th. The inspections were made by Messrs. Britton, Walden and Hollister, Mr. Hollister being taken from the gypsy moth work for two months for this purpose. Including one spring inspection, thirty-seven nurseries have been inspected and thirty-six certificates granted during the calendar year. Five firms have gone out of business and four new nurseries have been started. On the whole, the nurseries were in better condition than last season, and much less stock had to be destroyed on account of scale. Many nurseries, however, are curtailing their supply of fruit trees and are growing more and more ornamental stock of such kinds as are not affected by scale. There is also a decided change for the better in the care given the nursery stock by the owners, though a few nurserymen are still careless. A few years ago it was not considered practicable to spray any nursery stock; usually the owners preferred to destroy it. Several nurserymen, following our directions, during 1906 to 1907 have sprayed their growing stock as a measure of safety, using either lime and sulphur or one of the miscible oils. The results have been very satisfactory, it being certain that a much greater degree of infestation would have occurred on untreated stock. The miscible oils are especially convenient for this purpose and do not discolor the trees.

A bill was introduced into the legislature providing for slight changes in the insect pest law, but the matter was opposed at a hearing before the agricultural committee, which reported adversely upon it. The law therefore remains as before.

The nursery firms receiving certificates in 1907 are as follows:

List of Nursery Firms in Connecticut Receiving Certificates in 1907.

Name of Firm.	Location.	Inspection Finished.	Certificate Number.
Atwater, C. W.	Collinsville	Oct. 2,	254
Barnes Bros. Nursery Co.	Yalesville	Oct. 14,	263
Beattie, William H.	New Haven	Oct. 4,	257
Bowditch, J. H.	Pomfret Center	Oct. 18,	267
Brainard, Chester F.	Thompsonville	Sept. 14,	249
Burr & Co., C. R.	Manchester	Oct. 9,	260
Comstock & Lyon	Norwalk	Nov. 6,	278
Conine Nursery Co., The F. E.	Stratford	Sept. 26,	251
Conn. Agricultural College	Storrs	Oct. 29,	274
Conway, W. B.	New Haven	Oct. 5,	258
Dehn & Bertolf	Greenwich	Oct. 17,	265
East Rock Park Nursery	New Haven	Oct. 4,	256
Elizabeth Park Nursery	Hartford	Nov. 13,	280
Elm City Nursery Co.	New Haven	Sept. 9,	247
Gardner's Nurseries	Cromwell	Nov. 19,	279
Gurney & Co., H. H.	New Canaan	Oct. 11,	261
Hale, J. H.	So. Glastonbury	Oct. 23,	270
Holcomb, Irving	Granby	Oct. 24,	271
Houston & Sons, J. R.	Mansfield Depot	Oct. 29,	275
Hoyt's Sons Co., Stephen	New Canaan	Oct. 11,	262
Hubbard & Co., Paul M.	Bristol	Oct. 17,	266
Hunt & Co., W. W.	Hartford	Nov. 1,	276
Kelsey & Sons, David S.	West Hartford	Sept. 28,	253
Keney Park Nursery	Hartford	Nov. 13,	281
Malone, Geo. W.	Highwood	Sept. 26,	250
Norton, A. F.	New Britain	Oct. 25,	273
Pierson, A. N.	Cromwell	Oct. 7,	259
Platt Co., The Frank S.	New Haven	Sept. 28,	252
Purinton, C. O.	Hartford	Nov. 5,	277
Ryther, O. E.	Norwich	Oct. 25,	272
Scott, J. W.	Hartford	Oct. 15,	264
Sierman, C. H.	Hartford	Oct. 4,	255
Vidbourne & Co., J.	Hartford	Sept. 10,	248
Woodruff, C. V.	Orange	Oct. 23,	268
Woodruff & Sons, S. D.	Orange	Oct. 23,	269

TESTS OF VARIOUS GASES FOR FUMIGATING NURSERY TREES TO DESTROY SAN JOSÉ SCALE.*

The object of the tests herein described was to ascertain if there is any gas that can be used more conveniently than hydrocyanic acid gas, especially in fumigating small lots of trees, cions and budsticks. For this purpose the materials must be reasonably inexpensive, the gases easy to generate, the apparatus simple, and the operation comparatively free from danger to the operator as well as harmless to the trees.

The writer was assisted in the chemical part of this work by Mr. F. H. Heath, a graduate student in chemistry in Yale University; and by Mr. B. H. Walden, who did most of the fumigating work.

Some orchardists and nurserymen are considerably prejudiced against fumigating trees with hydrocyanic acid gas. This prejudice is not well-founded though it must be admitted that many trees have been injured by leaving them too long in the fumigating house, and by attempting to fumigate them when wet. When properly done according to the methods usually recommended, no injury results. This has been proven over and over again, not only in our own experiments, but also in the tests made by other entomologists.

In a large fruit nursery where most of the stock is dug in the fall and not sent out until the following spring, it is an easy matter to fumigate the stock before heeling it in on the grounds. But it often happens that a customer calls for two or three trees which have not been dug or fumigated. The nurseryman dislikes to turn away a customer, and if possible will furnish the stock desired. Of course each well-equipped nursery should have small fumigating boxes in which a few trees or shrubs can be treated, in addition to the large fumigating house. But most of them have only the large house, and it is very expensive to charge it with gas for only a few trees. Some of the small

* A brief abstract of this paper was given at the meeting of Economic Entomologists at Chicago, December 27-28, 1907, and will be published in the Journal of Economic Entomology.

nurseries are not provided with any sort of fumigating house. It is rather difficult for the average nurseryman to weight out the small quantity of cyanide necessary to use in a small box because he is not equipped with sensitive scales or balances for the purpose. If some volatile liquid could be used that he could measure in a glass cylinder, it would obviously be a much more simple and convenient matter.

For the purpose we therefore selected carbon disulphide and carbon tetrachloride for volatile liquids, and sulphuretted hydrogen and chlorine for gases generated by chemical action. In order to make comparisons, a few tests were made with hydrocyanic acid gas, and untreated trees were kept as checks.

The trees were fumigated in a long narrow box containing ten cubic feet of space. In order to ensure a more uniform distribution of the gas, two generating dishes were used, one being placed near each end. The liquids were volatilized in shallow pans placed upon crossboards near the top of the box and above the trees. For the other materials deeper generators were necessary, and ordinary pudding dishes served the purpose nicely. A piece of glass was set in each end of the cover so that the action of the materials in the generating jars could be watched from outside.

As some of these materials were being used in this work for the first time, no data were available as a basis from which to compute quantities. In some cases Mr. Heath figured out the quantities of chemicals necessary to generate a volume of gas sufficient to fill the box if all the air was displaced. We could then divide these amounts by two or by four, as seemed best.

With carbon disulphide we had, of course, Smith's* and Garman's† experiments in destroying the melon aphis and the experiments of various entomologists in fumigating stored grains to guide us. The writer once purchased some plants of red-twig dogwood for the garden, and when delivered at the house they were found to be slightly infested with San José scale. The plants were placed in one of the set laundry tubs in the cellar, an unmeasured quantity of carbon disulphide poured in, and the whole tightly covered for about twenty-four hours.

* New Jersey Agricultural Experiment Station Bull. 109, p. 32, 1895, and 121, p. 11, 1897.

† Kentucky Agricultural Experiment Station Bull. 53, p. 144, 1894.

The plants were then set in the garden, grew well, and showed no sign of scale during the season, or of injury from the treatment. However, with some of the gases it was necessary to guess at the quantities, but we sought to kill the scale, and expected that many of the trees might be injured. I am now convinced that further tests with some of the gases, especially carbon tetrachloride, in smaller quantities are desirable.

Baldwin apple and peach of several standard varieties were the trees used. All were more or less infested with San José scale, though none so badly as to seriously affect their vitality. Both roots and tops were fumigated, the trees properly labeled and planted in nursery rows on the station grounds, where they could be watched during the season. In all 359 trees were treated. The following table shows the number treated by each kind of gas:

	Apple	Peach
Carbon disulphide	59	61
Carbon tetrachloride	47	60
Sulphuretted hydrogen	10	15
Chlorine	25	22
Hydrocyanic acid gas	20	40
Total	161	198

The details of each test, with results, are given in the following descriptions and tables.

Volatile Liquids.

Carbon Disulphide.

Carbon disulphide (CS_2) is a heavy liquid having a specific gravity of 1.29 and a boiling point of 115° F. The vapor is inflammable, and ignites in air at about 300° F. It is 2.63 times as heavy as atmospheric air, and one volume of the liquid evaporates to make about 375 volumes of vapor. Pure carbon disulphide is colorless and has no unpleasant odor, but the commercial article has a yellowish color and an extremely disagreeable odor, both of which are due to impurities which enhance its poisonous qualities.* The price varies from fifteen to twenty cents per pound, but it is cheaper in large quantities.

* Farmers' Bulletin 145, U. S. Dept. of Agr., Washington, D. C., 1902.

Preliminary tests showed us that this liquid does not volatilize very readily at ordinary temperatures. Where large quantities are used this is quite a serious objection, as it not only requires a long fumigation period, but there is less certainty regarding the period in which the effect of the full amount of material is acting upon the scale and upon the trees. If trees with naked roots are exposed for too long injury will result from drying. It was suggested that this difficulty might be obviated by volatilizing the liquid in heated pans. Therefore heavy cast iron stew pans or "spiders" were used as generating dishes, these holding the heat much longer than thin ones stamped out of sheet steel. After heating to nearly 200° Fahr. one was placed near each end of the box above the trees. Small holes through the cover of the box enabled us to pour the liquid through a funnel directly into the heated dish. The holes were stopped with corks, and the carbon disulphide, which could be observed through the glass in the cover, volatilized in a few seconds or minutes, according to the quantity. Without the heated dishes, several hours were necessary in some cases. The quantities of materials used, length of fumigating period, and the effect upon scales and trees are given in Table I.

Results with Carbon Disulphide.

The smallest quantity used (10 fluid ounces per 100 cubic feet) did not kill all of the scales in a fumigation period of one hour. Where the heated dish was used to volatilize the liquid, 4.3 per cent. of the scales survived the treatment. Where the dish was not heated 19.2 per cent. came through alive, but one-third of the carbon disulphide was left in the dish at the end of the hour, so that much less of the vapor really acted upon the scales. All scales were killed in each of the other tests. It is to be regretted that this small quantity of disulphide was not given a two-hour period in one or more tests. One tree in Experiment No. 3 failed to grow, but this probably has little connection with the fumigation, as no other trees were injured until they were given three times the amount of liquid and four times as long a fumigation period. Moreover, untreated trees often die when transplanted. When the liquid equalled or exceeded thirty fluid ounces for one hour, some of the trees were

TABLE I.—CARBON DISULPHIDE.

No. Expt.	Fluid ounces of liquid used for 100 cu. feet.	Fumigating Period.	Number of Generating dishes.	Number of trees.		Effect on Scales.			Effect on trees.		Remarks.
				Apple.	Peach.	Alive.	Dead.	Per cent. Alive.	Alive.	Dead.	
3	10 fluid oz.	1 hour	1 heated dish	5	5	4	87	4.3	9	1	Peaches looking good. 4 apples looking good, 1 started but died back.
7	10 "	1 "	1 unheat'd dish*	5	5	23	96	19.2	10		All trees making fair growth.
5	20 "	1 "	1 heated dish	5	5	0	all	0	10		" " "
8	30 "	1 "	1 "	5	5	0	"	0	10		Peaches made good growth. 3 apples looking good, 2 died back considerably at tops.
9	30 "	2 "	1 "	5	5	0	"	0	10		4 peaches died back considerably at tops. 1 apple " " " 4 looking good.
12	30 "	4 "	1 "	5	5	0	"	0	8	2	4 peaches with poor growth, 1 dead. 2 apples " " " 1 "
13	60 "	3 "	2 "	5	5	0	"	0	3	7	1 peach making good growth, 4 dead. 2 apples with poor growth, 3 dead.
14	40 "	2 "	2 "	4	5	0	"	0	8	1	1 peach made good growth, 3 started low, 1 dead. 4 apples made fair growth.
15	60 "	2 "	2 "	5	5	0	"	0	5	5	4 peaches dead, 1 with poor sprout. 1 apple dead, 3 started low, 1 with weak sprout.
16	80 "	2 "	2 "	5	4	0	"	0	2	7	2 peaches made fair growth.
29	40 "	4 "	2 "	5	7	0	"	0		12	All trees dead.
31	40 "	3 "	2 "	5	5	0	"	0		10	" " "

* About 1/3 of liquid left in dish.

injured, and in some cases forty ounces for two hours killed all of the trees, though in other instances some trees survived even a larger quantity. It is quite possible that a longer period with the smallest quantity would have given satisfactory results.

Carbon Tetrachloride.

Carbon tetrachloride (CCl_4) is a clear, colorless liquid having a specific gravity of 1.63 and a boiling point of 169° F. It has a pleasant odor somewhat resembling that of chloroform, and its vapor is non-inflammable and less poisonous than that of carbon disulphide. Carbon tetrachloride is used chiefly as a solvent and costs about forty cents per pound, though in quantities it can be purchased at a much lower price. Heated pans were used to volatilize this gas, and the quantities used, fumigation period, and results are shown in Table II.

Results with Carbon Tetrachloride.

As carbon tetrachloride killed all of the scales in each of the tests made, it is probable that even smaller quantities would have answered quite as well. At the rate of forty fluid ounces per 100 cubic feet of space for two hours, some of the trees failed to grow, and all larger quantities produced similar results. Thirty fluid ounces appears to be about the maximum limit of safety, and further trials should be made with smaller quantities of liquid and shorter periods of fumigation. As regards convenience, this material is very promising, as it is not dangerously poisonous to breathe in small quantities nor liable to explode, though more expensive than carbon disulphide.

GASES GENERATED BY CHEMICAL ACTION.

Sulphuretted Hydrogen.

Sulphuretted hydrogen or hydrogen sulphide (H_2S) is an invisible gas generated in our experiments from iron sulphide and sulphuric acid. It is 1.19 times heavier than air. It has a disagreeable and distinctive odor, and is very poisonous, although on account of the odor its presence can be detected at once. Sulphuretted hydrogen is given off from spoiled eggs, and to some extent from the lime and sulphur mixture.

TABLE II.—CARBON TETRACHLORIDE.

Expt. No.	Fluid ounces of liquid used for 100 cu. feet.	Fumigating Period.	Number of Generating dishes.	Number of trees.		Effect on Scales.			Effect on trees.		Remarks.
				Apple.	Peach.	Alive.	Dead.	Per cent. Alive.	Alive.	Dead.	
35	10 fluid oz.	2 hours	2 heated dishes	5	5	0	all	0	10		All peaches making good growth. All apples " " "
38	10 "	6 "	2 "	5	5	0	"	0	10		3 peaches making good growth, 2 started low. All apples making fair growth.
39	20 "	4 "	2 "	5	5	0	"	0	10		3 peaches making good growth, 1 fair growth, 1 started below bud. All apples making fair growth.
37	30 " *	2 "	2 "	5	5	0	"	0	10		4 peaches making good growth, 1 started below bud. All apples making good growth.
18	40 "	2 "	2 "	0	10	0	"	0	8	2	4 peaches made good growth, 1 poor, 3 started below bud, 2 dead.
10	40 " †	3 "	1 "	5	5	0	"	0	9	1	3 peaches made good growth, 1 fair, 1 dead. All apples made fair growth.
11	40 "	3 "	2 "	5	5	0	"	0	3	7	1 peach started below bud, 4 dead. 1 apple made fair growth, 1 poor, 3 dead.
20	60 "	2 "	2 "	5	5	0	"	0	5	5	1 peach with thrifty sprout, 3 started below bud, 1 dead. 1 apple.
17	60 "	3 "	2 "	2	5	0	"	0	1	6	1 peach started below bud. All the other trees dead.
28	80 " ‡	2 "	2 "	5	5	0	"	0	1	9	1 peach with a good sprout, 4 peaches dead. 5 apples dead.
19	80 " §	3 "	2 "	5	5	0	"	0	4	6	All peaches dead. 4 apples with poor growth, 1 dead.

* Dishes heated only to 96°F. About 5 oz. left in one dish.
† " " " 150°. " 25 " " "
‡ About 15 oz. left in dishes. § About 23 oz. left in dishes.

The sulphide of iron used is in the form of hard lumps made by crushing the fused mass or slag. It is quite porous, which facilitates the generation of the gas. It should be crushed fine before use. Iron sulphide costs from eight to ten cents per pound.

Commercial sulphuric acid contains about ten per cent. of water, and costs about five cents per pound in nine pound bottles. Complete data regarding the tests with this gas appear in Table III.

Results with Sulphuretted Hydrogen.

All scales were killed by this gas and some of the trees receiving the largest and smallest quantities died, though for some inexplicable reason an intermediate amount produced no injury. The method of generating this gas is too slow to render it a convenient fumigating agent, even if it did not injure the trees. Possibly some easier and more satisfactory arrangement could be devised.

Chlorine.

Chlorine (Cl) is a heavy greenish gas with a pungent odor, and is not only poisonous but extremely irritating to the mucous membrane. It is about 2.5 times heavier than air, and is prepared by treating ordinary chloride of lime or bleaching powder with commercial sulphuric acid. Bleaching powder costs about five cents per pound.

Table IV. presents all of the statistics connected with the chlorine tests.

Results with Chlorine Gas.

As perhaps might be expected with chlorine, all of the scales were killed and most of the trees died also. This gas is altogether too inconvenient, too disagreeable and too destructive to trees to be of any value in fumigating work. A peculiar effect was noticed on those trees which survived the treatment. Nearly all buds were killed, and the bark was injured and discolored for half an inch or so each way from the bud, as if the gas entered through the bud and damaged the surrounding wood. The discoloration was apparent in some cases when the trees were removed from the fumigating box.

TABLE III.—SULPHURETTED HYDROGEN.

Expt. No.	Quantity of Materials for 100 cubic feet.	Fumigating Period.	Number of Generating dishes.	Number of trees.		Effect on Scales.			Effect on trees.		Remarks.
				Apple.	Peach.	Alive.	Dead.	Per cent. Alive.	Alive.	Dead.	
1	25.1 lbs. 260 fl. oz. Sul. Acid 170 " Water	1 hour	1 dish	0	5	0	all	0	2	3	2 made fair growth.
2	12.5 lbs. 170 fl. oz. Sul. Acid 70 " Water	1 "	2 "	5	5	0	"	0	10		All making fair growth.
4	5 lbs. 80 fl. oz. Sul. Acid 50 " Water	1 "	2 "	5	5	0	"	0	8	2	Peaches looking fair. 2 apples looking fair, 1 with poor growth, 2 dead.

TABLE IV.—CHLORINE GAS.

Expt. No.	Quantity of Materials for 100 cubic feet.	Fumigating Period.	Number of Generating dishes.	Number of trees.		Effect on Scales.			Effect on trees.		Remarks.
				Apple.	Peach.	Alive.	Dead.	Per cent. Alive.	Alive.	Dead.	
21	17.2 lbs. 125 fl. oz. Sul. Acid 500 " Water	1 hour	2 dishes	5	5	0	all	0	7	3	2 peaches with good sprouts, 3 dead.
22	8.6 lbs. 62.50 fl. oz. Sul. Acid 250 " Water	1 "	2 "	5	2 3 Jap. Plums	0	"	0	8	2	2 peaches making good growth. 2 plums making good growth. 3 apples looking poor, 2 dead.
24	17.2 lbs. 125 fl. oz. Sul. Acid 500 " Water	2 "	2 "	5	5	0	"	0		10	All died.
23	34.4 lbs. 250 fl. oz. Sul. Acid 1000 " Water	2 "	2 "	5	5	0	"	0		10	All died.
26	8.6 lbs. 170 fl. oz. Sul. Acid 670 " Water	2 "	2 "	5	5	0	"	0		10	All died.

Hydrocyanic Acid Gas.

Hydrocyanic acid is a colorless gas (HCN) and one of the most poisonous gases known. It has the odor and taste of prussic acid or bitter almonds. It is lighter than air, and is generated by adding water and sulphuric acid to potassium cyanide in about the following proportions:

Potassium cyanide	1 ounce
Sulphuric acid	2 fluid ounces
Water	4 " "

The quantities named have been determined by experiment to be suitable for one hundred cubic feet of space in fumigating dormant nursery trees. As potassium cyanide is often adulterated with sodium cyanide or with common salt (sodium chloride), only the best grade (98-99 per cent.) and the best commercial sulphuric acid should be used. The value of the tests with this gas is for purposes of comparison, and yet it also shows that nursery stock is not injured by it when properly fumigated. The results are given in Table V.

Results with Hydrocyanic Acid Gas.

All scales were destroyed and no trees were injured except in two lots one from each died, but there is no indication that they were killed by the gas. One point to be noted is that in Experiment No. 30 the trees were given the same quantity of cyanide commonly used for fumigating nursery stock (one ounce per 100 cubic feet) and twice the period. The trees were sprinkled thoroughly by means of a watering pot,—but none were injured by this fumigation. It should also be noted that twice the usual quantity for four times the usual period, and that three times the usual quantity for one-half hour (the usual period) caused no injury to the trees.

General Remarks.

These tests are preliminary and conclusions based upon them are scarcely warranted. Yet they indicate the desirability of making further tests with smaller quantities of carbon tetrachloride and with longer fumigating periods with the small amounts of carbon disulphide. Possibly it will appear that one or both of these liquids are suited for fumigating small lots

TABLE V.—HYDROCYANIC ACID GAS.

Expt. No.	Quantity of Materials for 100 cubic feet.	Fumigating Period.	Number of Generating dishes.	Number of trees.		Effect on Scales.			Effect on trees.		Remarks.
				Apple.	Peach.	Alive.	Dead.	Per cent. Alive.	Alive.	Dead.	
32	1 oz. Cyanide	½ hour	2 dishes	5	5	0	all	0	9	1	4 peaches made good growth, 1 started below bud. 4 apples made good growth, 1 died after starting.
30	1 oz. " *	1 "	2 "	5	5	0	"	0	10		All trees made fair growth.
25	1 oz. "	2 "	2 "	0	10	0	"	0	9	1	8 made good growth, 1 started below bud, 1 dead.
34	2 oz. "	2 "	2 "	5	5	0	"	0	10		All trees made good growth.
36	2 oz. "	½ "	2 "	5	5	0	"	0	10		" "
27	3 oz. "	½ "	2 "	0	10	0	"	0	10		8 made good growth, 2 made but little growth.

* Trees wet when fumigated.

of nursery stock, but at present we cannot do better than to use hydrocyanic acid gas in the same way as has been recommended. Care should be taken to do it properly, and the growth should be well ripened if treated in the fall.

It should also be noted that in many instances the apple trees were fully as susceptible to injury from the gases as peach trees. This is contrary to the belief of most nurserymen.

SPRAYING TESTS WITH COMMERCIAL "SOLUBLE OILS" TO KILL THE SAN JOSÉ SCALE.

By W. E. Britton and B. H. Walden.

Spraying tests with "soluble" or miscible oils were made on a few trees in 1907. On account of gypsy moth work, which required a large part of the funds at our disposal as well as nearly all of our time, it was impossible to devote much attention to spraying experiments. However, over two hundred young apple trees were treated with the three best-known commercial "soluble" oils on the market,—"Scalecide," "Target Brand Scale Destroyer," and "Kill-o-Scale." These substances are similar in composition and method of application except that Kill-o-Scale contains an addition of sulphur, while the others do not.

All the trees sprayed were apple trees except two Japan plums, and were portions of the orchards of A. E. Plant of Branford and E. M. Ives of Meriden. As the spring of 1907 was very late, the buds did not open until about the first of May. At Branford the spray was applied April 30th, and at Meriden, May 1st.

The tests show that all three products were about equally effective when used in the proportions of one part to fifteen parts of water. Very few scales survived the treatment in any case. The following tables give the statistics regarding these trials:

In addition to the tests recorded in the tables, all of the fruit trees on the station grounds were sprayed with "Scalecide," one part to fifteen parts of water, in the fall of 1906. When examined on March 29th very few living scales could be found. Mr. Ives also sprayed nearly all of his orchard of several

Table VI.—Experiments at Branford, April 30, 1907.

Kind of trees.	Number of trees treated.	Condition of trees before treatment.	Materials applied.	Out of 100 Scales on Twigs— Winter killed.	Killed by treatment.	Alive after treatment.	Percentage efficiency of treatment.
Apple	33	Moderately infested.	1 gal. Target Brand Scale Destroyer, 15 galls. water.	51.9	43.8	4.3	95.7
Apple	18	Moderately infested.	1 gal. Kill-o-scale, 15 galls. water.	60.	39.99	.01	99.99
Apple	57	Moderately infested.	1 gal. Scalecide, 15 galls. water.	56.	43.8	.2	99.8
	108						

TABLE VII.—EXPERIMENTS AT MERIDEN, MAY 1, 1907.

Kind of trees.	Number of trees treated.	Condition of trees before treatment.	Materials applied.	Out of 100 Scales on Twigs— Killed by winter and by fall spraying.	Killed by treatment.	Alive after treatment.	Percentage efficiency of treatment.
Apple	30	Badly infested. Sprayed in fall.	1 gal. Target Brand Scale Destroyer. 15 galls. water.	91.3	8.7	0.	100.
Apple	22	Badly infested. Sprayed in fall.	1 gal. Kill-o-scale. 15 galls. water.	97.7	2.29	.01	99.99
Japan Plum	2	Badly infested. Sprayed in fall.	1 gal. Kill-o-scale. 15 galls. water.	93.7	4.8	1.5	98.5
Apple	60	Badly infested. Sprayed in fall.	1 gal. Scalecide. 15 galls. water.	88.4	11.6	0.	100.
	114						

hundred trees with "Scalecide." The results were satisfactory. At Mr. Plant's orchard about seven hundred trees besides those recorded in the tables were sprayed with "Scalecide" by the owners, and the scale was kept well in check by the treatment.

A few words of caution should here be given for the benefit of those who use the "soluble oils." The contents of the original package should always be shaken or stirred so as to become thoroughly uniform before any is mixed with water. Directions to this effect are sent out by the manufacturers, and in some cases accompany each package. These directions should be followed. If such precautions are taken there will probably be no injury to trees from the use of "soluble" oils. If not thoroughly mixed, however, there is a slight separation of the ingredients, and the oil from the top of the barrel or can will not mix well with water and may cause injury to the tree. A large tree sprayed with one of these preparations not properly stirred was injured by having all the leaf and blossom buds killed on certain branches, which did not put out leaves until the other branches were in full leaf. Adventitious buds appeared, and later the tree was uniform in foliage. Sometimes after long standing it is necessary to add a small quantity of water and incorporate it with the oil before it will mix properly with the larger amount of water used at the time of applying it to the trees.

THE PEACH SAWFLY.

Pamphilius persicum MacGillivray.

A NEW ENEMY OF THE PEACH ORCHARD.

BY B. H. WALDEN.

The peach orchard of Barnes Brothers at Yalesville, Conn., was visited at the request of the owners on June 14, 1906, to look at some insects that were flying around among the trees. Many trees in this section had been partially defoliated the previous season, and while the insects were not observed by the owners at that time, the occurrence of an unfamiliar insect in numbers in the same locality the following season at once suggested the cause. The insect proved to be a four-winged fly about three-eighths of an inch long, the head and thorax black with yellow markings, the legs and abdomen reddish brown or brown ocher in color. At this time only six or eight were seen flying around each tree in the infested locality, but Mr. Barnes informed me that they had been very numerous a few days earlier. Upon examining the trees, numerous white eggs were found on the under side of the peach leaves, and some of these eggs were beginning to hatch. The number of eggs observed at once suggested that the insect might prove to be quite a pest.

Material was collected to rear, but while the writer was absent from the station in connection with other work, all specimens died. The next visit was made to the orchard July 27th, when all the larvae had disappeared. A number of trees had been badly defoliated, and evidences of the work of the insect were seen over a considerable area in the orchard. Observations made on this insect during the past season are presented in the following pages.

Identity of the Pest.

This insect promised to be interesting even before we saw it, as there are comparatively few insects that feed upon peach foliage. The specimens were sawflies, hymenopterous insects, belonging to the family *Tenthredinidae* (a familiar example of which is the common currant worm). They are called sawflies because the ovipositor of the female consists of a pair of plates with serrated edges, with which some of the species "saw" into the tissues of plants, where they deposit their eggs. Specimens were sent to Dr. A. D. MacGillivray of Cornell University, a specialist in this group, who pronounced it a new species and described the insect as *Pamphilius persicum*.*

Another sawfly, *Selandria obsoletum* Nort., has been reported by Prof. H. A. Morgan,† as seriously defoliating peach and plum trees in Louisiana, in an article giving a description of the insect and its work.

Injury to Trees.

The peach sawfly feeds upon the foliage and the injury depends of course upon the extent to which a tree is defoliated. In 1906 many trees in one section of the orchard were quite badly defoliated (see Plate VI, b.), and while surrounding trees showed some damage it was not noticed in another neighboring orchard, thus indicating that the insect was quite local in its work. This year it was more widely distributed, being found in all of Barnes Brothers' orchards, and appeared less local in its movements, though this feature could not be definitely observed, as the badly infested locality of the previous season was all thoroughly sprayed this year. In the orchards of Messrs. Hopson, Hall and Lyman the work of the insect was observed over considerable areas, but was nowhere serious.

The work of the insect is very characteristic, and is first noticed by the rolling of the leaves and later by their shredded appearance as shown on Plate I. This is more fully described under habits of the insect.

* Canadian Entomologist, Vol. XXXIX, p. 308, 1907.
† La. Expt. Station Bull. 48 Second Series, p. 142, 1897.

Food Plants.

This sawfly seems to be confined almost entirely to the peach. The foliage of the native trees and plants in the vicinity of the peach orchards, especially those belonging to the rose family, was carefully examined. The only plant found on which eggs had been laid and larvae were feeding was a small bush of the wild black cherry, *Prunus serotina* Ehrh. This was in an old division wall between two portions of the orchards in the badly infested locality. Other black cherries in the vicinity of the orchards were examined but no eggs or larvae were found on them. Many adults were seen resting on the leaves of apple trees, a number of which were in the peach orchard, but no eggs were found on them. On Japanese plums and sour cherries near the infested orchards no trace of the insect was found. In one of the breeding cages, where there was no chance to oviposit on peach foliage, a few eggs were laid on common sorrel, *Rumex acetosella* Linn.

These observations are contrary to the usual habits of native insects that become serious pests. Ordinarily the species will be found feeding on a number of closely allied wild plants, and gradually begins to work on cultivated species, the injury increasing from year to year. A new pest suddenly breaking out in numbers and confining its work to a single cultivated plant, as the peach sawfly is apparently doing, strongly suggests its being an introduced species. In regard to the peach sawfly it is certainly hard to answer the question,—where did they all come from?

Abundance.

From the examination made in the summer of 1906 it was evident that the insect must have been very numerous over quite a section in part of the orchard. They were the most abundant in this section during 1907. A few notes were made regarding the number of larvae and adults, as follows:

On May 15th a shovelful of earth examined contained *forty-six* larvae. The hole at the greatest diameter measured ten by eleven inches, and five and one-half inches deep at the deepest point. It was two feet ten inches from the nearest tree. This was the first shovelful examined, taken up at random at least two hundred feet from where the insect was found to be the thickest the previous year. The photograph of the holes where adults had emerged (Plate IV), was taken in the same vicinity, the particular spot not being selected on account of the large number of holes, but because it was level and free from rubbish, and is a fair record of conditions on between two and three acres. This photograph was taken natural size on a 5 x 7 plate, looking directly down on the ground, and shows thirty-seven exit holes, or a fraction over one to the square inch. In one of the small breeding cages, containing exactly three square feet, which had received no treatment, 132 adults emerged or 44 to the square foot. A few wings and parts of sawflies were found which may have been eaten by carabid beetles, and these would have increased the total number.

The greatest number of adults were seen on a visit to the orchard June 12th. They were especially abundant in an opening where a number of peach trees had been cut out; here they collected in swarms on the grass and weeds. They were so numerous as to make a slight rustling sound.

Needing adult specimens for our collection, etc., 462 specimens were taken, with an ordinary twelve-inch net, by sweeping it over the grass and weeds for about ten seconds. Twelve eggs were the largest number noted on a single leaf.

Natural Enemies.

Considerable time was spent looking for parasites, especially of the egg and larva, but no hymenopterous parasite or fungous disease was observed attacking either. Numerous carabid beetles belonging to the genus *Harpalus* were present in the section where the sawflies were especially abundant. Many fragments of the adults, which had evidently been eaten, were found in the breeding cages and while these beetles were not observed feeding on the sawflies, their presence indicated that such may have been the case. Numbers of small toads in the orchards may have also helped to reduce the numbers.

Life History.

The spring of 1907 was cold and backward, and the dates here given are considerably later than they would be in a normal season. This is shown in one or two cases where the date for the previous season is given. The various stages probably overlapped each other much more than they would in a normal season. Mr. Barnes remarked that he thought the adults were seen for a longer period and the larvae were feeding longer than they were the year before.

The adult sawfly emerges from the ground the last of May or first of June. The first adults were observed June 4th and the last date that any were seen was June 27th. They were the most abundant on June 12th, while in 1906 the majority had disappeared by June 14th. The eggs were first found on June 12th, eight days after the first adults were observed. These were found only after considerable searching, and then but five, one leaf with two and three with one each; the majority of the eggs were laid after June 14th. The eggs hatch in six to eight days, the first larvae being observed June 20th. In 1906 many eggs had hatched by June 14th. The larvae become grown in eight to ten days, considerable injury having been done to trees not sprayed by the end of June. The larvae go into the ground and remain until the following spring. The larvae transformed rather irregularly, pupae being found from May 21st until after the middle of June. A few larvae were found June 20th, and while no further notes were made, it is quite probable that at least some of these remain in the larval stage until the following spring. Adults began to appear fourteen days after the first pupae were observed. There is but one brood in a season.

Habits.

After emerging, the adults collect together in groups or swarm in sunny places. At the time the adults were the most numerous (June 12th) but few were seen on the trees, but in places where trees had been cut out they were very numerous, flying around and running over the grass and weeds. While the sun was shining they were very active, but when a cloud passed over the sun they would settle down and become quiet. The next visit to the orchard was on June 14th, which was a cloudy, windy day, and the insects were very quiet, even sluggish. On the previous date many of the insects were mating but the females were not observed in the act of ovipositing. The small whitish eggs are laid horizontally on the surface of the under side of the leaf along the midrib and on the basal portion of the leaf. See Plate II, a. The larva after hatching crawls to the edge of the leaf and soon spins a web of a few whitish silken threads over itself. When it begins to feed it eats a narrow strip inward from the edge and by means of the web draws or rolls the corner of the portion on which it rests over itself, forming a case within which it stays during the day, coming out to feed towards dark. Much of the damage is done when the larvae are nearly full-grown. Leaves partly eaten and with the characteristic rolling are shown on Plate I. The midrib of the leaf is left, and to it is often attached more or less of the adjoining tissue, thus giving to the foliage on the infested trees a peculiar shredded appearance. Small trees, set to replace large trees that had been removed, were often found nearly stripped while the surrounding large trees might show but little of the work. This may be due to their preference for sunny places.

After the larvae become full-grown, they go into the ground, where they remain until the following year. Observations regarding these larvae were made in April and May. From considerable digging and many measurements the majority of the larvae were found to be about three inches deep, though some were within two inches of the surface, and the deepest were between five and six inches. The only larvae found less than two inches deep were three that were obstructed by a large flat stone. Larvae occurred within six inches of the tree trunk and halfway to the adjoining tree, or in other words, they could be found in the soil all the way from one tree to another, but were the thickest about thirty inches from the base of the tree. The larva forms a small round unlined cell about one-fourth of an inch in diameter within which it remains curled up. The color of the larvae had changed from pale bluish green to a bright apple green. Larvae examined early in November had assumed this color.

When the larva pupates, no cell is formed, the larval skin is discarded and usually remains attached to the last abdominal segment, and the pupa is free. It has the same general shape as the adult; the antennae, legs and other appendages simply with a thin covering. Pupae are shown on Plate III, c.

Experiments in Checking the Insect.

At the time the experiments were started it was not definitely known that peach foliage could be sprayed in Connecticut with arsenate of lead, or in fact with any spray mixture. It was well-known that Bordeaux mixture was injurious to the foliage, and statements had been made to the effect that arsenate of lead was injurious. Three methods of combating this pest were tried, (1) cultivating the soil thoroughly while the insect was in the pupal stage; (2) treating the soil with carbon disulphide during the same period; (3) poisoning the larvae soon after they hatch by spraying the foliage with internal poisons.

Cultivating the Soil.

We have found in rearing sawflies that certain species are easily killed by disturbing the soil after they have gone into it to pupate. This suggested cultivating the soil thoroughly, especially near the trees, while the peach sawfly was in the pupal stage, as a means of reducing its numbers.

In order to note definitely the results, tight wire-covered cages were made and placed around a number of trees to retain any adults that might emerge within the area. These cages consisted of frames six feet square made of boards seven or eight inches wide and covered with wire mosquito netting. Each cage was built around a tree, the tree being in the center, with the netting fastened to the tops of the frames and fitted tightly around the tree. The cages were hinged at the middle so that one side could be raised and the soil cultivated halfway around the tree. This side could then be lowered and the opposite side raised and the soil cultivated on that side. The sides were then banked with earth to make the cage tight. A view of these cages is shown on Plate V, a., and a nearer view of a cage with one side raised is shown on Plate V, b.

Two cages were left as checks, and in four the soil was cultivated, once, twice, three and four times respectively. The ground was stirred as thoroughly as possible with a spade to a depth of at least four inches. All lumps were crushed, making the cultivation probably more thorough than would be possible with any of the ordinary orchard tools. The dates, number of times cultivated, etc., are given in the following table:

Cage No.	1st cultivation	2d cultivation	3d cultivation	4th cultivation	Condition June 12 (No. adults)	Condition June 14
2	May 23	------	------	------	About 12	Many adults
3 (check)	------	------	------	------	About 12	Rather more than in cultivated cages
7	------	May 28	June 4	------	6–8	Many adults
4	------	May 28	June 4	June 7	3	Many adults
5	May 24	May 28	June 4	June 7	12 or more	Many adults
8 (check)	------	------	------	------	About 50 adults *	Rather more than in cultivated cages

The cultivation seemed to slightly delay the development of the insect and on June 14th more adults had emerged in the check or untreated cages than in the cultivated; but at the next visit there was very little difference. Slight difference was noted between the cages cultivated a different number of times, and even in the cage where the soil was cultivated four times, which would not be practicable in orchard work, the treatment did little more than to retard the development of the insects.

During the latter part of May the orchard was plowed with a light gang plow, turning three furrows from two and one-half to three inches deep; this turned up many larvae, but there were still many left below the bottom of the furrow, and the majority of those that were plowed up emerged, as was shown by the numerous exit holes.

Carbon Disulphide.

Carbon disulphide has long been used in France against the grape phylloxera. The substance is injected into the soil around the vines, and the liquid evaporates, though much more slowly than it does in the air, and spreads through the soil. It is used in this country in various ways for underground insects, especially in killing ants. Professor Slingerland of Cornell University has used it successfully in experiments against the cabbage maggot.*

In our tests two cages were used like those described for the cultivation experiments. These cages were placed in the rows with the others, and the same check cages served for both experiments.

In one cage the carbon disulphide was used at the rate of one fluid ounce to a square yard, and in the other twice that amount, two ounces to a square yard. Holes five or six inches deep were made about eighteen inches apart, or four to the square yard, and an ounce of the liquid was divided between the four holes, or about two teaspoonfuls put in each hole, after which the opening was quickly closed with the foot.

The ground in the second cage was treated in the same manner excepting that double the quantity was used. This treatment proved effective, as no adults emerged in either cage. The insects might have been killed with a smaller amount of carbon disulphide, although the actual amount required would depend upon the mechanical condition of the soil. A light, dry, porous soil will require more than a heavy, compact, moist soil, as in the former the carbon disulphide is evaporated much more rapidly and the fumes would not be retained long enough to kill the insects unless a large quantity was used. The greatest drawback, however, is that there is no tool on the market with which the carbon disulphide can be injected into the soil. An instrument was devised by Mr. McGowen, inventor of the McGowen spray nozzle, called the McGowen Injector, and was suited for just such work as is mentioned above. The injector was put on the market, but owing to the small demand for such an instrument, its manufacture was discontinued.

Treating an orchard with carbon disulphide, even with a suitable injector, would of course be very expensive, but the experiment was made before we were sure that spraying could be practiced, and had the latter proved impracticable, this would have been the only treatment we could recommend.

* No. 8 was on rather higher ground than the other check, No. 3. No. 7 was a tree in row opposite No. 8.

* Cornell Expt. Station Bull. 78, p. 531, 1894.

In the above cultivation experiments and in those with carbon disulphide duplicate tests were made with small cages containing three square feet. These tests gave similar results to those of the large cages.

Spraying with Poisons.

At the beginning of the season we were in doubt as to whether the peach foliage could be sprayed with any poison. Dr. J. B. Smith, State Entomologist of New Jersey, informed us that he had used arsenate of lead on peach foliage without apparent injury. A statement was made by Prof. A. L. Quaintance of the Bureau of Entomology that in some experiments with arsenical poisons on peach foliage, all materials used injured either the foliage or the fruit.* As soon as the leaves were out sufficiently to make a test, fourteen small peach trees on the station grounds were thoroughly sprayed with arsenate of lead at the rate of one ounce in one gallon of water, which is about equal to three pounds in fifty gallons. No injury followed. This test was repeated with another brand of arsenate of lead with the same results.

The following materials were applied in Barnes Brothers' orchard to note the effect on the trees and insects:

Vreeland's arsenate of lead 3 lbs. in 50 gal. water	5 trees
" " " " 1½ lbs. in 50 gal. water	5 trees
Paris green ½ lb., 3 lbs. lime in 50 gal. water	10 trees
Hellebore, 3 lbs. in 50 gal. water	6 trees

These trees were sprayed on the forenoon of July 6th, and the application was followed by a light shower that evening. A visit was made to the orchard July 9th, and it was found that through a mistake these trees had all been resprayed that morning with arsenate of lead, which was being used on the remainder of the orchard. These trees were examined several times, and no injury was noted even where the Paris green was applied.

Extensive Spraying Operation by the Owners.

Probably the most extensive spraying operation ever undertaken in the Eastern States in a peach orchard when in foliage was carried out by the Barnes Brothers during this last season. Several hundred pounds of arsenate of lead was applied to

* Bureau of Entomology Bull. No. 67, p. 47, 1907.

4,000-5,000 trees between June 24th and July 10th. The owners intended to spray more, but during the first week in July had to suspend operations to wait for a shipment of lead arsenate. The arsenate of lead purchased was manufactured by the Powers-Weightman-Rosengarten Company of Philadelphia,* and was applied at the rate of 2½ to 3 lbs. in fifty gallons of water.

The larvae, like many sawfly larvae, were very readily killed by the poison, and probably used at one-half this strength (one and one-half pounds in fifty gallons) would have been effective. Mr. Barnes was unable to be in the orchards much of the time to see that the men thoroughly covered the foliage, and the stronger solution was used partly for this reason. Plate VI, a., shows the sprayers at work in this orchard.

Owing to the peculiar season, the young larvae probably appeared more irregularly than they would in an average season. During the first ten days of July many trees showed considerable of the insect work, and many of the larvae became full-grown, but there were still many partly grown larvae present on the same trees which might add much to the damage already done, and the spraying was continued until the 9th of July. The treatment was entirely successful, the work of the insect being checked wherever the trees were sprayed. From my notes of July 3d regarding trees sprayed about the 24th of June:—"Found many dead larvae in the rolled leaves on the sprayed trees, and the foliage shows a marked difference from that on trees not sprayed."

The writer examined many of the sprayed trees for two or three weeks following the operation, and in no case was any injury to the foliage seen. Mr. Barnes watched throughout the season, a number of trees which had received an extra heavy coating of arsenate of lead, and though the mixture showed on the foliage until the leaves fell, no injury was observed.

Description.

Egg. The eggs are pearly white in color, 1.64 mm. (average of six) in length, and .6 mm. (average of four) wide, sides nearly straight and of uniform width, the ends regularly and broadly rounded. Occasionally an egg is very slightly curved.

* Analysis, Conn. Agric. Exper. Stat. Bull. 157, p. 5, 1907. (See page 323 of this report.)

They are laid longitudinally along the midrib of the leaf. See Plate II, a.

Larva. When first hatched is pearly white in color with brown eye-spots on either side of the head. Mouth parts and antennae tipped with brown. Antennae .16 mm. long. Length about 2.5 mm. Head about .5 mm. wide, exceeding the body, which is .45 mm. wide back of head. Body fairly uniform in width, tapering somewhat towards anal end. Abdominal segments slightly wrinkled. Anal segments with a pair of three jointed appendages about .12 mm. long, the basal joint large, the second smaller and shorter, the third tapering to a point.

Full-Grown Larva. Length 15 mm., width 2.25 mm. Color pale bluish green, including the head; mouth parts, antennae, and anal appendages brownish. First thoracic segment with a dorsal transverse mark between two sublateral spots. Head roundish, about 1.5 mm. wide. Antennae slender, seven-jointed. Abdomen without prolegs, the segments wrinkled transversely, four wrinkles to a segment; the last abdominal segment flattened, tipped with a row of slender hairs and with a pair of three jointed appendages situated laterally on the ventral side. The larvae are shown on Plate II, b. and c.

After entering the ground the color of the larva changes to a bright apple green.

Pupa. No cell or pupa case is formed. The pupa is naked with all the appendages free, simply covered with a thin membrane. The head and thorax apple green, abdomen and appendages yellowish green. Before emerging the color and markings of the adult insect are plainly visible. Shown on Plate III, c.

Adult.

Dr. MacGillivray has described the female as follows:

"*Female*—Body black, with the following parts yellow: the labrum and clypeus broadly, the posterior orbits, the front orbits with a band extending to the occiput, with two tooth-like projections on the mesal side near the eye, a pair of lunate marks behind the ocelli, a small spot on the hypoclypeal area, the palpi, the V-spot, the tegulae and base of the wings, the scutellum, the post-scutellum, a small irregular spot on the pleura, and the legs, except the extreme bases of the coxae, becoming rufous beyond the middle of the tibiae; mandibles and abdomen rufous; antennae with thirty segments, the third and fourth subequal in length. Length, 10 mm."*

Male. Color and markings similar to female except the following:—The front orbits with a large irregular yellow spot opposite the eye, the lower edge continuous with the yellow of the posterior orbits. The yellow band extending from the inner superior border of the eye to the occiput. Antennal pits and the under side of the first basal antennal joints yellow. The lunate marks behind the ocellus smaller. Abdomen with the sides blackish and at least the posterior dorsal margins of the segments blackish, in a few specimens almost the entire dorsal surface of abdomen blackish. The ventral side rufous except at the lateral edges. Anal appendages rufous. Average length 9 mm.

Both sexes and their characteristic facial marking are shown on Plate III, a. and b.

Distribution.

Our attention was called to this insect in 1906, and Barnes Brothers observed its work in 1905. Since then we have received no complaint from other orchardists of injury that could specifically be laid to this pest. Observations regarding the distribution of the peach sawfly have been made as follows, the larger orchards having been visited especially to look for the insect or its work:

Places Where the Insect has been Found.

New Haven, June, in three city gardens and in garden of Experiment Station.

Meriden, July 9th, small peach orchard of E. M. Ives; occasional leaves had been eaten, and a few full-grown larvae were found.

Centerville, July 12th, orchard of George C. Neal. A number of larvae. The pest evidently well established.

North Haven, July 12th. The insect was present upon a few peach trees in a henyard.

East Wallingford, July 17th, orchard of George A. Hopson.

* Canadian Entomologist, Vol. XXXIX, p. 308, 1907.

Found considerable work of the insect, a few small trees with leaves nearly all stripped.

Orchard of Linus Hall, the insect rather more prevalent than in the orchard above mentioned.

Middlefield, July 17th, orchard of Charles E. Lyman. Conditions about the same as in East Wallingford.

Farmington, August 7th, orchard of Root Brothers. A few leaves eaten by this insect on two or three trees.

Young orchard of Prof. H. W. Hillyer showed evidences of the insect.

Mr. J. Norris Barnes reported the insect in their orchards at Cheshire and also at Durham.

Orchards Examined with no Indication of the Sawfly.

West Haven, July 5th, orchard of N. S. Platt.
Westport, July 16th, orchard of S. B. Wakeman.
Seymour, August 13th, orchards of Hale & Coleman.
Rocky Hill, August 15th, orchards of W. F. Griswold.
South Glastonbury, August 15, orchard of J. H. Hale.
Hartford, September 12th, peach trees in four city gardens.
New Canaan, Sept. 18th, orchard near Stephen Hoyt's Sons' Nursery.
Norwalk, October 3d, small orchard of Comstock & Lyon.

As far as we know, this insect has not been observed outside of Connecticut. A note was published in Bulletin 67 of the Bureau of Entomology, p. 87, stating that it had been observed in New Jersey and also in Pennsylvania, but these records refer to the distribution of an entirely different sawfly, *Priophorus acericaulis* MacGillivray, which confines its work to maple trees.

Will the Peach Sawfly become a Serious Pest?

Since the peach sawfly has been brought to the attention of the fruit growers, there have been many questions regarding its importance as a pest. It is hard for the orchardists to become reconciled to the fact that they have got to spray their orchards every one or two years for the San José scale, and the possibility of having to give their orchards an additional spraying for this pest is indeed discouraging.

It is impossible to predict with any certainty regarding this new pest. The sawfly promises to become distributed throughout the state, as it has been found in New Haven and Middlesex counties at points nearly thirty miles apart; but whether it will become numerous enough to cause serious injury depends largely upon the rapidity with which it multiplies, and the part that natural enemies may take in reducing its number. From our observations, the numbers are not greatly increased during a single season, and it would seem that the pest would necessarily have to be present in an orchard several seasons before it would do extensive damage. The larvae are very easily killed by arsenical poisons, and it is quite possible that one application may reduce their numbers sufficiently so that the operation would not have to be repeated for two or three years. It will be necessary to study the insect for a number of seasons before we can judge regarding the seriousness of the new pest that has been found in our state.

Acknowledgments.

The writer is indebted to Dr. Britton, under whose direction the work has been done, for much help and many suggestions.

To Barnes Brothers, who placed their orchard at our disposal, furnished lumber for breeding cages, and assisted the work in many ways.

To Mr. George A. Hopson and Mr. Charles E. Lyman, who spent considerable time at a very busy season, conducting the writer through their orchards.

Recommendations.

From our experience we recommend spraying the foliage with arsenate of lead, using it at the rate of one and one-half to three pounds in forty to fifty gallons of water. This should be applied as soon as the larvae begin to hatch, or if a large area is to be sprayed with a limited amount of help, the work could probably be started shortly after the eggs are laid. The exact date will depend, of course, upon the season; this was found to vary about two weeks during the past two seasons. The point is, the larval stage is short and the work must be done quickly at the proper time, and in order to determine this a close watch must be kept of the progress of the development of the insect.

Carbon bisulphide will kill the insect in the larval and pupal stages, but is probably too expensive to warrant its use; besides there is no injector with which to apply it, on the market at the present time.

BIBLIOGRAPHY.

1906. Britton, W. E. Sixth Report State Entomologist Conn., p. 235 (brief mention). P. 305, note regarding its work, etc.

1907. Britton, W. E. Report Conn. Pomological Society, p. 30 (brief mention).

MacGillivray, A. D. Canadian Entomologist, Vol. XXXIX, p. 308. (Original description of female.)

Walden, B. H. U. S. Dept. Agriculture, Bureau of Entomology, Bull. 67, p. 85, Plate I. (Article regarding its occurrence, habits, work, etc.)

PROGRESS OF THE WORK OF CONTROLLING THE GYPSY MOTH IN CONNECTICUT.

The first account of the discovery of the gypsy moth in Connecticut in March, 1906, was published in Bulletin 153 of this station. The report for 1905 was then being prepared, and in it was included, on page 246, a more complete history of the discovery. Work was started immediately and kept up until September 1st. The details were published in full in the report for 1906, page 235. The present paper is a report of progress during the calendar year of 1907.

Beginning November 16th, 1906, Mr. George H. Hollister has had immediate supervision of the work, and to his faithfulness and ability much of its success is due. During the winter three men worked with Mr. Hollister, scouting for egg-masses, pruning trees and cutting brush. After the caterpillar season began, the force was increased, twenty being the greatest number of men employed at any one time during the banding season. Excellent progress has been made in the suppression work, as a large number of trees were banded, brush cut and trees pruned over a large area, and the total number of caterpillars found was less than one-third the number taken during 1906.

On September 1st the work was suspended on account of the annual inspection of nurseries, and again resumed on November

18th. Details of the suppression work are given in the following pages.

Scouting and Destroying Egg-Masses.

All trees throughout the infested region, including those in the village and as far north as the cemetery road, were examined by the men during the winter. In the immediate vicinity of known infestations, fences, walls and buildings were also carefully inspected. Plate VII shows men engaged in scouting and destroying egg-masses. Creosote is applied by means of a brush, enough being used to thoroughly soak the egg-mass, and this prevents the eggs from hatching. Much of this territory was again examined in December. About 106 unhatched egg-masses laid in 1906 were found and destroyed by the men employed by the state. Considerable time in summer was spent scouting for caterpillars.

Government Coöperation in Scouting.

Following previous arrangement by correspondence, Mr. D. M. Rogers, special field agent in charge of the Government work against the gypsy and brown-tail moths, put four men at work scouting about Stonington on March 20th, and later their force was increased to five. These men were instructed to make a careful search over the whole town of Stonington and the easterly portion of Groton near West Mystic, eastward surrounding Westerly, R. I., and north to include a portion of the town of North Stonington. The Government men examined not only the infested region, which was later scouted by state men, but a large area surrounding this region. No egg-masses were found outside the limits previously known to be infested. Twelve egg-masses were found by the Government scouts, who were engaged about four weeks in examining this territory.

Destroying Egg-Masses in Stone Walls.

In several of the worst infested spots caterpillars transformed in stone walls, and the females there laid their eggs. In order to destroy them it was necessary to overhaul the stones and treat each egg-mass with creosote. Around the places of M. Chesebro, F. Allen, and near the Alexander Rose estate on North Main street sections of stone wall were overhauled and relaid, altogether about fifteen rods being thus treated.

Examining Woodpiles.

Piles of wood, lumber and rubbish near which caterpillars were found were suspected of containing egg-masses and were therefore overhauled and examined. One pile of old railroad ties at F. Allen's (shown on Plate X, a.) contained seven egg-masses. The pile of waste lumber, packing boxes, etc., at the velvet mill was also looked over, and six egg-masses found. Ten such piles of rubbish, lumber and fuel were examined.

Pruning and Scraping Orchard Trees.

There are many old apple trees in and about the infested region at Stonington. Some of these are in orchards and were planted, but others, probably chance seedlings, are scattered over the fields or are growing beside the stone walls. A large proportion of them have been neglected for many years, and the tops were filled with a tangle of living and dead branches, and the trunks and larger limbs covered with lichens and loose rough bark. As the gypsy caterpillars are found on such trees, it was absolutely necessary to put the trees in such shape that effective work could be done in controlling the insect. During January a heavy fall of snow made brush cutting impracticable, and the men went to work pruning and scraping these old apple trees. The dead wood was first removed, then enough thinning was done in the tops to let in the light and air. In all about 450 such trees were pruned during the year, and over two hundred trees were scraped. The wounds were painted wherever large branches were cut. Views of the pruning operations are shown on Plate VIII.

Rough bark on the trunk and branches of a tree enables the caterpillars to find protection under the upturned edges of bark so that they will not crawl under the burlap bands. Likewise, if the top of a tree is thick and dark, the caterpillars there are sufficiently protected, and cannot be trapped under the bands.

Filling and Tinning Cavities.

Many of the trees described above contained cavities caused by the neglect of broken and decayed branches, and these cavities were convenient places for the caterpillars to hide out of reach of all enemies. In them caterpillars will transform, and later perhaps egg-masses will be laid therein and escape discovery. It was therefore necessary to fill these cavities so as to exclude the caterpillars. In some cases this can best be done by filling the opening with stones and cement, and in others it is better to nail a piece of tin over the opening, fitting it around the edges so that caterpillars cannot crawl under it. Wherever tin was used, the metal was painted over with dark paint to make it as inconspicuous as possible. In this manner cavities were filled and covered in 130 trees during the year.

Plate XII shows a tree that has been scraped and pruned and the cavities filled.

Banding Trees with Burlap.

Burlap bands were placed around the trunks or stems of trees as described in the report for last year, page 238, but the bands were applied to trees over a much larger area than was covered last year, nearly ten times as many bands being used. All trees were banded through the streets and back yards of the village and as far north as the cemetery road from the Wequetequock River west to Sheridan's Corner, on the Mystic road. All trees for a distance of about two hundred yards north of the cemetery road, including three apple orchards, were also banded, but no caterpillars were found there.

During July caterpillars were found on maple trees along the drive leading from the Mystic road to Walnut Grove. All trees in this vicinity were banded at once, about eight hundred being so treated.

Altogether about thirteen thousand trees were banded in 1907. The appearance of banded trees is shown on Plate XI and the method of applying the bands may be seen on Plate X, b. The first banding was done about May 25th. Burlap (eight ounce weight) was purchased from Boston, all cut into ten inch strips ready for use. In the infested area these bands were examined each day through the caterpillar season; outside this area they were turned every second day, and later twice a week.

Destroying the Caterpillars.

The territory was divided into sections, and each man engaged in examining bands was given a section of banded trees. Notes were kept each day of all caterpillars found and of the locality where taken. Thus at the end of the season we had a record of the entire matter, and knew where to look for the greatest number of egg-masses. The caterpillars were gathered with forceps and destroyed in the same manner as last year, by dropping them into small bottles of alcohol carried by the men.

Cutting Brush.

Plans were made to clear from brush all of the land between the northernmost extension of the water from Stonington harbor to the Wequetequock River and as far north as the cemetery road. Mr. Phelps, at his own expense, had cut considerable brush just east of his residence and south of the cemetery road, and by January 8th, 1907, a strip had been cleared from water to water, though not very wide, near the east entrance to the cemetery. During the first part of the winter there was little snow, and the brush cutting work could be carried along without hindrance. Some brush cut during August had not been burned, and this was gathered and fired. Considerable heavy brush east of the cemetery was cut in early summer, and the section between North Main street and Elm street south of the cemetery road was entirely cleared of brush except a small patch just east of Mr. Phelps' house, which was cut in November, 1907. The heavy brush near Mr. Atwood's was also cut and the remaining trees pruned, but it was not possible with the force employed to cut all of the scattering brush in the pasture north of Mr. Atwood's house. This area was finished up in December, 1907. As a few caterpillars were found at Walnut Grove in July, a gang of men were set at work cutting brush in this vicinity. Mr. Hollister estimates that during the past year a hundred acres of brush land has been cut over, and some of this was heavily covered with green brier (*Smilax rotundifolia*), often called "bull brier," making the work extremely difficult. Some of the men were so badly poisoned with poison ivy that for a few days they were unable to work. Brush along the boundary walls of fields and meadows has also been cleaned up over an area of about three-fourths of a square mile. Brush cutting work is shown on Plate IX.

Infestation at Walnut Grove.

About the middle of July the men found some gypsy caterpillars on the trees beside the drive leading from the Mystic road

to Walnut Grove. Men were at once put at work there, and a considerable area of brush cleaned up. Some eight hundred more trees were banded in the vicinity and though much hunting was done for caterpillars, only a few were found, and most of these were on trees between the house and the northernmost extremity of water. Though the trees have since been examined very carefully for egg-masses, none have been found. Not even an old one has been discovered. How the caterpillars reached this place is a matter of conjecture, but it is possible that an egg-mass or a portion of an egg-mass was blown across the water on the ice. On the other hand, it is possible that one or more egg-masses were laid at Walnut Grove in 1906 and escaped detection.

Infestation of Spruce Trees at the Stanton Place.

During August, after the caterpillars had transformed, Mr. Hollister, on looking into the top of one of the Norway spruces of which there are several on the Stanton place, noticed some female gypsy moths laying eggs. This tree was immediately given a thorough examination, and over fifty new egg-masses were found. These were creosoted, and later the tree was cut and burned. A similar number of egg-masses was found in the other spruce trees in December. Although these trees were all banded, few caterpillars were taken from under the bands, and there was no indication that the trees were infested to any such extent. The tops of the trees were thick and dark, and furnished to the caterpillars all the protection necessary, hence they did not descend to hide under the bands. The caterpillars had eaten some of the leaves in the tops of the trees, but not enough to be noticeable from the ground. The excrement even did not indicate their presence by dropping to the ground, but was caught and held by the thick leafy branches underneath. It was an extremely difficult matter to find and destroy the egg-masses on these trees, as some of them were at the extremities of the branches on the small twigs, and nearly all on the under side. In spite of the very thorough examination given these trees, some egg-masses may have been overlooked, and a close watch must be kept on them next season. No egg-masses were found on the arbor-vitae trees growing near by on the premises.

Statistics.

	1906	1907
Egg-masses laid during preceding year, number destroyed	29	118*
Egg-masses laid during same year, number destroyed	47	70
Caterpillars, number destroyed	10,000	2,936
Pupae, number destroyed	47	200
Trees banded with burlap, number of	1,300	13,000
Funds expended by the state†	$1,500.00	$4,550.00
" " " government	——	272.00

Transformations of Gypsy Moth in Connecticut in 1907.

The spring was an unusually late one, all forms of vegetation being fully two weeks later than usual. Ordinarily the eggs hatch soon after May 1st, but a cluster placed in the breeding cage did not hatch until May 18th, when 382 caterpillars had emerged from it, and the first caterpillar taken from the trees was found on June 8th. The first pupa of the season was found on July 25th, and only a few had been taken August 1st. The pupa stage lasts from ten to fourteen days, when the adults emerge. They soon mate and the females lay eggs, which hatch the following May. Thus about nine months or three-fourths of the year are passed by this insect in the egg stage. Caterpillars, adults and egg-masses are shown on Plate XIII.

Men Employed in the Work.

Throughout the year Mr. G. H. Hollister has acted as local superintendent and has been given full authority to employ or discharge men as he saw fit. All other men employed have been residents of Stonington or vicinity. Laborers were paid $1.50 per day of nine hours for the time which they worked, but during the summer, when most needed, they were given $9.00 per week as a guarantee against loss of wages on account of bad weather, and reported each morning, even though stormy, as some of the men could be used in sharpening and repairing tools. Through the winter months Mr. Hollister and three men worked scouting, cutting brush, pruning and scraping trees, but the force was increased as needed, until during the caterpillar season twenty men were employed.

* Including twelve found and destroyed by government scouts.
† These amounts are for the calendar and not for the fiscal year.

All work was suspended September 1st, and Mr. Hollister assisted in inspecting the nurseries of the state. On November 18th work was resumed at Stonington by Mr. Hollister and six men.

Funds.

The report for 1906 explained (page 245) how a portion of the general fund received by the station from the state was used in controlling the gypsy moth and also how eight hundred dollars was appropriated for the purpose by the State Board of Agriculture. During 1907 the expenses were met from the insect pest fund prior to the passage of a bill by the legislature providing for the prosecution of the control work. As this bill did not finally become a law until June 5th, and as none of the money could be used to pay bills contracted before that date, we came very near being obliged to stop work at a critical time for lack of funds. In order to keep the men at work the State Board of Agriculture appropriated one hundred dollars on May 25th. The new state appropriation of one thousand dollars became available on June 5th, and was immediately drawn, and as soon as the legislature adjourned the State Board of Control appropriated fifteen hundred dollars more, which amount was nearly all expended when the work was temporarily stopped on September 1st.

After the leaves had fallen so that scouting for egg-masses could be done advantageously, the Board of Control granted another one thousand dollars, which had been only about half expended on January 1st, 1908. Thus during the calendar year approximately $4,550 had been used, and this, together with the amount expended in 1906, make a total of more than six thousand dollars thus far expended in attempting to exterminate the gypsy moth colony at Stonington.

Legislation.

Prior to June 5th, 1907, no special legislation regarding the gypsy or brown-tail moths had been enacted in Connecticut, and in the control work at Stonington the state entomologist had no authority except that granted under the insect pest law—Sections 4386-4390 of the Revised Statutes. Consequently it was necessary to obtain the owners' permission before cutting brush, pruning trees, etc., though clearly we had the right to enter any premises in the performance of our duties. More authority, as well as funds, was needed, and in consultation with a committee of the Board of Agriculture on January 30th a rough draft of a bill was prepared. By request of Colonel James F. Brown, Secretary of the Board, this bill was introduced by Representative Allyn of Ledyard. Later we had this measure examined by legal counsel, and while not sacrificing any of the essentials, the bill was put in better legal form and introduced as a substitute at a hearing before the agricultural committee on February 19th. This committee, after changing certain portions of the bill, reported favorably upon the substitute, but though we urged early action and explained the necessity of it, the appropriations committee refused to consider the measure before March 26th, when the bill was up for a hearing. There was no opposition to the measure except within the committee, which, after making more changes, finally reported favorably. This bill passed the House May 14th, and the following day the state entomologist went to Hartford, examined the bill, and consulting with other state officials learned that the money would not be available until July 1st, and would not be paid over by the state treasurer until the end of the quarter, or October 1st. The bill was therefore recalled, amended, and again passed the House May 15th. In due time the Senate acted favorably upon it and the Governor signed it on June 5th, making it a part of the law of the state.

The text of the new law is as follows:

The New Law Regarding the Gypsy and Brown-Tail Moths.

An Act Concerning Gypsy and Brown-Tail Moths.

General Assembly,

January Session, A. D. 1907.

Be it enacted by the Senate and House of Representatives in General Assembly convened:

Section 1. **(Public Nuisance.)** The insects commonly known as the gypsy moth and the brown-tail moth, being serious pests of vegetation, are, in all stages of their development, hereby declared to be a public nuisance.

Section 2. **(Authority.)** The state entomologist shall have authority to suppress and exterminate said gypsy and brown-tail moths, and may employ such assistants and laborers as he deems expedient; may cut and burn brush and worthless trees in fields, pastures, or woodlands, or along the roadsides on any public or private grounds; and may prune, spray, scrape, or fill cavities in any fruit, shade, or forest trees, or clean up any rubbish for the purpose of furthering said work. The said state entomologist, or any of his assistants, deputies, agents, or employes, shall have the right, at all times, to enter any public or private grounds in the performance of their duties.

Section 3. **(Living specimens must not be transported. Penalty.)** Any person transporting living eggs, larvae, pupae, or adults of the gypsy or brown-tail moths into the state, or from an infested region within the state to a region not hitherto infested, shall be fined not more than one thousand dollars or imprisoned not more than one year.

Section 4. **(Wilful obstruction illegal. Penalty.)** Any person wilfully obstructing or hindering said state entomologist or his assistants or employes, in the work of suppressing said insects, shall be fined not less than twenty-five nor more than five hundred dollars.

Section 5. **(Appropriation.)** The sum of one thousand dollars is hereby appropriated to be paid out of any money in the treasury not otherwise appropriated, for the purpose of this act for the two fiscal years ending September 30, 1909; and the board of control is hereby authorized, if said board deem it advisable, to increase said appropriation to such amount not exceeding in the aggregate the sum of ten thousand dollars as, in the opinion of said board of control and the state entomologist, is necessary, said sum to be in addition to the total amount to which said board of control is limited by law.

Section 6. This act shall take effect from its passage, and the appropriation provided for in section five shall become immediately available for the purpose of this act.

Approved June 5, 1907.

Provisions of the Law.

An examination of the preceding measure will show that the State of Connecticut has by statute provided for the control of the gypsy and brown-tail moths. First it declares these insects to be a public nuisance. The state entomologist is thereby given authority to employ the necessary help; to enter any public or private grounds; to cut and burn brush and worthless trees; to prune, scrape, spray or fill cavities in trees, or clean up rubbish. Anyone wilfully hindering the suppression work is subject to prosecution and a heavy fine.

Anyone bringing these insects alive into the state, or from an infested region within the state to a locality not hitherto infested, is liable to be heavily fined and imprisoned, and it makes no difference whether the insects are in the egg, caterpillars, cocoon or adult stages.

This law further provides an appropriation for carrying on the work, and that the act take effect immediately upon its passage.

The text of the law with explanations was immediately printed as Bulletin of Immediate Information No. 5, and a copy distributed at every house within the infested region, and was also published in the local newspapers.

Legislation and Appropriations for Gypsy Moth Work in other States.

Connecticut was not alone in enacting new laws for the suppression of the gypsy and brown-tail moths. In Maine and New Hampshire, where such legislation did not previously exist, new laws were passed in the winter or spring of 1907, giving authority and appropriations for carrying on the work. In Rhode Island, where a small appropriation had been made and expended the preceding year, the law was renewed and strengthened and a much larger appropriation granted. In Massachusetts, the state most seriously infested, the appropriation was renewed. In addition to these state appropriations Congress appropriated a large sum of money to be used by the Bureau of Entomology of the United States Department of Agriculture in coöperation with the authorities of the five infested states. The following figures give the approximate area infested by the gypsy moth and the amount appropriated for suppressing both gypsy and brown-tail moths in each state:

State.	Area Infested.	Appropriation.
Connecticut	1 square mile	$ 10,000 (biennial)
Maine	228 " miles	30,000 (annual)
Massachusetts	3,000 " "	300,000 (biennial)
Rhode Island	25 " "	10,000 (annual)
New Hampshire	1,500 " "	25,000 (biennial)
United States		150,000 (annual)
Total	4,754 " "	$525,000

In addition to the amounts given in the preceding table, the laws of Maine, Massachusetts and New Hampshire, require that individual owners, town and municipal authorities, take measures, when necessary, to suppress these pests on their own property, or that under their charge, the expenditures not to exceed a certain low percentage of the assessed valuation of the property. On proof that this has been properly done by cities and towns, the commonwealth may reimburse the cities and towns for a certain proportion of such sums expended in accordance with the law. In this respect, the laws of Maine and New Hampshire are based on the Massachusetts law, but in Rhode Island and Connecticut the suppression work is done entirely by state and government authorities, city, town, and private owners not being obliged to act, because extermination and not mere suppression is the end in view. Should these states ever become generally infested, a measure similar to that in Massachusetts would be necessary to control the pest, and would doubtless be enacted. In addition to the $300,000 appropriated by the Massachusetts Legislature, the sum of $25,000 was made available for experimental work on parasites of gypsy and brown-tail moths. Thus according to Superintendent Kirkland the money expended by the state, by towns and individual owners in the work of suppressing the gypsy and brown-tail moths in Massachusetts in 1907, amounted to a total of nearly three-quarters of a million dollars.

Introduction of Parasites.

Many species of parasites of gypsy and brown-tail moths have been introduced into Massachusetts by Dr. L. O. Howard in coöperation with Mr. Kirkland. Dr. Howard has made three annual trips to Europe and enlisted the aid of European entomologists in the work of collecting parasitized material and sending it to this country. Parasites have been reared from this material at Mr. Kirkland's laboratory, and all hyperparasites destroyed before liberating them. The prospects for relief from this source are most promising, but it will be several years, perhaps, before the value of these parasites can be determined as a control measure. In the meantime, the other work should be continued, until it has been shown that the natural enemies alone are able to reduce the number of gypsy and brown-tail moths so materially that little or no damage will be done to property by them.

Present Conditions and Necessary Work for the Future.

The preceding pages give an account of the work which has been done in Stonington during the past year. What then are the conditions as they exist at present, and what is the outlook for the future?

About twice as great an area as is now infested or nearly two square miles has been cleared of brush, except that in some cases the season's growth has not been cut. Most of the neglected apple and other fruit trees have been pruned, scraped, and the cavities filled. The pest is well under control, though not yet exterminated. The conditions for exterminating the gypsy moth in Stonington are therefore much better than at any time since the infestation was discovered. But the work must not stop here. Trees must be banded for at least two years more, extreme thoroughness must be practiced in scouting for egg-masses and destroying them and in hunting for caterpillars both inside and outside of the present area known to be infested.

If funds are available, we shall prosecute the work along the most promising lines until the pest has been exterminated from within the borders of the State of Connecticut.

It should be borne in mind, however, that this work being done by the state is experimental, and is for the purpose of exterminating a dreadful pest from a small area. If the gypsy moth ever becomes widely distributed in Connecticut it will of course be necessary to enact laws compelling property owners to clean up their own land as is the case in Massachusetts.

THE BROWN-TAIL MOTH.

Euproctis chrysorrhaea Linn.

In the report of this station for 1902 (second report of state entomologist), page 165, is given a brief account of the brown-tail moth. The insect is also treated in Bulletin 153, issued in March, 1906. Though the brown-tail moth has not yet been found within the state, we may reasonably expect that it will appear in a few years at the most. It has been a companion pest of the gypsy moth in Massachusetts, New Hampshire and Maine, and in all of the states where suppression laws have been enacted for the latter pest the brown-tail moth has been included. The latter spreads much more rapidly, however, because the female can fly, and it has a different life history. Different combative measures are therefore necessary. We can exterminate the gypsy moth from small isolated areas, but not so with the brown-tail, though we can hold it in check, and nature supplies more effective controlling agents in the way of insect and fungous parasites than in the case of the gypsy moth. During the spring and summer of 1906 thousands of caterpillars in Massachusetts were killed in their nests by a fungous disease, thus materially checking the pest. This fungus, according to Kirkland,* was examined by Dr. G. E. Stone, botanist of the Agricultural College at Amherst, and pronounced *Empusa aulicae* Reichardt, a species common in Europe and often serving there as an important check to the outbreaks of the brown-tail moth.

Distribution of the Brown-Tail Moth in America.

First noticed in Somerville, Mass., about fifteen years ago, this insect was supposed to be some native species, but as it increased in abundance it was brought to the attention of entomologists in 1897 and pronounced the brown-tail moth, a European pest which had doubtless been introduced into this country by accident. A special appropriation was granted the Gypsy Moth Commission for fighting this insect, but all work of the commission was discontinued in 1900 because the legislature refused to grant further appropriations. Since then the brown-tail moth

*Second Annual Report of the Superintendent for Suppressing the Gypsy and Brown-Tail Moths in Mass., p. 127. 1907.

has spread rapidly toward the north and east. In Massachusetts the entire eastern portion is infested nearly as far west as the Connecticut River valley. The insect is reported from Pawtucket, East Providence and Woonsocket, R. I., though it is not known what portion of the state is infested. The moth has been found in the entire southeastern portion of New Hampshire, even as far north as the White Mountains, and it has spread through the State of Maine into the Province of New Brunswick. So far it is not known to us that it has been found in Connecticut.

Habits and Life History.

The eggs are laid on the under side of the leaves during the latter half of July, in masses smaller and more elongated than

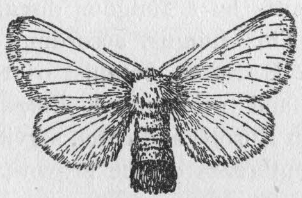


Fig. 1.—Female brown-tail moth.
(After Fernald.)

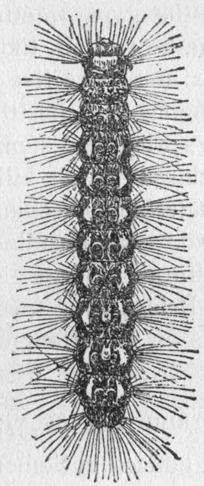


Fig. 2.—Caterpillar of brown-tail moth.
(After Fernald.)

those of the gypsy moth. They are also more reddish in color, but are covered with hairs in much the same manner, and contain about three hundred eggs each. See Plate XIV, a.

The eggs hatch early in August, and the young caterpillars feed gregariously upon the upper leaf surface, but soon begin to fasten a number of leaves together with silken threads which

they spin, forming a nest or web on the ends of the small branches. On the approach of cold weather, about 250 caterpillars enter each web, and remain there, about one-fourth grown, through the winter, coming out early in April and feeding upon the buds, and later the opening blossoms and leaves. The caterpillars (see Figure 2) become full-grown the last of June, and are between one and two inches long, dark brown in color with an interrupted white stripe on each side of the dorsum and two conspicuous red dots or tubercles on the posterior end of the body. Long hairs arise from tubercles along the sides of the body.

The cocoons are formed often in a bunch of leaves at the ends of the twigs. Two weeks is the length of the pupal or

Fig. 3.—Web or winter nest of brown-tail moth.
(After Fernald.)

chrysalid stage, and the moths emerge usually about the middle of July.

Both sexes are similar except that the female is larger, pure white, with brown hairs on the end of the abdomen, giving it the name of the brown-tail moth. The wing expanse of the female is about one and one-half inches. Both sexes fly at night, and are strongly attracted by electric lights. The adults, cocoons, winter nests and egg-masses are shown on Plate XIV. See also Figures 1, 2 and 3.

Food Plants.

Fernald and Kirkland give a list* of about eighty species of trees and plants on which the caterpillars are known to feed. The pear is the first preference of the caterpillars, followed by the apple and the stone fruits. Maples, elms and oaks are perhaps the chief kinds of shade and forest trees liable to be injured. As the gypsy caterpillars feed upon over six hundred different kinds of plants, it will be seen that the brown-tail is much more limited in regard to its food plants. Pear, apple and oak trees are stripped by the brown-tail caterpillars.

Irritation Caused by the Caterpillars.

The hairs of the caterpillars are barbed and brittle, and break off easily. When they come in contact with the human skin, they cause an irritation or rash which is quite serious with certain persons. The worst forms of rash are caused by actual contact with the caterpillars, but the broken hairs which blow about will cause the milder forms. The matter has been carefully studied by Dr. E. E. Tyzzer† of the Harvard Medical School, who finds in these hairs a definite poisonous principle which causes certain changes in the blood. The long hairs do not seem to possess this quality, but the short barbed hairs of the red dorsal tubercles are the ones chiefly responsible, though similar hairs occur with the long ones on various portions of the caterpillar, and on the posterior extremity of the body of the adult. In making the cocoon the hairs are rubbed from the caterpillar and woven into the new structure, and those from the adult female are worked into the formation of the egg-mass, so that either cocoon or egg-mass may produce the rash. Such hairs are doubtless cast with the skin when the caterpillars molt, and are often rubbed or broken off from their bodies and blown

* The Brown-Tail Moth, Mass. Board of Agriculture, p. 57. 1903.
† Second Annual Report of the Superintendent for Suppressing the Gypsy and Brown-Tail Moths, p. 154. 1907.

about, and coming in contact with the skin of human beings cause the brown-tail rash.

As a remedy for this rash Kirkland recommends the following, which should be well shaken together and rubbed thoroughly upon the affected parts:

Carbolic acid	½ drachm
Zinc oxide	½ ounce
Lime water	8 ounces

Methods of Control.

The best of all remedies against this insect is the destruction of the caterpillars in the winter webs or nests, which can be readily seen at the ends of the twigs throughout the winter. These should be clipped off with a long-handled tree pruner

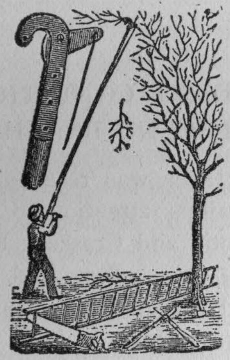


Fig. 4.—Tree pruner.

such as is shown in Figure 4, gathered and burned. The caterpillars are hibernating in these nests from October to April. It is of no use to cut off the nests and leave them on the ground, as the caterpillars may remain uninjured and in spring crawl back to the trees.

Spraying with poison is much more effective against this insect than against the gypsy caterpillar. Arsenate of lead at the rate of three pounds in fifty gallons of water is recommended for the young caterpillars, but this quantity should be increased to five pounds for the large or nearly full-grown caterpillars. Paris green at the rate of one pound in one hundred gallons may be used in place of arsenate of lead, but lime should be added to prevent injury to the foliage. Arsenate of lead causes no injury, and adheres to the foliage for a long time.

Caterpillars which are crawling about in great numbers on trees, fences, etc., should of course be destroyed. Sprinkling with kerosene, either pure or in an emulsion, or even with strong soapsuds, is of considerable value in destroying them.

Trees which are free from caterpillars may be kept so during the season by applying a sticky band to prevent the caterpillars from crawling up the trunk. Wherever the brown-tail moth becomes abundant, it must of necessity be held in check chiefly through the efforts of property owners in coöperation with town or city authorities. The problem does not require the same degree of care as is necessary in handling the gypsy moth, and therefore it is not as essential that it be done by competent men employed by the state.

MOSQUITO BREEDING CONDITIONS AT NIANTIC AND CRESCENT BEACH IN 1907.

On August 16th a letter was received from Mr. Anson T. McCook of Niantic, calling attention to the mosquito nuisance in the vicinity of Niantic and Crescent Beach, which had been worse this season than ever before, and expressing a desire to aid in abating it. By his request an examination was therefore made of the worst areas, Mr. Walden visiting the region on August 28th, and reporting as follows:

The examination here reported was made August 28th. The writer was accompanied by Mr. A. T. McCook, and the places visited were those suggested by Dr. Dart and Mr. McCook as being probable breeding areas. No attempt was made at a systematic examination.

The Fresh Water Problem.

Dodge Pond. A large fresh water pond situated a short distance west of Niantic village. The pond is partially divided into two sections. The small western section near the road is covered with lily pads, and owing to the unusual season is dry at this time. This drying up must have been gradual, leaving

numerous small pools in the uneven muddy bottom which were ideal breeding places for fresh-water mosquitoes, including *Anopheles.* Stones have been dumped along the shallow edge and are overgrown with low bushes and weeds. Mosquito breeding must take place along this edge at all times during a normal season. The large easterly portion of the pond contains water and is stocked with fish. While this part of the pond was not examined, there is much brush along the edge and the conditions are probably similar to those of the small pond.

To make Dodge pond safe I would suggest that the edge be made more abrupt by filling and that any brush growing near the edge in the water be removed, so as to insure a clean edge with no small pools that cannot be visited by small fish.

The *Pataguanset River,* west of the road at this point, was examined for a short distance. This stream has clean edges and should be free from mosquito breeding. About one hundred feet west and parallel to the river is a swampy area, apparently without good drainage. Draining this into the river would do away with a possible *Anopheles*-breeding area.

Middle Pond. This pond at Crescent Beach was examined. A driveway cuts it off from the salt water, but a large drain extends under the driveway, through which, I was told, the tide comes in. I was afterwards informed that there is a gate in the drain keeping the tide out and that the pond contains fresh water. Fish were numerous and no mosquito larvae were observed. If this is maintained as a fresh-water pond the edge should be watched more carefully than would be necessary if it was washed by the tide.

Lower Pond. A large fresh-water pond south from Middle pond. At the north end is a cat-tail and sphagnum swamp extending northward and then easterly around an area of higher land called the "Island" (?) and connecting with the Middle pond. The edge around the rest of Lower pond is clean and in good condition. A portion of the swamp along the east side was examined and no suspected breeding places were observed. Where the driveway crosses this swamp to reach the "Island" is a bridge over a small ditch which extends into the Middle pond. The ditch has long been neglected and consists merely of a series of small pools which were found to contain larvae of *Culex.* This drain should be opened at least from the bridge to the Middle pond. This would drain the low area east of the bridge, which is now in a soggy condition.

This section should be examined in a normal season to best judge the conditions.

The Salt Marsh Problem.

The east side of the Pataguanset marsh from the railroad south was viewed from the road and a section at the lower end was examined. Most of the small pools contained fish or were reached by the tide. No mosquito larvae were found.

The marsh on both sides of the bridge where the Old Black Point road crosses the Pataguanset river was examined. On the south side of the bridge and east of the river the marsh is in a very soggy condition. The old ditches are choked and there are numerous pools of standing water, nearly all containing large number of wrigglers of the salt marsh mosquito, *Culex sollicitans*. A short distance from the bridge a small point of the marsh extends inland. This area contains a number of depressions where the water has dried out, and the mud is covered with dead larvae. This place would probably be more serious in a normal season. It could be drained by cleaning out an old ditch which extends towards this point from the river, and continuing it for about one hundred and fifty feet. This marsh should be examined southward as far as the railroad, and where breeding is found ditches should be dug to the river.

The east side of the river north of the bridge is also in a serious condition and needs ditching. Many pools with a large number of larvae were found here. Further to the north the marsh extends around a point of land and reaches nearly to the road. This area contains several large pools with very few fish in them. Mosquito larvae were present in great numbers. An old choked ditch extending in from the river is not connected with any of these pools. It should be cleaned and extended for about one hundred feet. It will probably be necessary to dig two or three lateral ditches on each side of this main ditch to drain the area. The marsh west of the river was not examined but appears to be in a similar condition to that on the east side.

The ditches recommended for draining this marsh should be from six to twelve inches wide and about two feet deep. Good drainage should be secured by placing the ditches one hundred feet apart. Without taking any measurements, I should judge that about one thousand feet of ditch would be required to drain the area examined. There are already a few ditches which could be cleared and deepened. Probably a good laborer could put the area in a safe condition in about eight or ten days.

The mosquito larvae found in these various pools were about full-grown, and to destroy these I would recommend the use of kerosene oil. This can be applied with a watering pot having a fine rose.

Mr. McCook soon oiled the worst areas, with satisfactory results, but no draining was attempted. It is usually possible, by the expenditure of moderate sums of money in draining and filling, to do away with the wholesale breeding of mosquitoes. The inhabitants of each neighborhood should coöperate to make the locality as attractive as possible—and one of the first things to be done in each settlement along the Connecticut coast is to abolish the pools of stagnant water where mosquitoes breed. If permanent ditching cannot be started, oiling the pools will afford temporary relief, but in order to be effective it should be repeated once in ten days or two weeks during the mosquito season.

THE CHEMICAL COMPOSITION OF LEAD ARSENATE AND PARIS GREEN.*

By John Phillips Street.†

The constantly increasing use of insecticides in various spraying mixtures makes the effectiveness and the cheapness of the poisons used a matter of considerable practical importance. Paris green has been more commonly used for many years than any other arsenical insecticide, and has proved very effective. There is, however, a certain serious objection to its use; the partial

* This paper, with the directions following it by Mr. Britton, was printed as Bulletin 157 and distributed in September. It is here placed in more permanent form with slight emendations.

† The analyses of Paris green have been made by Messrs. E. M. Bailey and E. J. Shanley; those of lead arsenate by the writer.

solubility in water of the arsenious oxide, which frequently causes damage to foliage. For this reason entomologists have sought a different poison, which would be effective against insects, harmless to plants, and economical for the farmer to use. Lead arsenate seems to meet these requirements, and possesses a still further advantage over Paris green in that its mechanical condition keeps it longer in suspension in the spraying mixture. There are a number of brands of this material on the market, varying greatly in appearance and consistency, and it was considered advisable to make a somewhat extended chemical examination of them to determine their relative value. As the various brands of Paris green on sale in this State had never been analysed at this station, they also have been included in this examination.

METHODS OF ANALYSIS.

In the analysis of lead arsenate the method proposed by Haywood* has been followed in all particulars, and has proved very satisfactory. With Paris green the same methods as used by the writer† in a similar examination at the New Jersey Station have been followed. In addition, however, a test of the water-solubility of the arsenious oxide was made by the official A. O. A. C. method,‡ treating the green with distilled water for ten days.

LEAD ARSENATE.

Ten of the eleven samples analysed were taken from the museum stock of Dr. Britton, the State entomologist, but were recently acquired and were believed to be representative; the duplicate sample of Swift's arsenate was bought in the open market. The samples were received in containers of various sizes and material, from a one-pound glass jar to a fourteen pound wooden bucket. The material itself showed striking differences in consistency. Disparene settled out completely, leaving a supernatant liquid filling from one-fourth to one-third of the vessel; the Target brand and Swift's also showed some separated liquid, while the others were more of the consistency of putty and quite homogeneous.

The samples analysed were as follows:

* U. S. Dept. of Agr., Bur. of Chem., Bull. 105, 165.
† New Jersey Expt. Station, Bull. 195.
‡ U. S. Dept. of Agr., Bur. of Chem., Circ. 10, 3.

19210. Eagle Brand. Adler Color & Chemical Co., New York.

19212. Target Brand. American Horticultural Distributing Co., Martinsburg, W. Va.

19211. Disparene. The Bowker Insecticide Co., Boston, Mass.

19216. Star Brand. Fred. L. Lavanburg, New York.

19215. Anchor Brand. Leggett & Bro., New York.

19213. Swift's Arsenate. Merrimac Chemical Co., Boston, Mass.

18703. Duplicate of No. **19213**, purchased in market.

19643. Arsenate of Lead. Monmouth Chemical Works, Shrewsbury, N. J.

19357. Arsenate of Lead. The Powers-Weightman-Rosengarten Co., Philadelphia, Pa.

19358. Aiboneta. Schoonmaker & Son, Cedar Hill-on-Hudson, N. Y.

19209. Arsenate of Lead. The Vreeland Chemical Co., 123 Maiden Lane, New York. (Factory at Little Falls, N. J.)

ANALYSES OF ARSENATE OF LEAD.

Station No.	Brand.	Original Material.						Water-Free.		
		Water.	Arsenic Oxide (As_2O_5).	Lead Oxide (PbO).	Soluble Impurities (other than As_2O_5 and PbO).	Insoluble Impurities (by difference).	Soluble Arsenic Oxide.	Arsenic Oxide (As_2O_5).	Lead Oxide (PbO).	Total Impurities.
19210	Eagle	54.55	14.89	28.46	0.32	1.78	0.46	32.76	62.62	4.62
19212	Target	50.30	12.30	34.03	2.73	0.64	1.31	24.75	68.47	6.78
19211	Disparene	46.47	13.87	35.11	4.34	0.21	0.39	25.91	65.59	8.50
19216	Star	50.57	12.64	35.63	0.47	0.69	0.51	25.57	72.08	2.35
19215	Anchor	35.59	17.11	44.05	2.02	1.23	0.86	26.56	68.39	5.05
19213	Swift's	49.95	14.91	33.08	0.80	1.26	0.57	29.79	66.09	4.12
18703	"	48.40	15.19	33.78	0.88	1.75	0.30	29.44	65.47	5.09
19643	Monmouth	58.44	11.29	25.59	1.41	3.27	0.50	27.17	61.57	11.26
19357	Powers-Weightman	51.79	11.42	33.70	2.69	0.40	0.22	23.69	69.90	6.41
19358	Aiboneta	41.95	11.72	37.90	7.94	0.49	0.42	20.19	65.29	14.52
19209	Vreeland	33.65	21.91	41.44	0.74	2.26	0.86	33.02	62.46	4.52

RESULTS OF ANALYSES.

The analyses show lead arsenate to be far from a uniform material; the arsenic oxide ranges from 11.29 to 21.91 per cent., and the lead oxide from 25.59 to 44.05 per cent. The soluble arsenic oxide was low in all cases, ranging from 0.22 to 1.31 per cent., and this after a treatment for ten days. No soluble lead oxide was found in any of the samples. The nature of the impurities was not determined in any case; **19210, 19358, 19643** and **19357,** however, showed traces of nitrates. The impurities were not high except in three samples, **19211, 19643** and **19358;** neither Disparene nor Aiboneta was sold as pure lead arsenate and therefore cannot be considered adulterated; the Monmouth sample, however, was sold as a pure material; in addition to its high content of impurities, it also contains the lowest percentages of both arsenic and lead oxides.

Lead arsenate is usually prepared by the action of lead acetate on disodium arsenate; some manufacturers, however, substitute lead nitrate for the acetate. Smith* has shown that the commercial grades of sodium arsenate and lead acetate and nitrate vary considerably. He found the lead oxide in lead acetate varied from 58.81 to 66.80 per cent., and in lead nitrate from 66.37 to 68.37 per cent.; while in sodium arsenate the arsenic oxide varied from 36.77 to 47.80 per cent. The calculation of the theoretical composition of commercial lead arsenate is, therefore, attended with some difficulty. Haywood,† however, has shown that, with pure chemicals, where lead acetate is used the theoretical composition should be 74.40 per cent. lead oxide and 25.60 per cent. arsenic oxide; and where lead nitrate is used, 64.26 and 33.15 per cent., respectively. The methods used in the above analyses give results very close to theory where the lead arsenate is prepared from lead nitrate, but where lead acetate is used slightly higher than theory for arsenic oxide and slightly lower for lead oxide, indicating that probably some secondary reaction takes place during the process of manufacture, resulting in the formation of some compound other than lead arsenate, probably an acid lead arsenate. By referring to the analyses of the samples on the water-free basis, it appears that **18703, 19209, 19210, 19213** and **19643** are made from lead nitrate, the others from lead acetate. Formerly it was the practice to add glucose to increase the adhesive power of the arsenate, but it has been shown that it adheres almost as well without glucose as with it, and its use has been largely discontinued.

* Agr. Massachusetts, 1897, 357–369.
† U. S. Dept. of Agr., Bur. of Chem., Bull. 105, 168.

Allowing for the variations in process of manufacture, it would seem, however, that the content of arsenic oxide in the various commercial lead arsenates was conditioned more by the wetness of the material than anything else; the content of water in the samples analysed ranged from 33.65 to 58.44 per cent. A perfectly dry material has not been found advantageous, for while even in such a form it remains in suspension several times as long as the finest Paris green, it settles about three times as fast as when the arsenate is used in the form of a paste. On the other hand, the paste must not be too tenacious or it will be difficult to break up and distribute evenly throughout the spraying mixture. Colby* has found this objection to hold with Disparene. In making the water-soluble determinations it was observed that there were marked variations in the rate of settling even when the samples were in the dry and powdered condition. It is probable that the same peculiarity would have been noted in the samples in their original state, but as in most cases the whole sample had already been dried, verification of this supposition was impossible.

HOME-MADE LEAD ARSENATE.

It has frequently been recommended that farmers prepare their own lead arsenate as they need it. Colby† recommends the following formula: Dissolve 24 oz. of lead acetate or 20 oz. of lead nitrate in one gallon of cold water; also separately dissolve 10 oz. sodium arsenate in three quarts of water, both solutions to be made in wooden vessels. Pour the separate solutions into the spray tank containing from 100 to 150 gallons of water; a white precipitate of lead arsenate immediately forms. This preparation may be made several times stronger without the least danger of injury to the foliage. The freshly precipitated home-made arsenate seems to keep in suspension better than even the best commercial preparations.

COST OF LEAD ARSENATE.

As stated before, only one of the samples was bought in the open market; the prices have therefore not been affixed in any case. By correspondence with the manufacturers the Station

* California Expt. Station, Bull. 151.
† Loc. cit.

received quotations as follows: In 100 lb. kegs, from 9.5 to 13 cents per lb.; in 5 to 20 lb. buckets, from 11 to 16 cents per lb.; and in 1 lb. cans from 11.5 to 17 cents per lb. The advantage of purchasing in quantity is apparent.

ITS ADVANTAGES.

Lead arsenate is very effective against leaf-eating insects. Its chief advantages over Paris green are its greater adhesive power and its harmlessness to the foliage. A single treatment of lead arsenate will adhere to the foliage for a period during which two or three sprayings with Paris green would be necessary to secure the same effect. The insolubility of its arsenic makes possible the use of large quantities without danger even in inexperienced hands. From the standpoint of effectiveness lead arsenate, although containing but from one-third to one-fourth as much actual arsenic as Paris green, is nearly as economical as the latter poison when sold at the same price. Purchased at the wholesale quotations noted elsewhere, and considering the duration and safety of its action, it is actually somewhat cheaper than Paris green. Furthermore, its greater power of suspension makes it more easily used and insures a more uniform distribution of the poison over the plant.

PARIS GREEN.

There is no law in this State regulating the sale of Paris green, but where a state inspection is in effect the requirements are generally very similar to those in the New Jersey law,* section 3 of which reads:

"Paris green, or any product analogous to it, when sold, offered or exposed for sale as such, in this State, shall comply with the following requirements:

"First. It shall contain arsenic, in combination with copper, equivalent to not less than fifty per centum arsenious oxide.

"Second. It shall not contain arsenic in water-soluble forms equivalent to more than three and one-half per centum of arsenious oxide."

Many analyses of Paris green have been made by the various Experiment Stations, showing the green to be of variable composition. These variations are chiefly due to different methods of manufacture or carelessness in carrying out the same. In many cases a large amount of the arsenic exists as free arsenious

* New Jersey Expt. Station, Bull. 195.

oxide, which may arise from intentional addition of white arsenic, as well as from careless manufacture. This is a serious adulteration, for white arsenic is a cheaper material, and its solubility in water renders its presence in anything but small quantities a source of much danger to foliage from scorching. Other adulterations have been detected, but the one just referred to is the most prevalent and most objectionable.

Paris green is essentially copper aceto-arsenite, and, if pure, should contain an equivalent of 58.65 per cent. arsenious oxide, 31.29 copper oxide and 10.06 acetic acid. The commercial article, however, usually contains small quantities of moisture and sand and varying amounts of sodium sulphate.

Twelve samples, representing eight manufacturers, were purchased from dealers by the Station sampling agent. A description of these follows:

19481. Made by A. B. Ansbacher & Co., New York. Sold by Lyon & Ewald, New London.

18662. Made by A. B. Ansbacher & Co., New York. Sold by the Sisson Drug Co., Hartford.

18634. Made by E. J. Barry, New York. Sold by Odell's Pharmacy, New Britain.

18509. Made by E. J. Barry, New York. Sold by J. H. & W. E. Cone, Hartford.

18704. Made by James A. Blanchard, New York. Sold by F. S. Platt, New Haven.

19547. Made by Morris Hermann & Co., New York. Sold by D. B. Wilson Co., Waterbury.

18569. Made by Leggett & Bro., New York. Sold by Lockwood & Palmer, Stamford.

18508. Made by Leggett & Bro., New York. Sold by M. H. Mallett, New Milford.

18512. Made by I. Pfeiffer, New York. Sold by Frank M. West, Bridgeport.

18510. Made by C. T. Raynolds & Co., New York. Sold by H. K. Brainard, Thompsonville.

18511. Made by C. T. Raynolds & Co., New York. Sold by Danbury Hardware Co., Danbury.

18663. Made by The Sherwin-Williams Co., Newark, N. J. Sold by R. E. Page, Hartford.

ANALYSES OF PARIS GREEN.

Station No.	Manufacturer.	Cost of Package.	Weight of Package.		Arsenious Oxide. (As_2O_3).			Copper Oxide. (CuO).	Arsenious Oxide combined with copper.
			Claimed.	Found.	Total.	Water-Soluble. 1 day.	Water-Soluble. 10 days.		
		cts.	oz.	oz.	%	%	%	%	%
19481	Ansbacher	13	* 4	3.6	57.92	1.46	2.92	28.76	53.78
18662	"	10	4	4.0	57.44	0.97	2.44	29.49	55.15
18634	Barry	35	*16	14.5	57.23	1.71	6.82	29.55	55.26
18509	"	18	* 8	8.0	56.62	2.44	6.82	29.01	54.25
18704	Blanchard	10	4	5.0	57.03	2.44	7.31	28.14	52.62
19547	Hermann	18	* 8	7.6	56.20	2.44	4.87	28.54	53.37
18569	Leggett	10	* 4	3.6	60.61	5.85	10.72	27.15	50.77
18508	"	20	8	7.3	56.83	2.92	8.77	29.34	54.87
18512	Pfeiffer	20	8	8.0	56.71	1.46	4.38	30.27	56.60
18510	Raynolds	28	*16	15.4	60.83	1.95	6.32	26.56	49.63
18511	"	10	* 4	4.0	61.19	2.44	9.74	27.15	50.77
18663	Sherwin-Williams	10	4	3.6	56.56	1.46	2.92	29.88	55.88

All the samples were carefully weighed with and without the container; one sample was overweight, four equalled the weight claimed, and seven were short weight. These shortages varied from 4 to 10 per cent., not large in any case, but indicating that the manufacturers' claimed weight is intended to include the weight of the container as well as the green itself, a practice without justification.

CHEMICAL ANALYSIS.

Total Arsenious Oxide. All the samples contained satisfactory amounts of total arsenious oxide, varying from 56.20 to 61.19 per cent. with an average of 57.93 per cent.; this average is only slightly lower than the equivalent of arsenious oxide contained in pure copper aceto-arsenite. Judging, therefore, alone from the content of arsenious oxide, it would appear that the Paris green on the market in Connecticut is of high quality. A definite decision as to the purity of the green, however, cannot be reached without considering also the amount of water-soluble arsenic present.

Water-Soluble Arsenious Oxide. Free arsenious oxide is always soluble in water, and the combined arsenic is liable to be

* Weight printed on label; in all other cases the weight is assumed from the size of package and price asked.

rendered soluble by prolonged treatment. Two methods for determining soluble arsenious oxide have been adopted provisionally by the Association of Official Agricultural Chemists, in one of which sodium acetate is used as the solvent, while in the other the green is treated with water for ten days. Investigations with these methods have shown that the sodium acetate method gives more closely the true percentage of free arsenious oxide, while the water-extraction method gives in addition some arsenic caused by the decomposition of the green by water. From a practical standpoint the portion of the green that is so loosely combined would in all likelihood soon break up and scorch the foliage quite as badly as would free arsenious oxide. The water-extraction method would seem, therefore, to indicate more accurately the probable effect of the green on foliage.

The provisional method of the A. O. A. C. requires treatment with water for ten days, but it has been pointed out that the usual practice among horticulturists is to mix the green with water not very long before they wish to use it. For this reason certain Stations, for instance New York, California and New Jersey, have adopted a one-day extraction period, which it is believed gives results more in harmony with actual practice. This Station has likewise adopted this method in the present work, and analyses by both the one-day and ten-day extractions are given in the table for comparison. The analyses clearly show that, if the ten-day method is to prevail as a standard, but three of the samples would fall within the usual legal limit of three and one-half to four per cent. of soluble arsenious oxide. With the one-day method, but one sample, **18569**, contains an excessive amount, 5.85 per cent. This sample varies greatly in composition from a duplicate sample from the same manufacturer, and under the microscope clearly shows the presence of white arsenic. The use of this sample would be exceedingly dangerous to foliage.

Copper Oxide. The amount of cupric oxide found in the samples varied from 26.56 to 30.27 per cent., with an average of 28.65 per cent. In pure copper aceto-arsenite the ratio of arsenious oxide to copper oxide is as 1.87 is to 1.00. This ratio is of value in assisting to determine whether white arsenic has been used to fortify the green, for arsenious oxide cannot be added without increasing the ratio. In the samples analysed, the ratio varied from 1.87 to 2.29; the high ratio shown in sample **18569** gives additional evidence of the presence of considerable quantities of white arsenic. The amount of arsenious oxide in combination with copper varied from 49.63 to 55.88 per cent., with one exception above the usual legal requirement of 50 per cent. In three of the samples the amount of arsenious oxide is more than 2.20 times that of the copper oxide, and the natural inference is that either arsenic has been added purposely or that the material has been carelessly manufactured.

A comparison of the water-soluble arsenic in Paris green and lead acetate emphasizes one of the chief advantages gained by using the latter insecticide. In lead arsenate from 0.22 to 1.31 per cent. was soluble in ten days, while in Paris green the solubility ranged from 2.44 to 10.72 per cent.

DIRECTIONS FOR THE USE OF LEAD ARSENATE AND PARIS GREEN AS INSECTICIDES.

Lead arsenate as an insecticide was first used in the work of the Gypsy Moth Commission in Massachusetts in the early nineties and it has since been employed in controlling nearly all of the leaf-eating insects, and has proved to be a valuable addition to our list of available arsenical poisons. When devoured by insects it is somewhat slower in its action than Paris green, and should therefore be applied earlier, before much damage has been done to the plants. On account of the excellent adhesive qualities of lead arsenate, it remains upon the foliage for a long time, while Paris green soon washes off if rains are frequent. Lead arsenate is gradually replacing Paris green as an arsenical insecticide, and especially during the past season the high price of the latter has induced many farmers and fruit growers to use lead arsenate. Paris green has been used to destroy leaf-eating insects ever since the Colorado potato beetle reached the Atlantic States. It is therefore the old standard remedy, and in many places is the only arsenical insecticide that can be purchased at the stores.

FORMULA FOR LEAD ARSENATE.

As lead arsenate is sold in paste form, and even when calculated as water-free contains less arsenic than Paris green, it is necessary to use a larger quantity by weight of the commercial

article to gain the desired end in spraying work. Lead arsenate can be used only in liquid form to be sprayed upon the foliage, and the usual formula is as follows:

Lead arsenate	3 lbs.
Water	50 gallons.

For sawfly larvae and some other insects that are easy to kill, one pound in fifty gallons may suffice, and in spraying to kill gypsy caterpillars five pounds in fifty gallons are the proportions considered the most effective. In spraying for elm leaf beetle larvae the poison should be directed against the under sides of the leaves. The amount of lead arsenate may be increased greatly without danger of injuring the foliage, and lime should not be added. Lead arsenate can be used in connection with Bordeaux mixture, though it is thought to be slightly less effective as an insecticide when used in this way.*

FORMULA FOR PARIS GREEN.

Paris green is put up in powder form and can be applied either dry or as a liquid. On account of the soluble acid which it contains (see page 328 of this report) there is always danger of "burning" the foliage unless some alkali is used with the poison. For this purpose lime is usually recommended, and the adhesiveness of the mixture is greatly improved by the lime. About three pounds of lime should be used for each pound of Paris green. If to be applied dry in a duster or powder gun, Paris green should be mixed thoroughly with air-slaked lime or land plaster in the following proportions:

Paris green	1 pound.
Air-slaked lime	100 pounds.

For use as a spray Paris green may be prepared as follows:

Paris green	1 pound.
Fresh quicklime	3 pounds.
Water	100 gallons.

In most orchards and potato fields Paris green is used in connection with Bordeaux mixture, and as this contains an excess of lime, no more lime is added.

* Tests made at this Station show that the presence of the Bordeaux mixture renders the lead arsenate perfectly insoluble. This perhaps may account for its lessened poisonous effect on insects.

THE HICKORY TUSSOCK MOTH.

Halisidota caryae Harris.

During the past two years this insect has been unusually abundant in Connecticut, and leaves of fruit and shade trees were eaten by the caterpillars. Late in the fall, solitary caterpillars nearly full-grown were found feeding upon the leaves of nursery, orchard and shade trees. I have not before seen this species so abundant during a residence of nearly fourteen years in Connecticut.

The eggs are laid early in June on the under side of a leaf in the form of a broad patch about an inch in diameter. The caterpillars are very small and gregarious at first, and may be easily mistaken for the larvae of the fall web-worm or several other species. As the larvae increase in size they take on characteristic markings with each molt, until next to the last molting stage they are very striking and pretty caterpillars, being covered with white hairs ornamented with spots of black. Near each end of the body there are two pencils of long black hairs and several tufts of long pure white hairs showing at both ends and along the sides of the body. Plate XV, a. shows this stage of the caterpillars, natural size. In the last caterpillar stage (see Plate XV, b.) the larva has a black stripe on the back, with the four pencils of black hairs as described above. The other hairs are white. The caterpillar is one and one-half inches long, and is very conspicuous and striking in appearance.

When fully grown it crawls under stones, fence rails, or into some other out-of-the-way corner, and spins a few silken threads, which together with its own hairs form a thin ash-grey cocoon, oval in shape, nearly an inch long and about one-half as thick. The cocoon is shown on Plate XV, c.

The adult moth measures nearly two inches from tip to tip of wings, and is shown on Plate XV, d. The fore wings are light brown, irregularly spotted with white and with darker lines along the veins. The rear wings are white.

Wherever the caterpillars are so abundant as to defoliate trees, the proper remedy is to spray with the arsenical poisons, either arsenate of lead or Paris green, according to the formulas given on page 331 of this report.

THE ROUND-HEADED APPLE BORER.

Saperda candida Fabr.

Young apple trees are often attacked at the base and seriously injured by borers. Even large trees are attacked, but do not become devitalized and show the effects of the work of the borer like the younger and smaller trees. Especially if the young orchard be isolated and surrounded by woodland is the attack liable to be severe.

Two kinds of borers are responsible for this kind of injury to trees,—the round-headed borer, *Saperda candida* Fabr., belonging to the family Cerambycidae, and the flat-headed borer, *Chrysobothris femorata* Fabr., which belongs to the family Buprestidae. The former is much more common in Connecticut, and we believe is the chief species attacking fruit trees. Neither species is confined to orchard trees, but lives in various native trees of the fields and woodlands, the round-headed borer being especially fond of the wild thorn, mountain ash, shad bush and chokeberry, and the flat-headed species attacking many of the larger shade and forest trees.

The round-headed apple borer is found throughout the United States and Canada, at least east of the Rocky Mountains. The adult is a long-horned beetle about three-fourths of an inch long, dark grey or brownish, with two straight white stripes or bands on the back running lengthwise of the body. These bands are not quite parallel, but join on the head and are furthest apart at the base of the wing covers, coming near together again at the apex. The antennae, legs and front of the head are white. The antennae are long and slender, as is characteristic with this family of beetles. This insect, with its characteristic injury, is shown on Plate XVI.

The eggs are yellow or pale brown, three times as long as broad and three times as broad as thick, and about one-eighth of an inch long. They are laid in incisions in the bark made by the ovipositor of the adult female, the eggs being placed lengthwise the trunk. The adults appear in June, July and August, most of the specimens in the station collection being taken in June. In Connecticut, therefore, the eggs are laid during these three months. The young borer tunnels just under the bark, working downward as far as possible before winter. Though inactive during the cold weather, it again begins operations in the spring, and burrows in the sapwood throughout the season, becoming about half-grown by the second winter. As it increases in size it does more and more damage to the tree because it is more voracious and active and makes larger tunnels through the wood. The next summer, when about three-fourths grown, it tunnels into the solid wood of the tree, and as it becomes full-grown works its way outward to the bark, making a circular hole as shown on Plate XVI. Remaining in the burrow unchanged through the winter, the larva transforms to a pupa in the spring and the beetle appears during the summer. About three years are therefore required for the complete transformations of this insect. Where several larvae are at work in the same tree they often girdle and kill it. The larva is white, with brown head and black jaws, and is about one inch long when full-grown. Usually the burrows are partially filled with particles of wood or castings from the excavations, and the pupating chamber is made of this material. Some of the castings are crowded or thrown out of the burrow, and form the principal evidence of the presence of the insect. This beetle and its work is shown on Plate XVI, where about twenty large galleries were made in the wood of the trunk of a quince tree.

Many remedies have been tried but most orchardists prefer to watch their trees and dig out the borers with a knife when found. Sometimes carbon bisulphide can be injected into the burrow from an oil can and the opening stopped with clay, soap, or wax, and the borer inside will be killed. External washes and other applications are of somewhat doubtful value, and the painting of the trunks is liable to cause great injury to the trees. Covering the base of the trunk with arsenate of lead may be of some value in keeping out borers, but this has not yet been thoroughly tested. It will adhere for a long time.

MISCELLANEOUS INSECT NOTES.

Pine Leaf Scale on Hemlock. On October 23d the writer examined a hemlock tree on the estate of the late J. M. Greist in Westville which was said to be dying. Several branches on

the south side of the tree were dead and leafless. Otherwise the tree appeared perfectly vigorous and the foliage was of a dark green color. Finally a few leaves were observed that did not look quite healthy, and they were found to be infested with the pine leaf scale *Chionaspis pinifoliae* Fitch. Some branches were considerably infested, and the dead ones may have been killed in this way. It was certainly difficult to find any other explanation. This insect was mentioned in Bulletin 151, page 11, and in the report for 1905, page 240, and shown on Plate II, c. It resembles the scurfy scale, and is found on the leaves of pine and spruce trees. It is becoming rather common in Connecticut, and has been observed on white pine seedlings at Windsor the past season. It has also been sent in from various parts of the state on other species of pines from cultivated grounds. I have seen no record of its occurrence on hemlock. The remedy is to spray with kerosene emulsion soon after the eggs hatch.

Willow Curculio. In Massachusetts, New York and Minnesota the willow curculio, *Cryptorhynchus lapathi* Linn., causes considerable injury to ornamental willow and poplar trees in parks and on private grounds. Previously, however, the insect has not been very common in Connecticut. On July 7th, 1905,

FIG. 5.—The willow curculio, twice natural size.

the writer collected a specimen of this beetle from a bunch of native willows (*Salix discolor*) at Torrington. The willows had been tunneled through and through by this insect, and though of no value, were ruined. In 1906, another species of willow at Guilford was observed to be likewise injured by this beetle. During 1907 several bunches of willows near New Haven have been killed outright by its attack. This beetle is one of the snout beetles or curculios, and is shown in Figure 5.

The Poplar Borer. While engaged in cutting and pruning trees to control the gypsy moth in Stonington, the men came across a poplar tree showing serious injury by borers. Chips or castings were falling from large galleries in the wood of the trunk. As the tree was of no value and was in such shape as to be a hindrance, it was removed. A section of the trunk was placed in a breeding cage and during August several specimens of the poplar borer, *Saperda calcarata* Say, emerged from the galleries and were killed and mounted for the collection. This beetle is one of the long-horned beetles closely related to the round-headed apple borer, and is of a mouse-grey color with yellow stripes and spots on the thorax and wing covers, and with fine black dots sprinkled over the wing covers. It is about an inch in length.

The Maple Borer. This insect, which is closely allied to the preceding, is causing serious damage to maple shade trees in Connecticut. A large proportion of the street trees in the cities and villages, as well as the shade trees along the country roads, show injury caused by this insect. The maple borer,

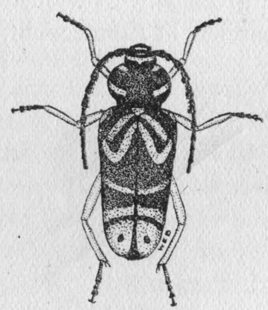


FIG. 6.—The maple borer, natural size.

Plagionotus speciosus Say, is a handsome black beetle with yellow markings, and is about an inch long. It is shown in Figure 6. The insect was studied many years ago, and the evidence gathered showed that three years are necessary for the species to develop from the egg to the adult stage, but the subject should again be investigated. The beetles emerge here usually about the first half of July, and probably soon lay their

eggs. The trees should be examined in the fall for the fine castings thrown out by the small larvae. Constant watching is the only safeguard, and where found, carbon disulphide will kill the insect if the burrow is stopped up so that the fumes cannot escape.

The Grape Vine Flea-Beetle. Beetles were received from Plantsville and from Danbury about the middle of May with reports that they were causing injury by eating holes into the buds, which had not then opened. This is a small dark blue beetle bearing the Latin name of *Haltica chalybea* Ill. Covering the buds with an arsenical poison like Paris green or lead arsenate will prevent injury.

The Elm Leaf Beetle. (*Galerucella luteola* Müll.) This insect was less abundant than in 1906, though made the subject of Bulletin 155, which was issued in May, 1907. This bulletin is not reproduced in this report, but will be sent to any address on application as long as the supply lasts.

An Injurious Myriapod. Specimens were received from Guilford and from North Haven of a small Myriapod or "thousand-legged worm" that had been feeding upon the roots of plants, causing considerable injury. At Guilford large buds of hardy bulbs had been attacked and destroyed by them. I have similar records of injury by this same species from Woodbridge and from Massachusetts. It was identified as *Julus hortensis* Wood, a species known to injure various plants, but apparently no experiments have been made with remedies and the literature contains few suggestions as to treatment.

A Fungus-Inhabiting Beetle. On December 7th a beetle was received from Watertown with the statement that it was found crawling about in the house. The beetle was *Boletotherus bifurcus* Fabr., a species known to inhabit shelf fungi which grow upon trees and logs. Probably a piece of fungus on fuel was brought into the house and the insect emerged from it.

The Bag-worm. This name is erroneously given to the common Tent caterpillar by many persons. The bag-worm *Thyri-*

dopteryx ephemeraeformis Steph. is an entirely different insect and is much more common in the southern states than here. Nevertheless it occurs here and is occasionally found feeding upon arbor vitae in the shore towns. Specimens of larvae with their bags of cases attached to fence posts were received from Cheshire.

The Rabbit Bot-fly. In September we received from Southport, large larvae which had been found under the skin of a rabbit below the neck. Though not familiar with this parasite I consulted Professor Osborn's paper on "Insects Infesting Domestic Animals" * and found that the larvae agreed with the description and figures of the rabbit bot-fly, *Cuterebra cuniculi* Clark.

* Bulletin 5, new series, Division of Entomology, U. S. Dept. of Agriculture, page 108, 1896.

ILLUSTRATIONS.

The illustrations in Part V of this report are from the following sources:

Plate XV a, from photograph by D. B. Pangburn.

Plates VII, VIII b, IX c, X, XI, and XII from photographs by G. H. Hollister.

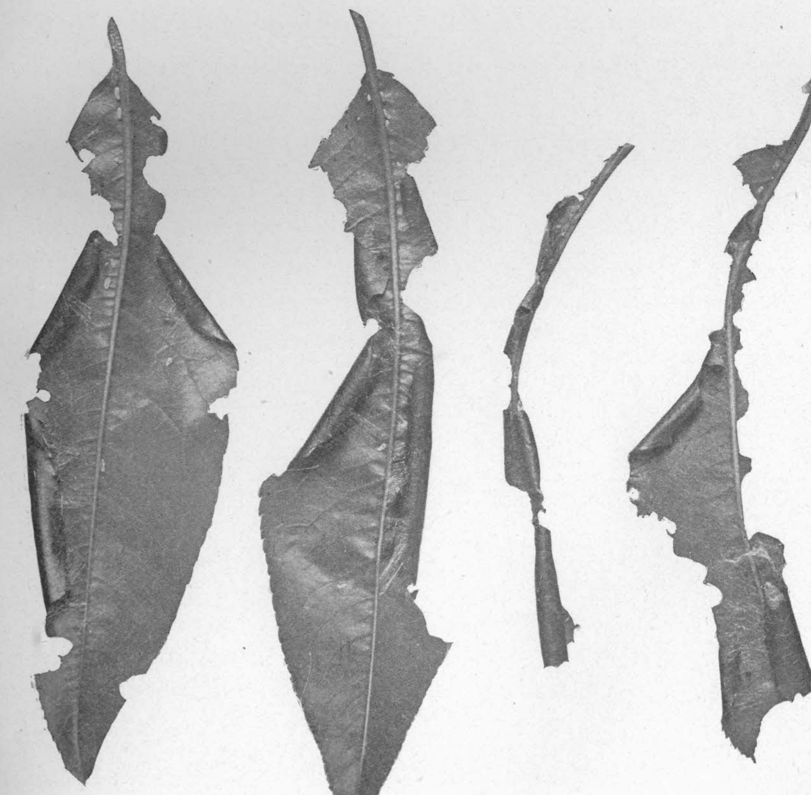
Plates VIII a, XIII b, XIV a, XV b, c and d from photographs by W. E. Britton.

Plate III b from drawing, and all other plates from photographs by B. H. Walden.

Text figures 1, 2, 3 and 4 are from Fernald, Special Bulletin Massachusetts Agricultural Experiment Station, 1897.

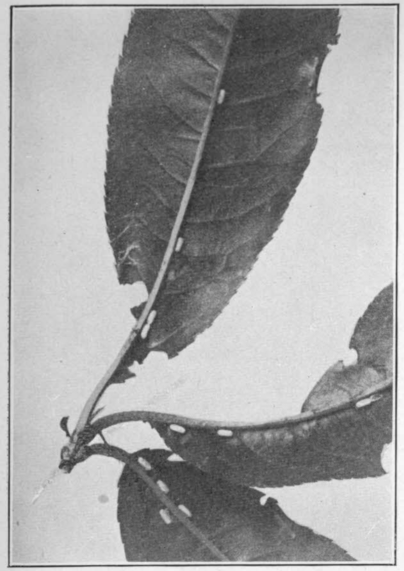
Figures 5 and 6 are from drawings by W. E. Britton.

a.—Twig partially defoliated by the larvae.

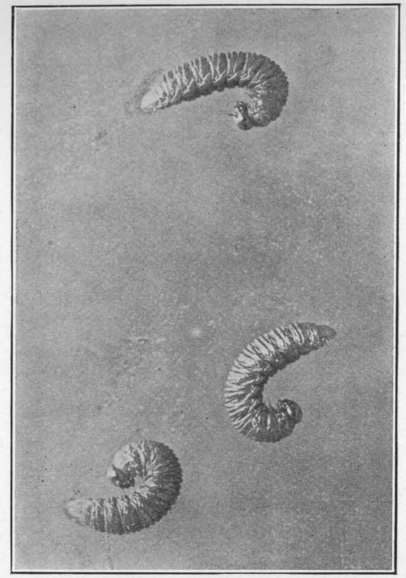


b.—Leaves eaten and rolled by the larvae. Natural size.

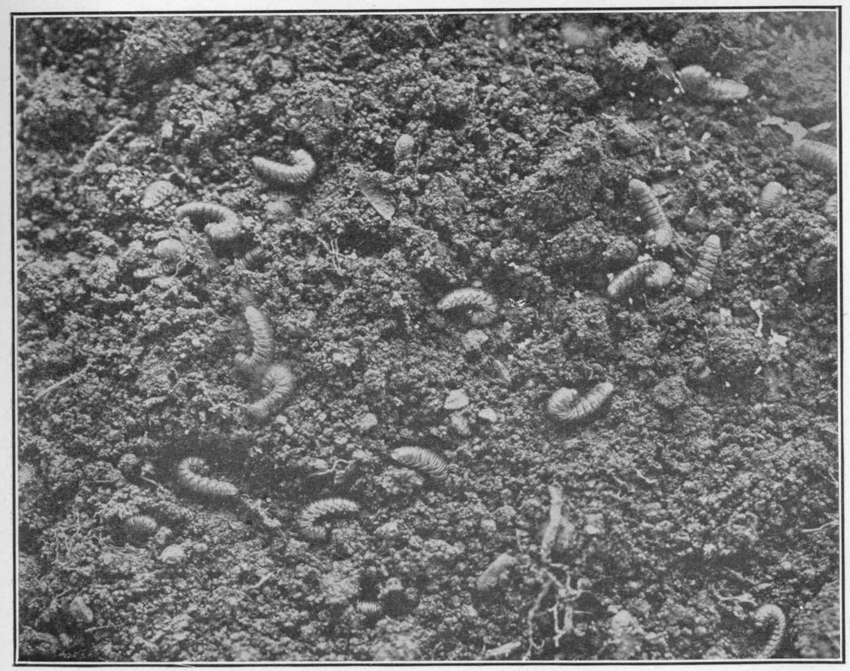
WORK OF THE PEACH SAWFLY.



a.—Eggs on the under-side of peach leaves. Natural size.

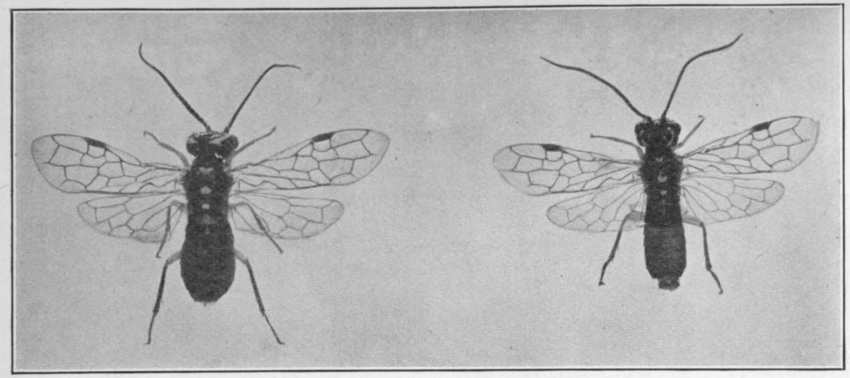


b.—Larvae. Twice natural size.



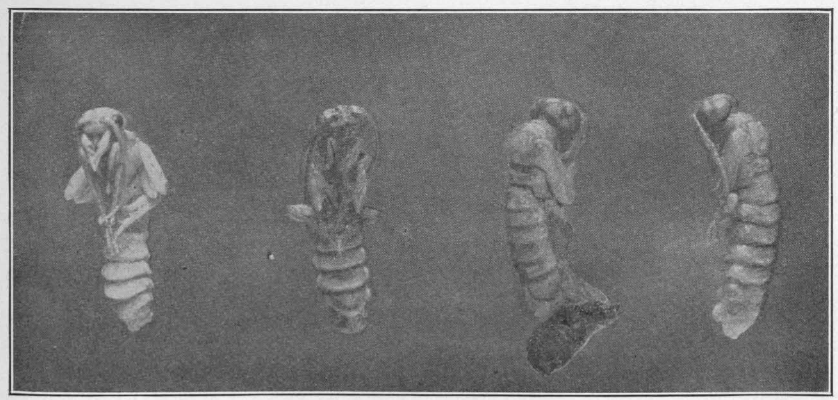
c.—Larvae taken from ground in spring. Natural size.

EGGS AND LARVAE OF THE PEACH SAWFLY.



a.—Adults, female at left. Twice natural size.

b.—Facial markings of the sexes, male at left. Greatly enlarged.



c.—Pupae. Twice natural size.

ADULTS AND PUPAE OF THE PEACH SAWFLY.

HOLES IN GROUND WHERE ADULT SAWFLIES HAVE EMERGED. NATURAL SIZE.

a.—General view of breeding cages.

b.—A near view showing side of breeding cage raised.

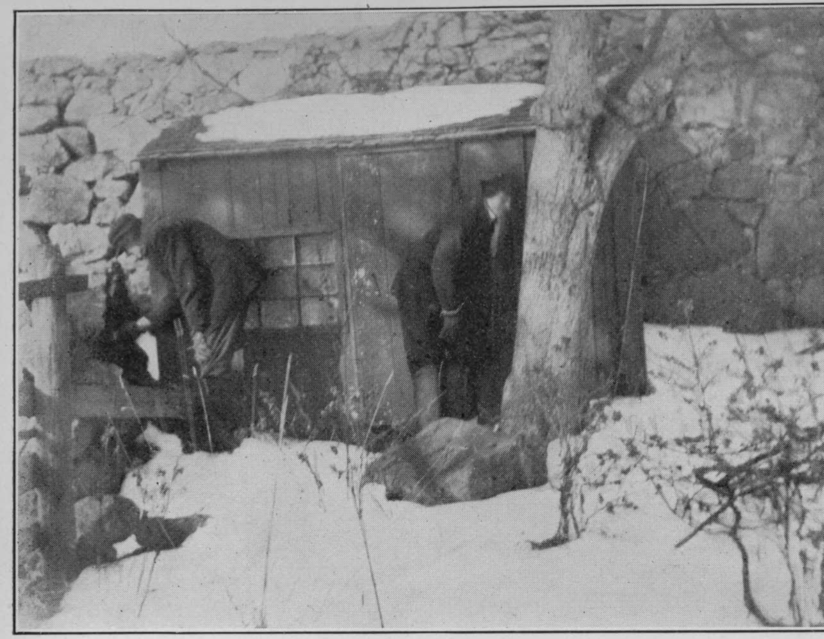
BREEDING CAGES USED IN PEACH SAWFLY EXPERIMENTS.

a.—Spraying peach trees with arsenate of lead and water.

b.—A peach tree partially defoliated.

SPRAYING PEACH TREES, AND VIEW OF DEFOLIATED TREE.

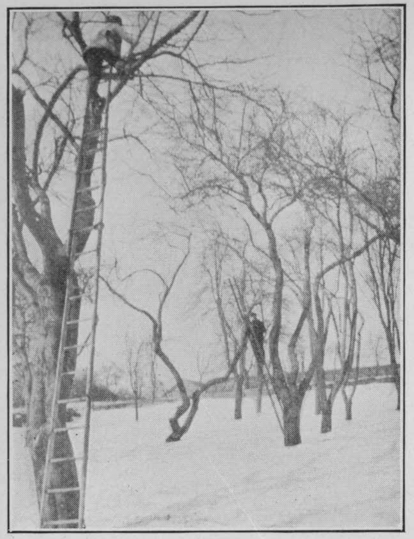
PLATE VII.

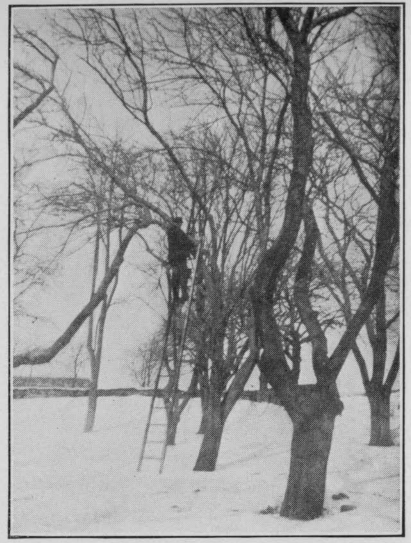


a.—Scouting for egg-masses.

b.—Treating an egg-mass with creosote.

DESTROYING GYPSY MOTH EGG-MASSES.





a.—Two views in Stanton orchard. Pruning trees and painting wounds.

b.—Thinning the top.

GYPSY MOTH WORK: PRUNING TREES.

a.—Gang of workmen cutting brush.

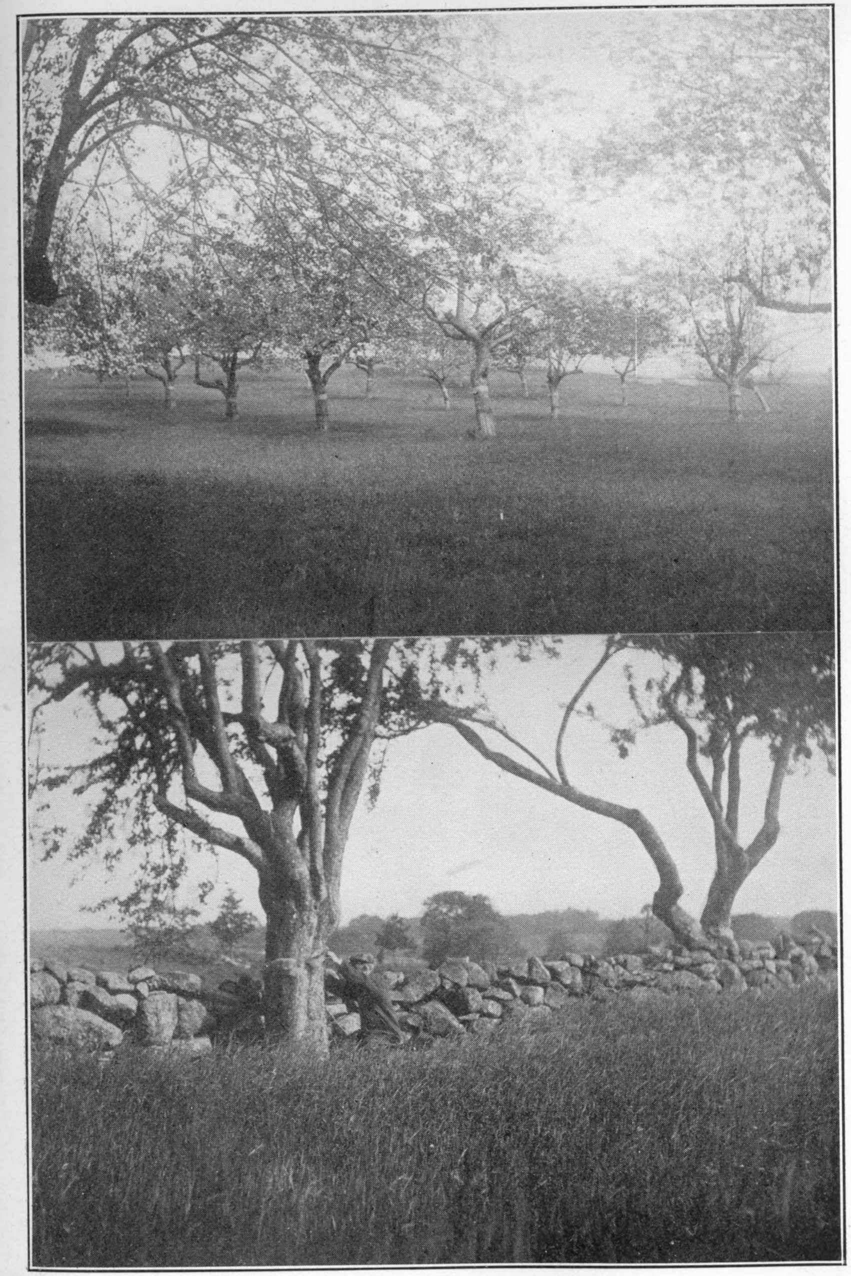
b.—Brush area cleaned up.

GYPSY MOTH WORK: CUTTING BRUSH.

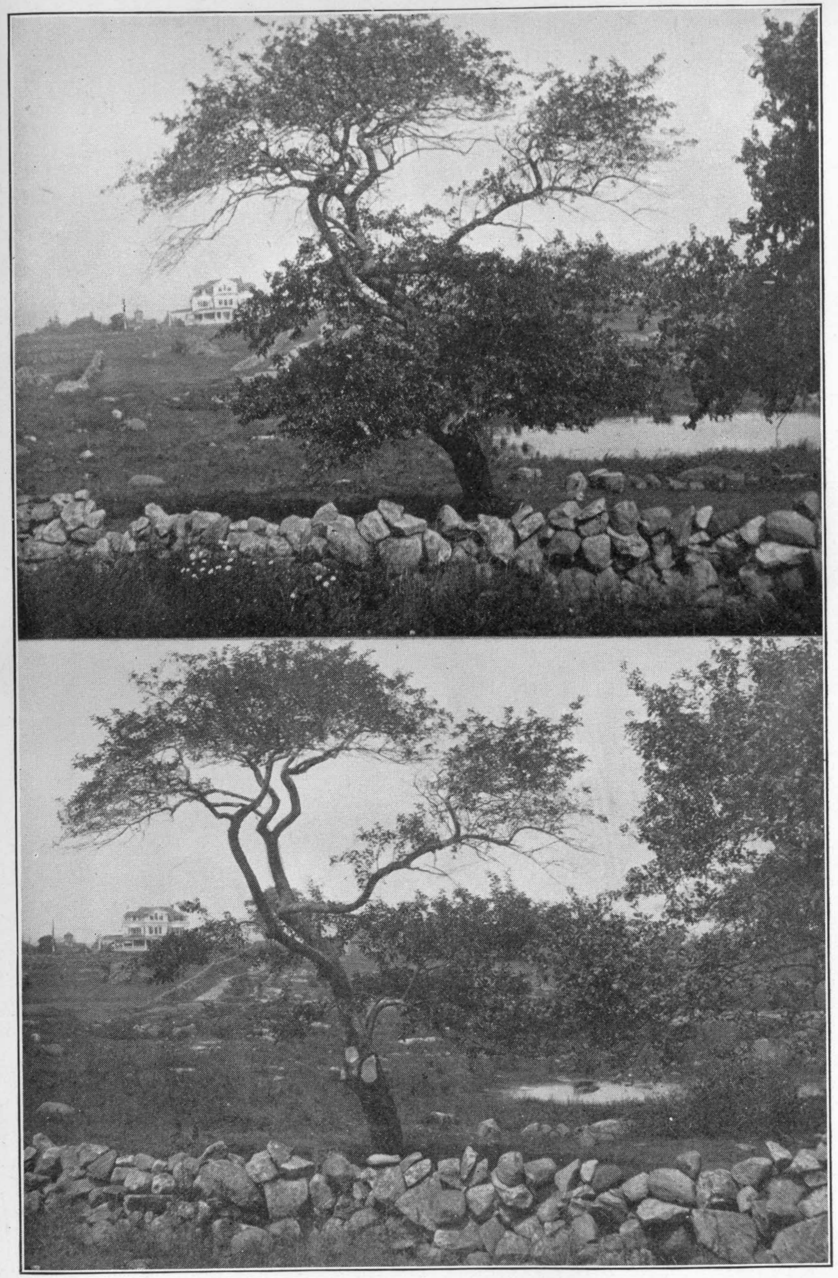
a.—Woodpile in which seven egg-masses were found.

b.—Method of applying burlap band.

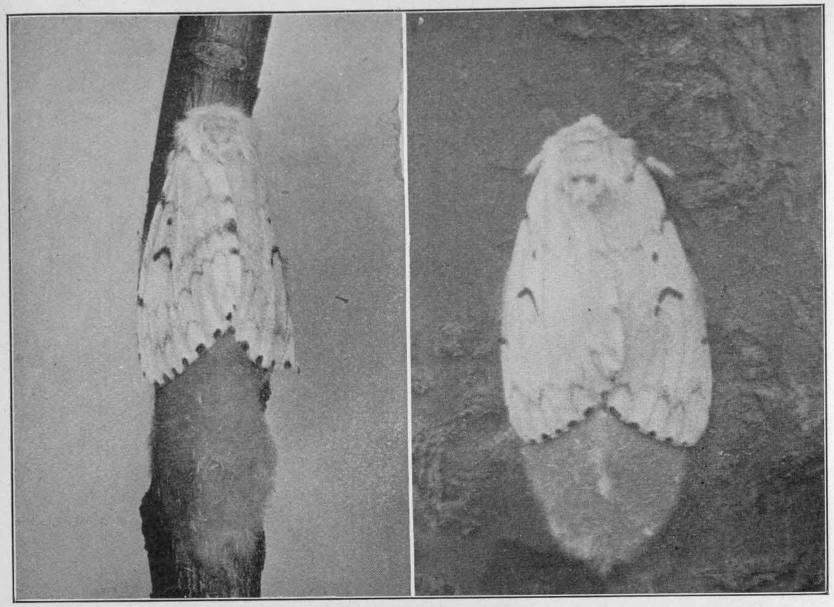
GYPSY MOTH WORK: INFESTED WOODPILE—BANDING A TREE.



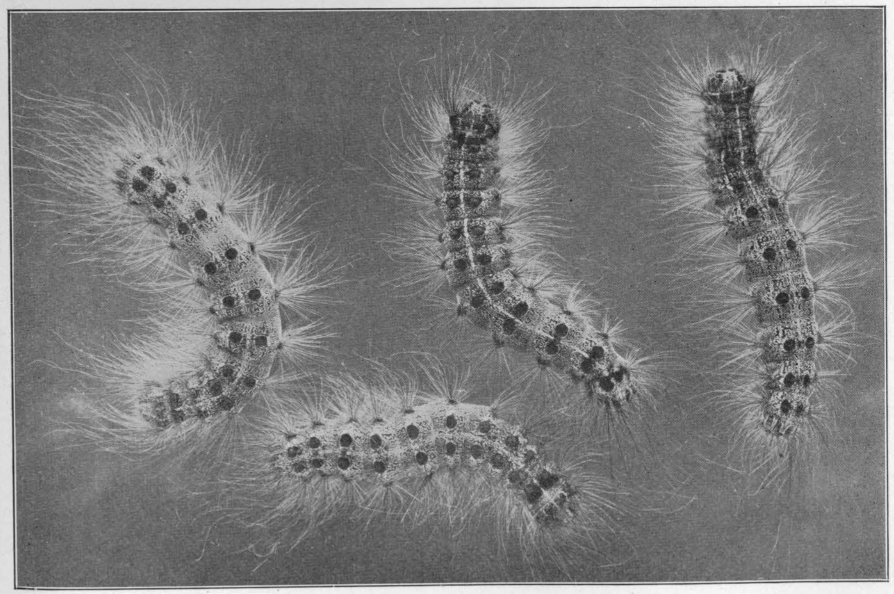
BANDED ORCHARD, AND WORKMAN EXAMINING A BAND TO DESTROY GYPSY CATERPILLARS.



GYPSY MOTH WORK: APPLE TREE BEFORE AND AFTER PRUNING, SCRAPING AND FILLING CAVITIES.

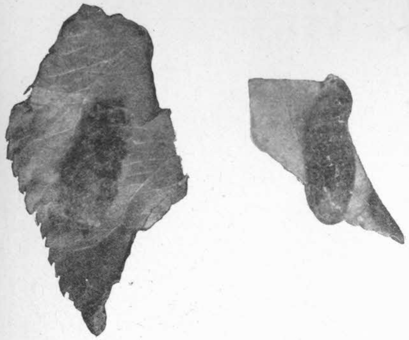


a.—Female moths laying eggs on bark. Natural size.

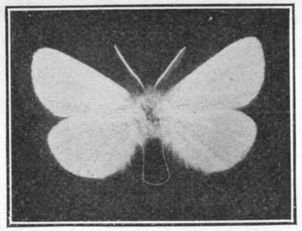


b.—Caterpillars photographed with black background.

GYPSY MOTHS, CATERPILLARS AND EGG-MASSES.



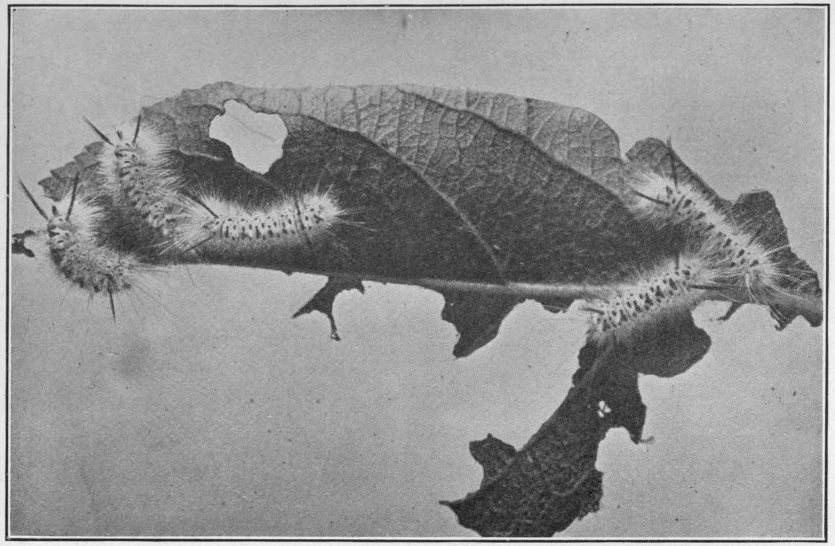
a.—Egg-masses on leaves. Natural size.



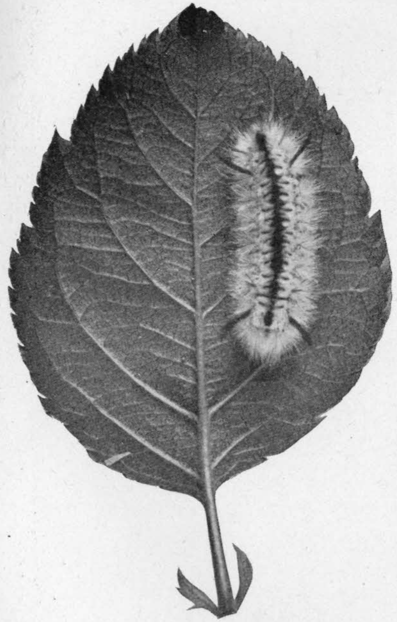
b.—Adult. Natural size.

c.—Winter nests. Natural size.

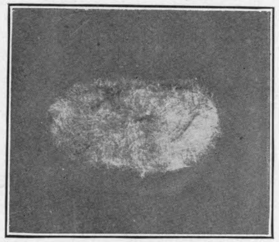
BROWN-TAIL MOTH. EGG-MASSES AND WINTER NESTS.



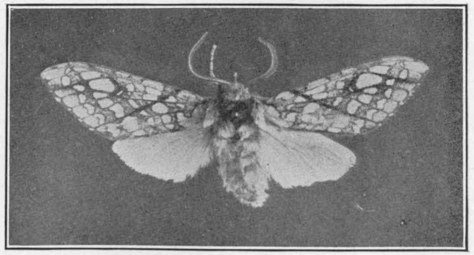
a.—Penultimate stage of caterpillars. Natural size.



b.—Fully-grown caterpillar on leaf. Natural size.

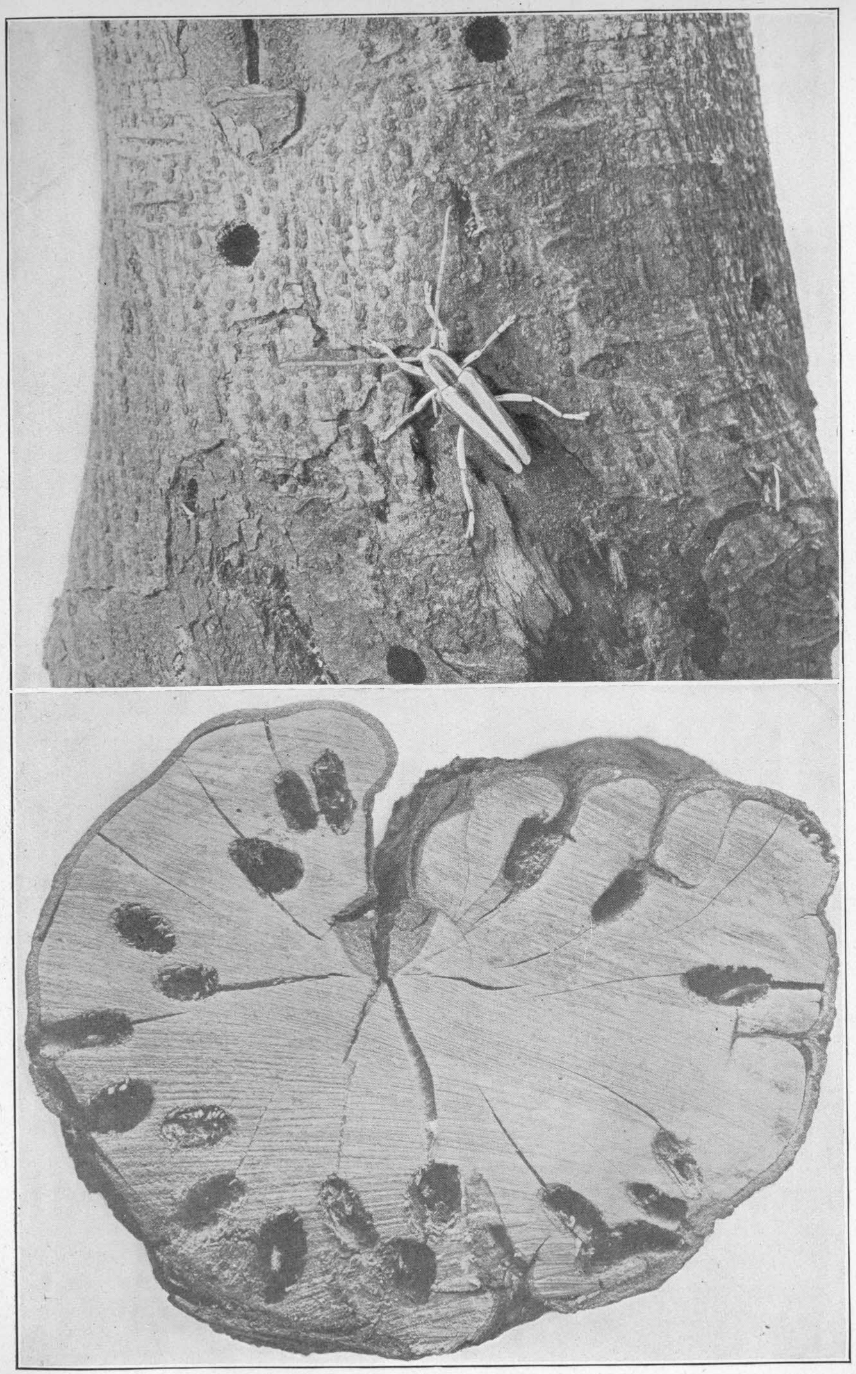


c.—Cocoon. Natural size.



d.—Adult. Natural size.

HICKORY TUSSOCK MOTH. COCOON AND CATERPILLARS.



THE ROUND-HEADED APPLE BORER AND ITS WORK. ALL NATURAL SIZE.

PART VI.

REPORT OF THE BOTANIST FOR 1907

G. P. Clinton, Sc.D.

I. NOTES ON FUNGOUS DISEASES, ETC., FOR 1907.

GENERAL NOTES ON DISEASES PREVIOUSLY REPORTED.

Weather conditions. Even more so than the previous year, 1907 was characterized by comparatively little injury to plants from fungous diseases. This does not mean that it was an excellent year for crops, for, on the contrary, it was an unusually poor one, since the conditions that proved unfavorable for serious attacks by fungi also prevented good plant growth. These unfavorable conditions were chiefly those of the weather. To begin with, there was some winter injury to the fruit buds, especially those of the peach, which, except in restricted localities, were largely killed before spring, so that the peach crop was a practical failure for the state. Some injury, too, was done to the young twigs, but there was no such serious injury to the trees in general, as was experienced during the winter of 1903-04.

The spring was very backward, so that up to the middle of May the work of the market gardeners was about a month behind the usual time. Coupled with the late spring were two unusual frosts on May 11th and May 21st, which did considerable damage to the exposed tender vegetation, and the blossoms developing at that time. Especially there should be mentioned frost injury to the unprotected early tomatoes, to strawberry and grape blossoms, and to the unfolding foliage of the sycamores.

Following this late spring came an unusually dry summer, including most of the months of June, July and August. The total rainfall for these months was only 5.49 inches, as compared with the average of 12.80 inches during the past thirty-four years, as shown by the records of the United States Weather

Bureau at New Haven. This drought was felt over the entire state, but was especially severe in certain districts, so that the yield of most of the crops was very materially decreased. The drought was not broken in the vicinity of New Haven until August 24th. Fortunately, the fall, both as to its length and the amount of moisture, proved fairly favorable for vegetation, so that crops which were not too severely damaged made good gains during this period. The more important of the previously reported fungous and physiological troubles of the year are briefly discussed under the following heads:

Apple. Little injury was done by either the *sooty blotch* or *apple scab*. On the other hand, the *fruit speck* trouble, first described in our Report for 1905, p. 264, was more conspicuous than usual. We have not been able to study this trouble further, so that the particular fungus responsible for it is still in doubt. Since our first report, we have had complaint of it from Pennsylvania and New Hampshire, and this year it was said to have caused very considerable damage in Maine. The writer was also told that it was a very common and injurious trouble with apples on the Boston market the past season.

Baldwin spot is another trouble that was more prominent than usual. It was seen on the Greening, and some fall varieties, as well as on the Baldwin. The fruit at storage time showed little of the trouble, though it soon began to develop, and continued evident up to the end of the season. The reddish-brown diseased spots often appear entirely within the flesh, but may work outward so as to form a slightly sunken discoloration in the epidermis, as shown in the illustration, Plate XVII, a. On cutting the apple, the tissue of these spots was often torn rather than cut sharply across, indicating a tougher or more spongy texture. Microscopic examination revealed no fungous threads or bacteria present. The cell contents were more or less disorganized, colored reddish-brown and in some cases there was more starch present than in the surrounding healthy tissues. Cultures, attempted both in December and February from isolated spots in the interior, gave absolutely no growth of any kind, thus confirming the results of previous investigators that this is not a parasitic trouble. After these spots reach the surface they may offer entrance for fungi causing true rot, especially that caused by the blue mold. The trouble seems to be physiological, and possibly bears some relationship to the weather, especially to drought such as was experienced the past season. It was suggested by one grower, whose apples were rather badly affected, that injury by the aphis, when the apples were quite young, might be the starting point of the trouble.

Market Garden Crops. Early in the season some of the cucurbits, especially the cucumber and muskmelon, suffered considerably from the *bacterial wilt*, but this did not progress, so that where the stand was sufficient the injury was not so great as was expected at first. *Onion brittle*, or something very similar to it, was more general all over the state than ever before, and some of the crops while quite young were very severely injured. Further study of the trouble did not throw any additional light upon its cause. The onion crop as a whole was fair, since seed onions suffered little, if any, from the *blossom blight*, and the *black spot* did little injury to the bulbs of the white varieties.

Tip burn was the only serious trouble of the potato; but this, because of the drought, was so severe that the crop was cut very short in many fields. There was practically no complaint of rotten tubers, and it was only after the most diligent search during the entire season that the *blight* fungus was finally found on a few green vines at Storrs and at this station about the first of October. In the fall, market potatoes from Maine, however, showed considerable injury from blight, and were seriously objected to by the buyers for a time.

During the drought the tomatoes suffered considerably from the *point rot* trouble, which was a frequent source of complaint by growers. After the drought it was less evident, which seems to indicate that it was a physiological rather than bacterial or fungous trouble. The Lima bean *mildew* was not seen during the whole season, though looked for in fields where frequently it is very troublesome.

Ornamental Plants. No very serious or unusual troubles of ornamental plants were found other than those reported under new diseases, except possibly *yellows* of asters and the *leaf spot* of the European horse chestnut, which was certainly unusually conspicuous after August. *Leaf scorch* injuries of shade and forest trees due to the drought were not uncommon.

Peach. The *leaf fall* trouble mentioned in our last Report, p. 317, was even more conspicuous than last year. A thorough examination was made of one of the orchards where it showed most prominently, and the trees were found with their wood severely winter injured, while those not suffering were free from winter injury. This winter injury, coupled with the severe drought, was, in our opinion, the cause of the trouble, especially in orchards where the soil could not be thoroughly tilled to conserve the moisture. *Yellows* is another trouble that showed signs of being greatly on the increase. One prominent grower estimates that fifty per cent. of the trees in the state are now infected with yellows. Mr. Waite, of the United States Department of Agriculture, states that Connecticut is at the northern end of an area reaching along the Middle Atlantic coast in which there is a very severe outbreak of this trouble. Whether or not the outbreak in this state is as severe as some suppose, remains yet to be seen, since the premature development of the buds last fall, taken as one of the signs, may have resulted from the wet fall following the prolonged summer drought.

Tobacco. There was some complaint, especially in the region of Granby, of injury to tobacco beds from the *root rot* fungus. Tobacco in the field finally did somewhat better than was expected after its injury by the drought, but upon curing, the quality was said to be below the average, and the price obtained was much lower than usual. There was again evident injury in certain fields near Suffield that could not be laid to the weather; and, so far as the writer could determine, did not seem to be entirely the work of the root rot fungus, but was possibly due to unknown soil conditions of a chemical nature.

DISEASES NEW TO THE STATE.

While this year developed few serious fungous outbreaks, at least the usual number of new diseases were found. About one-fourth of these troubles are of physiological rather than of parasitic origin, and such are indicated by italicized common names in the following accounts:

APPLE, *Pirus Malus.*

Spray Injury. Plate XVII, b. We have mentioned before (Report for 1903, p. 303) the ordinary forms of Bordeaux

injury, such as spotting of the leaves, and russeting of the fruit. Last December there were sent to the station, by Mr. E. A. Moore of New Britain, Baldwin apples that showed a form of injury which we had not seen before. These apples had been sprayed several times with Bordeaux and lead, the last application being made about the middle of August. When examined, the fruit still showed more or less of the spray in the stem and bloom ends. The injury consisted of small specks, as shown in the illustration, reaching but slightly beneath the epidermis, and clustered chiefly at the bloom and stem ends. Evidently some injurious ingredient of the spray had in time become dissolved and been carried into the tissues, probably through the lenticels or insect punctures, killing the cells with which it came in immediate contact. The damage resulting from this kind of injury is not nearly so serious as the more common forms.

BEAN, LIMA, *Phaseolus lunatus.*

Chlorosis. The past summer a trouble of Lima beans was seen on occasional plants that was somewhat similar in appearance to the calico of tobacco. It shows as a yellow mottling of the tissues, the chlorophyll usually retaining its normal color in the vicinity of the larger veins. Attempts to produce the same trouble on healthy plants by touching the leaves with juice from the diseased tissue, as can easily be done in the case of calico of tobacco, were not successful, thus indicating that the chlorosis is not of an infectious character. Just what conditions produce this trouble is not known, and, since not serious, it is chiefly of interest because of its general resemblance to the chlorosis of variegated plants.

BELLFLOWER, *Campanula rapunculoides.*

RUST, *Coleosporium Campanulae* (Pers.) Lev. Plate XXV. This rust was found in October causing some damage to plants in a New Haven nursery, where it had been noticed by the owner for a few years past. The uredinial or II stage is the one that does most injury, since this is chiefly influential in spreading the trouble. It shows as dusty orange outbreaks about the size of small pinheads scattered or clustered on the under side of the leaves. Sometimes there is a slight discoloration of the upper surface. The III stage occurs late in the season, as very small, slightly elevated, reddish, waxy areas also on the under side of the leaves. Kellerman has shown that the I stage of this fungus occurs on the needles of the pitch pine, from which it goes to the Campanula. The III stage carries it back to the pine. This fungus is further discussed in the last article of this Report.

BITTERSWEET, JAPANESE, *Celastrus articulatus.*

CROWN GALL, *Bacterium tumefaciens* Sm. & Towns. The above is a new host for the crown gall, at least for Connecticut. Dr. Britton found the infected specimens while inspecting a nursery in New Haven. The galls are so similar to those found on the peach and other hosts in this state that there is no reason for believing them different or caused by a different agent. New interest has been aroused concerning the crown gall because of the recent publications of Smith and Townsend (Science 25: 671-3. Ap. 1907. Centr. Bak. Par. Inf., II, 20: 89-91. D. 1907) of the United States Department of Agriculture, who seem to have proved that crown gall on its various hosts is caused by the bacterial organism named above instead of by a slime mold, as claimed by Toumey, the first extended investigator of the trouble. They were able to produce galls on peaches and a variety of other plants by inoculation with pure cultures of this bacterium obtained originally from galls on cultivated marguerite.

BLACKBERRY, *Rubus villosus.*

RUST, *Kuehneola albida* (Kuehn) Magn. This forms much less conspicuous and injurious outbreaks than the orange rust which attacks the same hosts. The II stage of the fungus was found at Storrs on leaves of the cultivated blackberry, but was not very prominent on these, being much more luxuriant on the wild swamp blackberry. However, it sometimes proves an injurious pest, as Stone of Massachusetts (Ann. Rep. Hatch Exp. Stat. 9:74. 1897) has reported a case in which considerable damage was done in 1894 to cultivated varieties in that state. The II or injurious stage shows as very small, yellowish-orange, dusty outbreaks on the under surface of the leaves. The final article of this Report contains further information concerning the fungus.

CHESTNUT, *Castanea sativa americana.*

CHESTNUT BARK DISEASE, *Diaporthe parasitica* Murr. Plate XVIII, a. Mr. F. V. Stevens, Jr., tree warden of Stamford, informs the writer that the chestnut disease, which has proved so serious in the vicinity of New York City and on Long Island, has become common in the neighborhood of Stamford. He also reports having seen the trouble in one or two other places in the state. Dr. Murrill, of the New York Botanical Garden, has carried on extended investigations during the past three years, and finds that a particular fungus is responsible for the injury. This fungus produces cankers in the bark, and in time becomes so general on an infected tree as often to kill it. While most injurious so far to the native chestnut, it also occurs on the chinquapin and the European chestnut, but has been found only occasionally on the Japanese.

Both Murrill and Metcalf, of the United States Department of Agriculture, who has also made a study of the trouble, take a rather alarming view of the danger to all chestnuts in infected regions. Mr. Metcalf (U. S. Dept. Agr. Bur. Pl. Ind. Bull. 121, VI. 1908) says: "Unless something now unforeseen occurs to check its spread, the complete destruction of the chestnut orchards and forests of the country, or at least the Atlantic States, is only a question of a few years' time." While the trouble is no doubt a serious one, we are inclined to believe that its power of spreading and the likelihood of its annihilating all the trees of infected regions, have been overemphasized. Spraying against the trouble seems not to have proved either practical or effective. Pruning off all diseased branches has not always been successful in freeing the trees of the disease, or if so, they have become re-infected through the wounds.

Whether or not the trouble is the same, serious injury to native chestnuts and chinquapins has been reported before from different parts of the United States. We quote the following from an article by Mr. Jones, of Georgia, which appeared in the *American Journal of Science and Arts,* vol. I, page 450, in 1846: "The present remarks are particularly directed to the death and disappearance of some of our trees and shrubs. The first that I will mention is the *Castanea pumila,* which is a tree from ten to thirty feet in height. In the year 1825, during the months from June to September, I observed this tree dying when in full leaf and with fruit half matured. I examined numerous individuals, and could find no internal cause for their dying. I at first attributed it to the great fall of rain which took place in the year 1823, for during the month of July of that year a considerable quantity of land, not subject to overflow, was covered with water for some time, and the highest lands were completely saturated. The latter part of 1824 was also very rainy. Knowing that this tree belongs in our highest and driest soils, I concluded that it was owing to a too moist state of the ground. But since that time I am convinced that there must be some other cause, for the tree continues still to die up to the year 1845, and if the disease is not arrested, in a few years I fear it will be entirely exterminated."

Dr. Mohr, writing more recently, 1901, in *Plant Life of Alabama,* says concerning the chestnut in that state: "The chestnut, usually one of the most frequent trees of these forests, is at present rarely found in perfection. The older trees mostly show signs of decay, and the seedlings as well as the coppice growth proceeding from the stump, are more or less stunted. It is asserted by the old settlers that this tree is dying out all over the mountainous region, where at the beginning of the second half of the century it was still found abundant and in perfection."

COW PEA, *Vigna sinensis.*

LEAF BLIGHT, *Cercospora Dolichi* E. & E. This fungus forms reddish subcircular or angular spots, about one-eighth to one-quarter of an inch in diameter, usually scattered over the leaves and showing through on both surfaces. With age these spots sometimes have a greyish center. By the aid of a hand lens the fruiting stage of the fungus can often be seen on the spots as an inconspicuous coating of very short olive-black threads. Two or three other species of Cercospora (*C. cruenta* Sacc., *C. Vignae* E. & E., *C. Vignae* Racib.) have been described on species of Vigna, or Dolichos, as it is sometimes called, which possibly may not be distinct from this. On some of these spots a species of Alternaria occasionally occurs, but perhaps only as a saprophyte.

LEAF SPOT, *Amerosporium oeconomicum* E. & T. A second fungus frequently appears on the same leaves with the preceding,

producing very similar spots. However, the latter can be distinguished in its mature state by having spots with a reddish border and whitish center in which the fruiting stage shows as minute black imbedded bodies. In the N. A. F. no. *2574,* on *Dolichos arvensis,* Ellis & Everhart issued a specimen which they named *Amerosporium Dolichi* E. & E. *n. s.,* which does not seem to be different from our species described by Ellis & Tracy three years before (Journ. Myc. 4: 102. 1888). These exsiccati specimens plainly show that the spores are septate (about three septa) when old, and the specimens collected in Connecticut also indicate that they would become septate with age. This may mean that the fungus belongs in a different genus, since the spores of Amerosporium are said to be continuous.

In the specimens collected at Storrs in September, besides the Cercospora and Amerosporium, the leaves also had numerous more or less elevated reddish spots or specks the size of a pinhead or less. While these may be the beginning of the fungous troubles already mentioned, they look very much like injuries caused by sucking insects. Altogether the spotting caused by these various agents becomes quite conspicuous, and causes considerable injury to the leaves.

CURRANT, *Ribes rubrum.*

BITTER ROT, *Gloeosporium rufo-maculans* (Berk.) Thuem. Plate XVIII, c. During the latter part of July, in a small plantation at Storrs, the white currant was found rather badly affected with a fungous trouble that caused the berries to gradually shrivel and dry up into wrinkled mummies. The fruiting stage of the fungus shows under a hand lens as minute black specks, frequently with a lighter center, but these may become obscured by the small masses of pinkish spores that ooze out on the surface. At the same place, but not necessarily on the same bushes, there was also found a small amount of anthracnose, *Gloeosporium Ribis* (Plate XVIII, b), that often attacks currant leaves. In passing it might be noted that Klebahn (Zeitschr. Pflanzenkr. 16: 65-83. 1906) has recently shown that this fungus is the conidial stage of *Pseudopeziza Ribis n. s.* that develops on the fallen leaves in the spring. At first it was believed that the fruit disease was also caused by this Gloeosporium, although it is not commonly reported on the fruit, Stewart, in Bulletin No. 199 of the N. Y. Exp. Station, being the only one known to the writer who has found it on the fruit and stems as well as on the leaves. Microscopic examination, however, showed that the spores from the berries and leaves were quite different in appearance. The spores from the leaves were chiefly 16 — 20μ by 5 — 6μ, and decidedly *curved*, being usually bow-shaped and often tapering to the ends; while the spores from the fruit were *straight*, less tapering, and somewhat narrower, varying chiefly from 14 — 22μ by 4 — 5μ. So similar are the spores to those of the bitter rot fungus, especially to grape rot mentioned in our last Report (1906, p. 314), that we have decided, at least for the present, to consider the fungus the same, though it has not before been reported on the currant as a host. We have found no other Gloeosporium mentioned as occurring on the fruit of currants, though *Gloeosporium ribicolum* E. & E. was described on the fruit of Ribes sp. (cultivated gooseberry). A few days after collecting the fungus at Storrs, the white currants on the Experiment Station grounds at New Haven were examined, and the fruit of these was found to be somewhat similarly injured. Microscopic examination, however, showed that in this case the Gloeosporium present was different, the smaller spores varying chiefly from 7 — 15μ by 3 — 6μ. As many of the shriveled berries showed no signs of this fungus, it is quite probable that it occurred here as a saprophyte, and the trouble was really due to some other cause, possibly the very dry weather. The spores of this fungus were similar to those of *G. ribicolum*, except slightly broader.

POWDERY MILDEW, *Sphaerotheca mors-uvae* (Schw.) B. & C. Plate XIX. While the powdery mildew has been reported from Connecticut on the gooseberry, this is the first mention, so far as known, of its occurrence on the currant. Specimens were found in July on red currants in a nursery at Storrs, where it confined its attacks to the ends of the young branches and their leaves, the latter being checked in their development. At the same place the fungus occurred on the gooseberry, but limited its attacks here to the fruit. The dirty white or brownish mycelium forms a thickish felt (in which are imbedded the fruiting bodies as dark specks) on the affected parts, and is thus directly exposed to fungicides when applied. However, to secure good results, the

treatment must be started before the appearance of the trouble, since the plants infected in this case had been sprayed, apparently tardily, with Bordeaux, with little effect.

FALSE INDIGO, *Baptisia australis*.

POWDERY MILDEW, *Erysiphe Polygoni* DC. This fungus has been noted before from the state on several hosts, such as the columbine, crowfoot and pea, but this is the very first report, apparently from anywhere, of its occurrence on the above host. The mycelium forms a luxuriant growth on either side of the leaf and an abundance of the perithecia were developed. Altogether, it caused considerable disfigurement of the infected plants, which were growing in a local nursery.

FERN, *Adiantum Farleyense*.

Leaf Scorch. Plate XX, a, gives a good idea of the appearance of this trouble of the Farleyense fern. It was first seen by the writer in the fall of 1902, in a Connecticut greenhouse, where it was quite troublesome. Complaint was made of it again in January, 1907, by Mr. A. N. Pierson, a large grower of ferns at Cromwell, who sent specimens for examination. The trouble shows on the leaves as prominent, often wedge-shaped, reddish-brown areas that extend inward from the clefts of the pinnae. These spots give a variegated appearance to the plants, which produce a less luxuriant growth, but otherwise appear in a healthy condition. A careful microscopical examination of the roots, stems and leaves showed no indication of any bacterial or fungous parasite. There seemed to be no unfavorable conditions of the soil to produce the injury. It appeared on the whole to be a physiological trouble. So far as the writer could determine, it seemed to be a leaf scorch, not necessarily entirely due to hot rays of the sun, but to loss of moisture from the leaves under unfavorable conditions, such as too dry an atmosphere, sudden changes of air moisture, etc. A somewhat similar trouble has been seen occasionally in nature where ferns suffered from lack of moisture. The Farleyense fern is very delicate, and, because of its very thin leaf tissues, is much more sensitive than other cultivated ferns to unfavorable conditions. The fact that the trouble seems to start near the veins, and that under the microscope the stomates often show discoloration before the surrounding cells, indicate that it is a trouble connected with the inability to properly control transpiration of moisture. While no doubt it is a common trouble, and probably noted before in floral writings, the writer has seen no mention of it in the literature of plant diseases. Halsted (Ann. Rep. N. J. Exp. Stat. 14: 420. 1894) describes and figures a somewhat similar trouble caused by a definite fungus (*Phyllosticta Pteridis* Hals.), and briefly states that unfavorable environment also often causes ferns to die and turn brown at their tips. Concerning the Farleyense trouble, Mr. Pierson wrote: "I do not think it is due to sun burn or scald, because the disease, which we have always called rust, is hardly noticeable in the summer time, but rather when the cold, damp weather comes on in the winter; particularly is it so this year. These very same plants that look so badly, with hardly a perfect leaf on them, will, by cutting the old leaves away, throw up perfect leaves in the spring, without a spot on them, and can be sold for decorative purposes." This last statement seems also to indicate that this trouble is a physiological rather than a parasitic one.

HEMLOCK, *Tsuga canadensis.*

Rust, *Caeoma Abietis-canadensis* Farl. This rust shows as small orange-yellow pustules on the leaves. Apparently it is never injurious to cultivated hemlocks, as it has only been found once, and then in very small amount, on a tree in a yard in Westville.

Rust, *Peridermium Peckii* Thuem. Plate XXIX, a. Another rust quite distinct from the preceding also occurs here on the hemlock. It forms small, cylindrical, white receptacles, usually in double rows, on the under surface of the leaves. In time these peridia rupture and discharge the orange-colored spores. The rust has been collected a number of times the past year, both on cultivated and native hemlocks, but never occurred in such abundance as to cause any noticeable injury, though the few infected leaves are shed prematurely. Both of these rusts are discussed further in the final article of this Report.

HERBACEOUS PLANTS, *Delphinium* sp., *Funkia* sp., *Pentstemon barbatus, Valeriana officinalis.*

Stem Rot, *Undet. sclerotial fungus.* Plate XXI. A serious soil fungus was found last fall in a New Haven nursery doing considerable injury to a variety of herbaceous plants, especially to the Valeriana and Pentstemon mentioned above. The mycelium attacks the parts of the plant at or near the surface of the ground, frequently rotting off the stems. In the fall it forms subspherical reddish sclerotia both in the tissues and in the soil nearby. Pure cultures were obtained, and while the fungus grows luxuriantly, it has never produced a true spore stage. The sclerotia form as swellings at the tips of clustered threads, and are at first whitish, but soon turn reddish-brown on the outside. Their size depends somewhat on the character of the medium used in the cultures. Plate XXI, b, shows sclerotia on nutrient potato agar, which are quite similar to those found in nature, and others, grown in nutrient corn meal agar, which are much larger and more irregular. In artificial cultures made from the sclerotia these give rise to similar sclerotia, but what they will produce in the soil has not yet been determined. According to Professor Thaxter, they are probably the sclerotia of some hymenomycetous fungus.

JUNEBERRY, *Amelanchier canadensis.*

Rust, *Gymnosporangium clavipes* C. & P. Plate XX, b. The I stage (*Roestelia aurantiaca* Pk.) of this fungus has often been seen on specimens of wild juneberry, but last July it was also found on cultivated specimens in the nursery at Storrs. It occurs most commonly on the fruit, the fringed white receptacles, containing bright orange-colored spores, often thickly covering the berries. The III, or mature stage, occurs on the cedar, so that the trouble is easily controlled by excluding this alternate host.

LAUREL, MT., *Kalmia latifolia.*

Leaf Spot, *Septoria Kalmicola* (Schw.) B. & C. The native mountain laurel is often grown for ornament in Connecticut, and the last legislature made it the state flower. Any fungus causing injury to it thus becomes of interest. The leaf spot mentioned above is a very common trouble on both the wild and cultivated plants. Its chief injury consists in greatly marring the appearance of the leaves. The subcircular spots produced by it are scattered over the leaves, and reach a maximum size of about a quarter of an inch, except when closely placed, they may run together and form a more extended injury. They have a definite purplish border, with a greyish center on the upper surface in which the small black fruiting receptacles can be seen with the naked eye. Often on the same leaves other somewhat similar spots are present, but are distinguished by having a reddish-brown rather than a greyish center. The immature fungus found on these could not be determined, but the spots look like those of *Phyllosticta latifoliae* E. & E.

MEADOWSWEET, *Spiraea (Ulmaria)* sp.

ANTHRACNOSE, *Cylindrosporium* sp. We have not been able to determine specifically this leaf fungus; but, from lack of definite fungous walls in the imbedded receptacles, it seems to be a Cylindrosporium rather than a Septoria, though the spores are narrower than those of *C. Filipendulae*. A number of species belonging to these two genera have been described as having Spiraea for a host, and there seems to be some confusion regarding them. This particular fungus has spores more or less curved, with usually some indication of septa, often five when mature. The spores vary in size from 35 — 50μ by 2μ. Frequently the spore masses can be seen with a hand lens as minute white tendrils that have oozed out on the upper surface of the leaves. The spots are purplish, most evident on the upper surface, rather thickly placed, and generally are one-eighth of an inch or less in diameter. This fungus causes considerable injury to certain of the cultivated varieties of Spiraea; the one mentioned here was collected in a New Haven nursery on plants labeled *Ulmaria purpurea elegans*.

OAK, WHITE, *Quercus alba.*

ANTHRACNOSE, *Gloeosporium canadense* E. & E. This fungus injures the leaves, most frequently near the margins, where the tissues die and dry up into light brown areas of considerable extent. Isolated spots, surrounded by perfectly green tissue,

also occur. The trouble is very similar to the leaf scorch of oak, and often one is not entirely sure, even after a microscopic examination, which is which. The specimens reported here were sent from New Canaan by Mr. A. L. Benedict, who complained of injury to his trees.

PINE, SCOTCH, *Pinus sylvestris.*

RUST, *Peridermium pyriforme* Pk. Plate XXVIII. The writer has recently shown that this rust is merely the first stage of *Cronartium Comptoniae* Arth., which has the sweet fern for its alternate host. The first stage has been found in Connecticut on the pitch as well as the Scotch pine. The rust on the Scotch pine was first found by the State Forester, who had noticed for several years that a number of these young pines in the state plantation at Rainbow were attacked by some fungus. This rust occurs only on the stems, usually at the base of the young tree, and as its mycelium is perennial, appears year after year in the same specimen. It causes a slight swelling of the trunk, and considerable injury to the bark and young wood, so that badly infected young trees are no doubt sometimes killed. In time the spores are scattered, and all signs of the fruiting stage disappear, so that by the end of July the infected trees are not readily detected. The trouble should be easily controlled by destroying infected branches and young trees and keeping down the sweet fern in the neighborhood. This fungus is further discussed in the final article of the present Report.

PINE, WHITE, *Pinus Strobus.*

Pine Blight. Plate XXII. This so-called *blight* was one of the most conspicuous diseases of the year, since it occurred quite generally not only in Connecticut, but over most of New England. More complaints of the trouble, all after the middle of August, were received at the station than of any other for the year. Its widespread appearance caused general alarm and discussion, and an extended and intelligent account of it appeared in the Boston *Transcript* of August 20. The same, or a very similar trouble has been under observation for several years past by Professor Stone of the Massachusetts Experiment Station, who first noticed it after the severe winter of 1903-04. He attributes it to winter injury, and its prominence the past year to the unusually dry summer. In our last Report (1906, p. 320) we mentioned a case in this state which was also apparently due to winter injury. There is no question that the trouble, whether or not always due to the same causes, has been more prevalent this year than ever before.

The most serious complaints were from the northwestern part of the state, where many of the older trees were reported as seriously affected. The writer's observations were made after the first of August, chiefly on small trees from five to fifteen feet high in a Westville nursery and in the state plantation at Rainbow. We have seen no sign of the trouble in the nursery seedlings. In most of the cases examined the leaves were killed from their tips inward for about a third or two-thirds of their length, the dead tissues turning a reddish-brown color. Sometimes there was an inconspicuous yellowish spotting on the tissue below the dead area. This year's leaves were the most frequently injured, and in all cases were undersized, thus indicating the trouble at least began before the leaves reached maturity. In the fall often one or more of the leaves in a bundle dropped out, and no doubt all are shed prematurely. Occasionally a tree was seen with all the leaves dead, in which case there was no hope for it, as usually the roots were also dead. Most of the trees examined, however, showed no signs of injury to the trunk or root, such as a severe winter freeze might make; but the smallest fibrous roots were sometimes somewhat dried out, thus indicating possible suffering from lack of moisture.

Most persons have been inclined to consider this trouble the result of fungous attack. One firm claims to have sprayed trees with good results. This, if true, the writer believes to be due to stopping the transpiration of water by clogging the stomates, rather than to any fungicidal effect. We see absolutely no reason for believing the trouble due to a parasitic fungus on the leaves. The fungi found on the injured leaves were of the nature of saprophytes, being more or less tardy in their appearance. Then, too, the widespread injury to practically all of the leaves of the affected trees, while adjacent interlocking trees were often entirely free, is against any such theory. The dry season was also unfavorable for such a sudden and widespread injury

by fungous agents. We have had seedlings for several months in the greenhouse with their leaves interlocked with leaves from diseased trees with no sign of contagion. Since the trouble is so general in its effect on the tree, a fungus, if the cause, would more naturally be found at work on the roots. As yet we have obtained no satisfactory evidence that a soil fungus is the cause of the trouble. In fact, the evidence in the main is against such a belief. We have seen some dead trees with a fungous growth on their roots and in the surrounding soil; and in one case young pines were planted in pots containing soil with such a fungus, but with no injury to the pines after several months' exposure. There seems to be no reason in the opinion of the entomologists who have examined the injured trees for believing that the trouble is caused by insects.

Everything considered, the trouble seems to be a physiological one, brought on by adverse conditions. In some cases winter injury alone probably accounts for it. In this state during the past year, it is apparently largely due to the drought; or possibly the late frosts of May 11 and 21 may have injured the protruding tips of the young leaves and thus have been altogether responsible for the unusual prominence of the trouble. The pine needles grow from the base, so that the exposed young tips could have been killed or injured and a growth still be made from the protected basal part. In the case of the sycamores, which we know suffered from these frosts, the whole of the young leaf was exposed, and so was entirely killed. In view of these possible and at the same time unusual causes, we do not look for the trouble to be so prominent the coming season as last year.

POTATO, *Solanum tuberosum.*

Internal Brown Spot. Plate XXIII, a. The writer first saw this trouble in Connecticut in potatoes that were imported from Scotland in 1906 for experimental purposes. It was especially bad in the Midlothian Early variety. The past year it was also found not uncommon in certain of Mr. East's numerous varieties, especially in those of European origin. Among the worst affected of the varieties were Sutton's Field Ash Leaf, Alderman, Harbinger, Royal Ash Leaf Kidney, Britannia, Snowball, and Early Maine, of which the last only is of American origin. A few Connecticut growers have complained of trouble similar to this, and Morse (5) also reports it from Maine in 1907.

The trouble is in no sense a true rot. The affected tubers may or may not show the disease on the outside. Usually, however, some indication of its presence is given by a slightly shrunken appearance and a reddish discoloration of the skin. When cut open, the tubers show a conspicuous reddish disease of the tissues. This may occur in isolated spots scattered through the healthy flesh, having no apparent connection with the exterior, or there may be a band starting from the exterior and progressing more or less deeply inward. Taken as a whole, the trouble most frequently starts at the stem end and works toward the bud end and inward. In the cases where the trouble shows as a band at the surface, it can scarcely be told from the blight disease caused by Phytophthora. In some of the worst affected European varieties the spotting finally runs all through the tuber, appearing much worse than that shown in the illustration. Often the spots have a watery appearance, especially in varieties poor in starch, but no evident wet rot develops from them.

Microscopic examination shows that the protoplasmic contents of the cells in the injured areas are diseased and discolored reddish-brown. Often this gives an appearance as if the plasmodium of some extraneous organism were present. No evidence of fungous threads or bacteria was detected. Attempted cultures made from the diseased tissues uniformly gave no growth of any kind, except in a few cases where outside contamination had occurred. Similar cultural attempts made by the writer (I) in Illinois some years ago, likewise indicated that the trouble was not of a parasitic nature, and Stewart of New York also failed to obtain any parasitic organism from the diseased tubers. All of the investigators in this country agree in considering it a physiological trouble, and to the writer it appears to be very much like the Baldwin Spot of apples.

Poor soil, dry weather, lack of potash or lime, susceptibility of certain varieties, etc., all have been assigned as probable or partial causes. In this state last year the drought was certainly severe, but so far as observed by the writer, the trouble was conspicuous only in varieties poor in starch. Stewart (6), who made a study of the disease in New York in 1895, showed that it was not prop-

agated by diseased tubers, and others have had similar results. The trouble was particularly prominent in this country about 1893-95, as it was then reported by the writer (1) in Illinois, Green (2) in Minnesota, Stewart (6) in New York, and the United States Department of Agriculture. It seems to be common in Europe, and according to Jones (4), it is not generally regarded there as a parasitic trouble. Sutton (7) notes its presence in England, where it is very likely to occur on light loams or sandy soils, when twenty to seventy per cent. of the tubers may be diseased. Helms (3) reported its presence in Australia in 1895. The following are the references to this trouble that have been alluded to here:

1. **Clinton, G. P.** Interior Spotting. Ill. Agr. Exp. Stat. Bull. 40: 138–9. 1895.
2. **Green, S. B.** Internal Brown Rot of Potatoes. Minn. Agr. Exp. Stat. Bull. 39: 212–3. *Ibid.*, 45: 310. 1895.
3. **Helms, R.** Report on an Investigation into the Potato Diseases prevalent in the Clarence River District. Agr. Gaz. N. S. Wales 6: 328. 1895.
4. **Jones, L. R.** Internal Brown Spot. U. S. Dep. Agr. Bur. Pl. Ind. Bull. 87: 12–13. 1905.
5. **Morse, W. J.** Internal Brown Spot of the Tuber. Me. Agr. Exp. Stat. Bull. 149: 318–21. 1907.
6. **Stewart, F. C.** Internal Browning of Potatoes. N. Y. Agr. Exp. Stat. Bull. 101: 78–82. 1896.
7. **Sutton, A. W.** Internal Disease. Journ. Roy. Agr. Soc. Engl., III, 9: 599–600. 1898.

SCURF, *Spondylocladium atrovirens* Harz. Plate XXIII, b-d. In the spring of 1907 this potato disease was first called to my attention by Mr. East, who noticed it on a few tubers among the many varieties to be tested that year by the station. It was also found not uncommon that fall on a still larger number of these same varieties. While not a serious potato trouble, it is interesting because it has not before been reported in this country. It has been known for some time in Europe, and apparently was introduced into Connecticut on imported varieties. On unwashed tubers the trouble does not show very plainly, but on perfectly clean ones it appears as a slightly sunken area, of greater or less extent, which has a darker brown color. It is not nearly so conspicuous or injurious as scab, though it finally causes the tubers to shrink somewhat over the affected areas, and may offer entrance for decay germs.

The fungus that causes this trouble is usually evident, when tubers are kept for a time in a moist chamber, as a scanty growth of short, upright, blackish bristles, easily seen with a lens. These are the conidiophores, and bear irregular whorls of spores on their upper end (see illustration, Plate XXIII, c). The conidiophores are dark reddish-brown, often with a slightly swollen base, and taper somewhat toward their free extremity. They are septate (6—16 septa), and vary in length from 160—425μ, and in width from 6—12μ. While stiff, and generally erect, they are sometimes somewhat bent or kneed, and rarely branched toward their base. They arise singly, or more than one, from a knot of fungous cells which infest the epidermal cells. The spores are reddish or greyish, but lighter colored than the conidiophores, and easily fall from them. They vary from oval to chiefly obclavate, and are 4—8, usually 6, celled. They are fastened to the conidiophore by the broader end, and are usually acute at the apex, but will occasionally be rounded at both ends. On falling off, they generally show the point of attachment as an evident dark ring at their base. They vary from 23—52μ, chiefly 30—40μ in length, and from 6—9μ in greatest width. In germination they put forth a single tube at the pointed end.

This fungus was apparently first found and described in Vienna, Austria, by Harz, in 1871 (Einige Neue Hyphomyceten: 129-30), Frank, in 1897 (Kampfbuch gegen die Schädlinge unsere Feldfrüchte) and again in 1898 (Ber. Deut. Bot. Ges. 16: 280-1) called attention to a new sterile fungus, named *Phellomyces sclerotiophorus,* which formed very minute dark colored sclerotia in the epidermal cells, and which he held responsible for a sort of dry rot of potatoes under some conditions. Johnson (Econ. Proc. Roy. Soc. Dublin 1: 161-6. 1903) and Smith and Rea (Trans. Brit. Myc. Soc. 1903-04: 59-67) have also called attention to this Phellomyces causing injury to potatoes in Great Britain. In 1905 Appel and Laubert (Ber. Deut. Bot. Ges. 23: 218-20) succeeded in getting these sterile sclerotia to produce a fruiting stage which they recognized to be the *Spondylocladium atrovirens* of Harz. In 1907 they gave a further account of the fungus in Arb. Kaiserl. Biol. Anst. Land. Fortw. 5: 435-41.

In some of the specimens which we have seen, very small blackish spots or "sclerotia" occurred on the surface of the tubers apart from and with the fruiting stage of the Spondylocladium; these we have considered to be the *Phellomyces sclerotiophorus* of Frank. These sclerotia are composed of compacted colored cells of the fungus, which more or less completely fill the epidermal cells (see Plate XXIII, d). The mycelium of the fungus evidently at first does not penetrate very deeply into the tissues, and so forms only a superficial injury.

Saccardo (Syll. Fung. 10: 662) describes another species of Spondylocladium, *S. abietinum* (Zuk.) Sacc. on potato tubers, also from Vienna, Austria, that very probably is the same as this, though the spores are said to be only 3—4 septate, but are 38 by 9μ. The spores of our specimens are smaller than the measurements given by Appel and Laubert for *S. atrovirens,* but agree in the number of septa, while they agree in size with the other species, but not in the number of septa. Specimens were sent to Appel, who states that he is not yet sure whether these two species are distinct or not, though there seem to be at least two forms, one having larger spores than the other. If the species are distinct, our specimens apparently belong to the smaller spored species.

ROSE, *Rosa* sp.

RUST, *Phragmidium speciosum* Fr. Sturgis, in his Report for 1893, p. 86, mentioned injury to cultivated roses by another species of rust, *P. subcorticium,* but this is the first note in the station's Reports of the above species. It was found on cultivated roses in Westville, causing considerable injury to the stems, to which it was limited. As usual, only the III stage appeared on the infected stems, forming small, hard, black pustules, usually occurring in clusters.

SWEET PEA, *Lathyrus odoratus.*

DAMPENING OFF, *Pythium* sp., *Rhizoctonia* sp. During last July, when sweet peas were about one-third to one-half grown, occasional vines showed evidence of trouble by turning yellowish, wilting, and finally drying up entirely. An examination of such plants showed that they were more or less separated from their roots near the surface of the ground by a reddish-brown rot. Microscopic examination of the injured tissues revealed the presence of one or the other of the above fungi as the cause of injury. Although the trouble was quite common, usually enough plants escaped to make a fair stand. As manure encourages the growth of such fungi, it should be used with care, especially at the surface of the ground. The cold, backward spring was apparently largely responsible for the unusual amount of dampening off this year.

SYCAMORE, *Platanus occidentalis.*

Frost Injury. One or both of the severe frosts of May 11 and 21 severely injured the unfolding leaves of the sycamore trees throughout the state, so that practically all of those out of the buds were killed outright. The injury was evident immediately afterward, but became even more conspicuous later, when the remaining leaves began to assume some size, through the very scanty foliage, which in many cases was confined entirely to the tops of the trees. While some trees had all their leaves killed, and so were destitute of foliage for a time, most of them finally put forth about one-fourth to one-half the normal foliage, but even then the injury was evident all summer. This injury to the sycamore was not limited to this state, since von Schrenk (Rept. Mo. Bot. Gard. 1907: 81-3) has published a short article in which he calls attention to similar injury extending from the Mississippi Valley eastward. The writer did not notice any serious damage to the leaves of other trees, but probably the sycamore leaves were the only ones just in the right condition for such an injury when the frosts came. Murrill (Journ. N. Y. Bot. Gard. **8**: 157-61. Jl. 1907), Lloyd (Plant World **10**: 213. S. 1907) and Halsted (Ann. Rep. N. J. Agr. Exp. Stat. **1907**: 381. 1908) have made the mistake of attributing this trouble to the fungus *Gloeosporium nervisequum,* which frequently injures the foliage of sycamores.

TOBACCO, *Nicotiana Tabacum.*

SUMATRA DISEASE, *?Bacterial.* Shamel has previously called attention to this trouble in Bulletin 150 of this station. The seed from which the Sumatra tobacco was grown was imported by the United States government a few years ago. Last June Mr. Shamel showed the writer a small experimental seed bed at

Granby in which most of the plants had been killed by this disease; the surviving plants had ceased to grow, at least for the time, and a few that were transferred to crocks in the greenhouse never made any further growth. The injury was not exactly like either the dampening off troubles or the root rot disease. So far as could be determined from this bed, the disease started in the roots, and was most manifest in the vicinity of the bundles, up which it developed a short distance above ground. The roots and the base of the stem, in time, were so severely injured that most of the plants succumbed. Those alive usually showed the lower leaves with a sickly, yellowish color, and within their tissues was sometimes found a Pythium-like fungus, which was apparently an after-comer. The disease appears, on the whole, like a bacterial trouble of the bundles, but specimens of the older plants were not seen to throw further light on the subject.

Concerning this trouble in the field, Mr. Shamel in his bulletin says: "A field was set out with plants grown from imported seed, which were attacked by a fungous root disease and all died with the exception of a few plants. These resistant or immune plants were found irregularly over the field, and produced ripe tobacco of excellent quality. All the other plants were completely destroyed, with the exception of one or two semi-resistant plants that produced a large amount of seed, but very few and extremely small leaves. The seed was saved separately from the resistant and semi-resistant plants, and sowed in separate sections of the seed beds. The resistant seeds produced perfectly resistant plants, both in the seed bed and in the field where the plants were destroyed the previous year. Most of the seedlings from the semi-resistant seed died in the seed bed. Enough were finally secured to set out one or two rows in the field. These plants grew slowly, some died, and none reached maturity, all having the characteristics of the diseased plants in roots, stem and leaves. Some of the resistant seed was sown on the seed bed where the diseased seedlings had been destroyed, and this immune seed produced perfectly resistant plants under these circumstances."

Mr. Shamel seems to think that our native varieties are not subject to this trouble, and so far it has not been found on them.

Stevens (N. C. Exp. Stat. Bull. 188. 1903), however, has described a bacterial wilt of tobacco from North Carolina that possibly may prove to be the same as this. Uyeda also has described a similar bacterial trouble from Japan, and Delacroix from France. All of these, however, describe it as a field disease, and little or no mention is made of its injury in the seed bed.

TOMATO, *Lycopersicum esculentum.*

Chlorosis. Last fall in Westville the writer saw a large field of tomatoes in which many of the plants showed leaves more or less mottled with yellowish-green. This unhealthy coloring was quite similar to the injury that can be transferred to tomatoes from calicoed tobacco. On inquiry, it was found that the tomatoes had been severely injured by the late frosts of May, but had finally recovered and had borne a fair crop. It looked to the writer as if this chlorosis of the plant was one of the after effects of the frost, and was of the nature of the so-called calicoed tobacco, but whether or not it was infectious through the juice of the injured plant was not determined. Woods claims that a similar trouble in tomatoes can be produced by a very severe pruning back of the vines, and possibly the frost injury was in effect merely such a pruning.

TRUMPET CREEPER, *Tecoma radicans.*

LEAF BLIGHT, *Cercospora sordida* Sacc. This fungus shows on the under surface of the leaves as small, angular, olive-brown patches, either distinct or more or less run together. The spore stage which forms these patches consists of short, dark, olive-brown conidiophores bearing lighter colored spores. The spores vary from linear to linear-obclavate, are smoky tinted, 4 — 12 septate, straight or somewhat curved, and range in size from 40 — 120μ by 2.5 — 5.5μ. The injury to the leaf first shows on the upper surface as a yellowish discoloration which in time may change to reddish-brown, but ordinarily it is not very severe. Two other species of Cercospora have been described from the United States on this same host, but it is doubtful if all three are distinct.

II. ROOT ROT OF TOBACCO—II.

In the Report for 1906 the writer gave a somewhat extended account of the fungus *Thielavia basicola* (B. & Br.) Zopf, and the injury it caused to cultivated plants, especially to the tobacco in Connecticut. In this article is added such additional information as came to hand during the past season, when the investigation was brought to a close. Dr. E. A. Bessey, of the Government's Subtropical Laboratory in Florida, writes that he has found this fungus on the roots of tobacco sent from Cuba, on cultivated violets from the District of Columbia, on the garden pea in South Carolina, on sugar beets from Utah, and on various plants in Florida. Galloway, in his book on violet culture, also reports it as a serious pest on violet roots. No doubt, it is a common and widely distributed soil fungus, at least much more so than reports have hitherto indicated.

Cultures. During the past year and a half the fungus has been under observation in cultures with various media in an attempt to develop the ascospore stage. This has not been obtained, though the fungus was grown on tobacco roots on which this stage occurs in nature in Connecticut. Fresh tobacco roots containing the fungus were sent to Professor Thaxter, who tried to isolate the ascospores by the Barber method, and obtain cultures directly from them—our cultures having come originally from the endospores, or possibly from the chlamydospores—but he was not successful in obtaining such cultures. Professor Thaxter has, on the other hand, a culture of another species of Thielavia which forms the ascospores, but never the endospores and chlamydospores. These facts possibly may indicate that the ascospore stage has no relationship to our fungus, and that it occurs on the tobacco roots as a parasite of the fungus rather than as a stage of it. However, the mature stage of certain other fungi, the apple scab, for example, is rarely, if ever, obtained in artificial cultures, while the other stages readily grow there. For the present it is perhaps best to consider the ascospore form as the mature stage of the fungus with the understanding that further study is needed to positively prove this connection.

Seed beds. There was more or less complaint of the root rot in the tobacco seed beds the past spring, especially in the neighborhood of Granby. Some growers lost their beds, and others gave them up because of previous injury, and made new ones. Where it can be done conveniently, this is perhaps the wisest thing to do. If it is of advantage to retain the old beds, our experiments have shown that they can be treated successfully with either formalin or steam, and the injury will be largely or entirely prevented.

Several beds were treated with formalin last fall and spring, all of which showed that the treatment had done no harm, and in most of them some benefit resulted even when the root rot or the dampening off troubles were not present to any injurious extent in the check beds. The two beds at Bridgewater, mentioned in our last Report, p. 329, which were treated in the fall of 1906 for the stem rot, did not give a fair idea of how effective this treatment would prove for this trouble, since no serious injury from the stem rot developed in the treated or untreated parts of the beds the next spring. In both cases, however, the plants upon the treated parts were a little more advanced than those on the untreated, and there were also fewer weeds and angle worms in them. In a bed treated for root rot at Poquonock in the fall, the soil had been covered with a layer of sand two or three inches deep just before the treatment, and this apparently interfered somewhat with the full action of the formalin on the infested soil beneath, since a little root rot was found the next spring in the treated part, though not as much as in the untreated. The injury in either case, however, was not severe, the sand apparently, when spaded in, having helped the mechanical character of the soil, or in some other way prevented as serious injury to the tobacco from the fungus as had occurred the year before.

The most extended experiments were made by the Director and the writer in a bed grown especially for the station by Mr. E. S. Hale of Portland, and upon these we report more in detail. This bed, which was one that had been injured considerably by the root rot the year before, was ninety-one feet long by six feet wide. In the fall, before treatment, it had been manured and tilled in the usual way, and in the spring such commercial fertilizers as were needed were used. It was sown with sprouted tobacco seed April 25, covered with cloth, and watered as needed. The only difference in the treatment of the various plots into which the bed was divided was as follows:

(1) In the fall, November 9th, a twenty-five foot plot was treated with formalin, strength 1 to 100 water, this being sprinkled on at the rate of one gallon to each square foot.

(2) In the fall a seventeen foot plot was treated with steam by means of a steam rake whose teeth were pushed about eight inches into the soil. The rake was wide enough to take in the width of the bed, and two lengths made the seventeen feet. The rake was covered with sacks and boards to hold in the steam. The treatment with the first length was made for two and three-quarter hours, because of some difficulty with the steam. At the end of the treatment tests of the temperature of the soil midway between the teeth showed an average at two inches of 96° C., at four inches of 99° C., at eight inches, 97° C., and at ten inches, 82° C. Between the rake and the boards on the outside of the bed the temperature was not nearly so high. The second treatment was made only for one and one-half hours, and probably the temperature did not reach quite so high, but no difference in the plants was noticed on this account.

(3) In the fall a nine foot plot was treated with formalin, strength 1 to 200 of water, using one gallon to each square foot.

(4) In the spring, April 16th, a fourteen foot plot was treated with formalin, strength 1 to 100, using two-thirds of a gallon to each square foot.

(5) After the plants were up, a ten foot plot was sprinkled with weak formalin water, about 1 to 1000 or 1200, nine times (May 3, 15, 22, June 1, 8, 12, 15, 20, 25) instead of being watered, as was the rest of the bed on those dates.

(6) A sixteen foot plot was reserved as a check; that is, it had no unusual treatment.

The final results of these treatments, in general, were as follows:

(a) The *steam heated plot* (No. 2) *produced the best stand,* with plants most advanced, though at the time for pulling it had lost much of this lead over the *formalin treated plot* (No. 1), which was *next best,* and had a fine stand of plants. The formalin treated plots (Nos. 3 and 4), though somewhat behind plots 2 and 1, produced a good lot of plants. The *formalin sprinkled plot* (No. 5) *and* the check or *untreated plot* (No. 6) were both about the same, and *made a very poor stand and growth.* The contrast between these two poorest plots and the two best at pulling time is shown by the illustrations in Plate XXIV.

(b) *Sprinkling with weak formalin* (plot 5) *evidently injured the plants,* as the stand was very uneven, and the plants small at pulling time. This was possibly due to the large number of treatments, and began to show about the time of the third treatment, though by accident the first was about twice as strong as the others. Apparently the sprinkling method is not of much value.

(c) The *steam treatment very materially reduced the number of weeds,* and apparently the formalin treatment had somewhat similar effect. The formalin and steam both killed the angle worms, and the latter, undoubtedly, wire worms, insects, etc. The total number of weeds taken from each plot and the rate per square foot for each was as follows: Plot No. 1, 1159, a rate of 8 per square foot; plot No. 2, 104, or a rate of 1 per square foot; plot No. 3, 606, or a rate of 11 per square foot; plot No. 4, 388, or a rate of 5 per square foot; plot No. 5, 885, or a rate of 15 per square foot; plot No. 6, 3188, or a rate of 33 per square foot. The rate of the last two was raised considerably by the poor growth of the tobacco, which thus failed to crowd out the weeds; in plot 5, this may have been offset by injury to the weeds from the formalin.

(d) The *untreated plot* (No. 6) *had considerable root rot* in it, but this was not so severe as to entirely rot off the roots of many of the plants, since these usually retained a firm hold on the ground. In the *formalin plots* (Nos. 1, 3, 4) *and* the *steam heated plot* (No. 2) *only a very little root rot* was finally found, *not enough to cause any harm* whatever.

(e) We do not believe that the marked difference between these steam and formalin treated plots and the untreated plot was entirely due to the prevention of the root rot, as this did not seem so prominent as to have caused this difference. *It is possible that part of the difference was due to a disturbance of the bacterial flora of the soil,* in favor of the species more beneficial to plant growth, such as has been reported in Europe in the treatment of the soil of vineyards with carbon bisulphide.

Conclusions. From all of the experiments we have made during the past two years, we believe that the formalin treatment is a very efficient and convenient method of protecting tobacco beds against the root rot and possibly the dampening off trouble.

The formalin is best applied in the fall, after the beds are prepared for seeding, but may also be used early in the spring, if the beds are thoroughly aired afterwards. Formalin, 40 per cent. strength, used at the rate of 1 to 100 of water, should be gradually sprinkled on the beds, using about one gallon to each square foot of surface treated. The bed should then be covered for a day or two to keep in the fumes. The steam treatment is fully as effective against the root rot, and even more efficient in killing weed seeds, but is more cumbersome and expensive, especially if the necessary apparatus is not at hand. The soil in this case should be steamed for at least an hour after the apparatus is in good running order.

In the fields. The drought of the past summer had considerable effect on the growth of tobacco at that time, but the moist weather coming toward the end of August helped many of the fields to partially recover. Because of the drought the root rot fungus apparently was not so conspicuous in the fields as last year, though no doubt the injury it did cause was more or less obscured by the injury from the drought. As in the previous year, the tobacco in the region of Suffield, especially in certain fields, suffered severely from root rot or some other cause. From our examinations there, we are more convinced than before that the trouble is not alone caused by the root rot fungus, though this is the only agent of injury that we can be sure of so far. It is very probable, however, that in the worst affected fields such matters as fertilizers, drainage, poisoning of the land through continued use for tobacco, may have had as much or more to do with the failure of the crop than this fungus.

Our crock experiments (see Report of 1906, p. 362) with fertilizers, etc., in soil from two fields in Suffield that gave very poor crops in 1906, did not throw very much light on the subject except that those crocks treated with formalin gave by far the best plants all through the test. At first the best plants in all the crocks were apparently those whose roots were freest from root rot, but the single plants finally left in each crock at the end of the experiment did not show so much difference in the amount of fungus on their roots as they did in their vigor of growth. We have noticed in the fields, too, that it is often difficult to entirely explain the difference in size of individual mature plants by the amount of fungus on their roots. However, this possibly may be explained by the fact that the injury which counts most is that given to the young plant when some main or tap root is rotted off and thus stunts the growth, at least for the time, rather than a general, but not so severe, injury distributed over the root system, and which in mature plants might show as conspicuously as in the other case, so far as the total amount of root rot is concerned.

No field experiments were conducted directly by this station, but the writer had the privilege of seeing those made under Mr. Shamel's directions at Suffield with various fertilizers, etc. While there was some slight difference between these plots (most prominent in the plot where the ground had been treated with formalin, and in one of the fertilized plots), there did not seem to be sufficient difference to indicate any practical way of successfully treating infected fields. These plots were part of a field that had been in tobacco before, and the rows continued onto land that was new, or at least, not in tobacco the year before. The difference in the size of the tobacco on the new and the old land, in favor of the new land, was the striking thing to be seen here, rather than that due to any difference in the treatment. In other instances that we have known, the tobacco on the new land seemed to do much better than that on the adjacent old land.

Conclusions. There seems to be, so far as now known, no effective treatment for a field in which the tobacco has been gradually going backward in spite of good care. In such a case the best thing is rotation for a year or two. Of course, on many farms the land available for tobacco is no more than is needed, and this is one of the reasons why rotation is not more commonly practiced. In such instances the amount of injury the crop suffers will determine whether or not the farmer can afford to use this land for other purposes. We saw one field last year, however, where there was no question but that the owner would have saved money if he had not used it at all, and no doubt there were other cases of the same sort.

III. HETEROECIOUS RUSTS OF CONNECTICUT HAVING A PERIDERMIUM FOR THEIR AECIAL STAGE.

GENERAL CHARACTER OF RUSTS.

Appearance. Rusts are among the most common and widely distributed forms of parasitic fungi. While it is difficult to describe their general appearance so that one unacquainted with the rusts can readily distinguish them from other fungi, still they do possess characters by which the expert readily recognizes these fungi with the naked eye. Perhaps to mention such common forms as the grain, asparagus, and chrysanthemum rusts, the cluster-cup of apple, and the cedar-apples of red cedar, is one of the best ways to describe them. In appearance they more nearly resemble the smuts than any other fungi, and in some cases are easily confused with these. In general their outbreaks occur scattered or clustered on the leaves or stems of plants (*hosts*), forming small roundish or linear spore clusters or *sori*. These sori, as a rule, are less dusty and more highly colored than the smuts. Early in the season the rusts often have a reddish, and later, a blackish color, as seen in the grain and asparagus rusts, due to the production of different stages.

Stages. The rusts are fungi that usually have more than one spore stage, in some cases having four different forms. The earliest stage, called the *pycnium* (O, spermagonium), is the most inconspicuous, and the one about which the least is known, for botanists are not yet certain whether it is a spore stage or the male element in sexual reproduction, and whether in either case it is now functional. It is generally associated with the next stage, often occurring on the upper side of the leaf, while the latter occurs on the lower, and is usually distinguished as minute blackish specks situated on discolored spots. (Plates XXVI, b; XXX, a.) The next, and generally considered the first spore stage, is called the *aecium* (I, aecidium, etc.). This usually has a distinct covering or cup-like receptacle called the *peridium,* which, when it opens, becomes toothed, fringed, or irregularly worn away, disclosing the enclosed mass of yellowish or orange-colored spores. The peridia in different species vary from the size of a small pinhead up to about one-third of an inch in diameter. (Plates XXVI; XXVIII, a-b.) The next stage, known as the *uredinium* (II, uredo-stage), usually forms numerous, small, naked outbreaks of reddish-brown spore masses on the surface of the leaves, etc. (Plates XXVII, a; XXVIII, c; XXIX, b.) It is the stage most commonly seen, as its function is to spread the fungus over the infected plants and to new ones. The last stage, called the *telium* (III, teleuto-stage), is usually formed late in the season, and is the one that generally carries the fungus over the winter, so it is considered the mature stage. (Plates XXVII, b; XXVIII, d; XXIX, c.) The sori in this case may be developed externally on the plants or be imbedded in their tissues, and so the spores do not always form a dusty mass to be easily scattered, as in the uredinial stage. With the germination of the telial spores (usually forming in this process very temporary thin-walled secondary spores called *sporidia*) the rust may start anew the cycle of its life history on successfully infecting its proper host.

Heteroecism. It will be seen from the preceding account that rusts possess, in some cases, a complicated life history. The I, II and III stages are so different that they were considered by the early botanists as distinct genera (now known as *form genera*), and so they were frequently described under different specific names. When the life history of a rust is fully determined, all of its stages are then united under one name, the generic name being decided by its telial form. The relationships of the rusts are further complicated by the fact that, with some species, certain of their stages may occur on one plant and the others on an entirely different plant. This is known as *heteroecism.* In such cases there is no general rule by which a person can definitely determine what hosts the different stages will occupy, though investigations are throwing considerable light on this matter. Therefore the life history of each species must be worked out by itself. Clues to the alternate host often may be obtained by closely watching the fungus in nature and determining what other related rusts with their hosts occur in the neighborhood of the one under observation. For instance, the farmers of England years ago noticed that the wheat rust was worst in the neighborhood of barberries having the cluster-cup rust; and from this clue De Bary, the great German mycologist, by infection

experiments on these two hosts was the first to prove definitely their relationship and the phenomenon of heteroecism.

Kinds of aecia and their relationship. With the heteroecious rusts usually the O and I stages occur on one host and the II and III on the alternate host. The use of the I stage is to carry the fungus to the second host, that of the II stage to spread it on this host, while the III stage carries it back to the first, usually early the next year. Now, the I stage, or aecium, may have the spores without a peridium (when it comes under the form genus Caeoma); the peridium may have the margin merely toothed (Aecidium); its margin may be more or less decidedly fringed (Roestelia); or the fragile peridium may break up rather indefinitely (Peridermium). The Caeomae species are not very common in this country, and their relationships have in but few cases been definitely worked out. From the investigations that have been made in Europe one may expect that most of them are stages of the Melampsora-like rusts. The species of the Aecidia are very numerous, and the American heteroecious forms have been found by Arthur and Kellerman to belong chiefly to the Pucciniae and Uromyces that inhabit grass-like plants. The American species of Roesteliae, which occur only on rosaceous hosts, through the studies of Farlow, Thaxter, Arthur and Kern, are now very completely connected with the species of Gymnosporangia, which occur only on cedar-like hosts.

Relationships of the Peridermia. The Peridermia, some thirty odd species of which Arthur and Kern (5) have described in their recent American monograph, limit their attacks to coniferous hosts. In this form genus the peridia generally extend prominently above the tissues of the host, the walls are white, very fragile, and separate in a rather indefinite fashion upon the wearing away of the aecia. All Peridermia, apparently, belong to heteroecious rusts, but so far the relationship of less than a dozen American ones to their telial stage is known. Added interest is given to the Peridermia because they are the aecial stages of at least seven telial genera, as now understood, namely, Calyptospora, Coleosporium, Cronartium, Melampsorella, Melampsoridium, Melampsoropsis, Pucciniastrum, and possibly Necium and Kuehneola (in case of *K. albida*). It is with the Connecticut species of these telial genera and their known or possible Peridermia that we are to deal especially in the present paper. So far, in America, Shear (16) has shown that *Peridermium cerebrum* on trunks of Pinus sps. belongs to *Cronartium Quercus* on *Quercus* sps.; Kellerman (13), that *Peridermium Rostrupi* on leaves of *Pinus rigida* is connected with *Coleosporium Campanulae* on *Campanula* sps.; and the writer (6, 7), that *Peridermium acicolum* on *Pinus rigida* belongs to *Coleosporium Solidaginis* on Solidago, etc., *Peridermium pyriforme* on trunks of Pinus sps. to *Cronartium Comptoniae* on *Comptonia asplenifolia,* and *Peridermium consimile* on leaves of *Picea nigra* to *Melampsoropsis Cassandrae* on *Cassandra calyculata.* The probable relationship of several of our other species is known through the work of European investigators, especially that of Klebahn. Farlow (9, 10) and others have suggested possible relationships of still other species.

Injury. While rusts in general are among the most injurious fungi, the forms discussed here are none of them very serious pests, at least in Connecticut. In Europe more or less complaint has been made of certain of the Peridermia attacking forest trees. Stone, a few years ago, recorded injury to blackberries in Massachusetts by *Kuehneola albida,* so far found here only once on cultivated blackberries. The rust on the leaves of the pitch pine was very common in a forest reserved for landscape effect at South Manchester, and caused the owner some uneasiness lest it become of more serious trouble. A rust which was found on the trunks of the Scotch pine in the state plantation also would become a serious pest if more abundant, since its injury to the young tree is very considerable. While one or the other of the hosts of all of the forms discussed here are of some economic importance, so far the injury to them by their rusts has not been such as to attract any considerable attention. It is not, therefore, because we consider these rusts at present of great economic importance in the state that we have made a special study of them, but rather because of their very interesting problems of heteroecism and a desire to solve more completely their life histories and to awaken a more general interest in them.

Classification. Because of their variable number of stages and of the heteroecism of certain species, the classification of the rusts is more difficult than that of most fungi, and gives a basis for honest differences of opinion among investigators. Some botanists lay more stress on the host than others, thus greatly multiplying the

number of species. A further source of trouble arises from the fact that morphologically similar rusts often infect entirely different, though closely related hosts, as proved by infection experiments. This gives rise to further confusion, since some botanists consider such rusts as distinct species, while others classify them as physiological species, or consider them merely as strains. These differences of opinion cause a grouping together of species and genera on the one hand, or to their splitting up on the other, according to the attitude of the investigator. In this paper we have used the nomenclature of Arthur (2), as given in his recent monograph, because he has made the most extended and thorough study of our American rusts; and, to avoid unnecessary confusion, we prefer to follow his work until further investigations shall have more definitely determined the nomenclature and relationships of the forms discussed.

Species considered. As stated before, we deal here only with Connecticut rusts supposed to have a Peridermium for their aecial stage. So far only four species of Peridermium (*P. acicolum, P. pyriforme, P. consimile, P. Peckii,* Plate XXXII, 1) have actually been found in the state. It is quite probable that other species exist here, since the search has extended only over a period of two years, and has not been made in the northwestern part of the state, where these species probably occur most abundantly. From their hosts and distribution, other species likely to occur here are *P. Rostrupi* on leaves of *Pinus rigida, P. Laricis* on leaves of Larix sps., *P. cerebrum* and *P. globosum* on branches of *Pinus rigida, P. globosum* and *P. Strobi* on branches of *Pinus Strobus, P. conorum-Piceae* on cones of *Picea nigra, P. elatinum,* which forms witches' brooms, and *P. balsameum,* which does not, on leaves of *Abies balsamea.* On the other hand, the uredinial or telial stages of thirteen species have been found in this state, namely, *Coleosporium Campanulae, C. Solidaginis, C. Vernoniae, Cronartium Comptoniae, Kuehneola (Chrysomyxa) albida, Melampsoridium Betulae, Melampsoropsis Cassandrae, M. Pyrolae, Necium Farlowii, Pucciniastrum Agrimoniae, P. minimum, P. pustulatum, P. Pyrolae.* Besides these there are six to ten other species that possibly may be found here in time. See list at end of this article. A special discussion of those already found here follows.

SPECIAL DISCUSSION OF CONNECTICUT SPECIES.

1. *Coleosporium Campanulae* (Pers.) *Lév.* (I. *Peridermium Rostrupi* E. Fisch.)

I. Plate XXV, a, (from Ohio Fungi *164*). The aecial stage of this fungus has not yet been found in Connecticut. The fact that it occurs on the same host as *Peridermium acicolum* and is scarcely to be distinguished from the latter may indicate that it has been confused with this species. While the relationship between a Peridermium on pine leaves and a Coleosporium on Campanula was first shown by European investigators, Kellerman (13) was the first in this country to produce *Coleosporium Campanulae* from a Peridermium on *Pinus rigida,* collected in Ohio. Arthur and Kern (5, p. 416) later called the aecial stage *Peridermium Rostrupi,* after the European form, though previously it had not been considered distinct from our common *P. acicolum.*

II, III. Plate XXV, b-c. These stages have been found in Connecticut only once, in October, 1907, on *Campanula rapunculoides* growing in a nursery at Westville. The II stage was common on the leaves, causing some injury, and the owner stated that he had noticed the rust on these plants for a few years past. The writer did not find the III stage on the plants outdoors, but it appeared later, after some of them were removed to the greenhouse for further observation. By the end of November the outdoor plants were entirely dead above ground. This shows that the fungus did not carry over the winter through the immature uredinia on the leaves, which in some plants escape winter injury. The III stage, of course, with all heteroecious rusts, is of use only in carrying the fungus to the alternate host, in this case, the leaves of *Pinus rigida.* There was little likelihood, however, that the Peridermium occurred on the pine trees in this vicinity, since these were watched rather closely without finding it. The question, then, as to how the fungus passes the winter and again appears on the Campanula is interesting. Of course it is barely possible that this is accomplished through an occasionally undeveloped infection on the underground perennial parts. As the uredinial stage is hardly to be distinguished from that of the Coleosporium on Solidago, and as the uredinia of the latter were common in this neighborhood, it occurred to the writer that possibly the rusts on these two hosts were not

distinct, as supposed. The germination of the uredinial spores of the two (Plates XXXII, 2), however, was somewhat different, those from the Campanula sending out irregular and much more branched germ tubes than those from the Solidago. The uredinial spores from the Campanula, too, sown on Campanula, produced the II stage in about eleven days, but failed to infect *Solidago rugosa* and Aster sps., upon which they were also shown. A later attempt to infect the Campanula with spores of the Coleosporium from a species of Aster likewise failed. The evidence as a whole seems to indicate that these species are distinct, and so how *Coleosporium Campanulae* passes the winter in this nursery is left unsolved.

2. *Coleosporium Solidaginis* (Schw.) Thuem. (I. *Peridermium acicolum* Und. & Earle.)

I. Plate XXVI. The earlier writers in Europe, and even more recently in America, called the common forms of Peridermium on species of Pinus, *Peridermium Pini,* sometimes distinguishing the leaf form as *acicola* and the stem form as *corticola.* Later Fuckel called the corticolous form *P. Pini* and the leaf form *P. oblongisporium,* and more recently a number of other European species have been distinguished. Arthur and Kern, in their Peridermium paper, consider the American specimens on the leaves of *Pinus rigida,* which they call *P. acicolum,* distinct from the European species, *P. oblongisporium,* on *Pinus sylvestris,* and the writer follows their usage, though not entirely convinced that they may not be the same. The European Peridermium was long ago connected by Wolff with a Coleosporium on Senecio, and the writer (6) has recently connected the American Peridermium with a Coleosporium on Solidago. Though both rusts possess different alternate hosts, these hosts are related, and as the morphological characters of the various stages of the rusts are so similar, it may be merely a question of physiological, rather than true specific difference that distinguishes them. Solidago and Aster are very uncommon genera in Europe, and Senecio is not so common here as in Europe, while *Pinus rigida* is an American and *Pinus sylvestris* an European species. Thus the rusts, if the same, would of necessity have different hosts in the two countries.

Peridermium acicolum was first called to the writer's attention in May, 1906, by Mr. Schults, a forester in Hartford, who found it very abundant on *Pinus rigida* in a private grove at South Manchester that was being developed for landscape purposes. The owner was afraid the rust would become a serious pest, and so Mr. Schults asked for information concerning spraying the trees to keep it in check. The writer advised against this, but recommended that a search be made for its alternate host, which at that time was not known to science, and that this, if found, be eradicated as a means for keeping the pine rust under control. An examination late in June, when the Peridermium on the pine was passing its prime, showed that *Coleosporium Solidaginis* on *Solidago rugosa* was just beginning to become prominent. This was the only rust present that could at all be connected with the Peridermium, and besides occurring on the above Solidago, it was found sparingly on two or three other species. The connection between the Peridermium and the Coleosporium was very plainly indicated by the fact that the Coleosporium on the Solidago only occurred prominently under the infected pine trees, and as the pines were mostly young, the branches reaching to the ground, several cases were found where infected branches interlocked with unusually badly infected plants of the Solidago. Upon our advice, these young pine trees were pruned of their branches for a distance of two to three feet up the trunk, and the goldenrod, especially beneath the trees, was mowed to the ground during the season. The next year an inspection failed to show any rust on the pines, except a small amount on one or two very small seedlings that were overtopped by some goldenrod. So this procedure seems to be an effectual method for controlling this rust. So far as was observed, the rust limited its attack to the limbs nearest the ground, and consequently was not found on the very large trees with no branches near their base. The young trees most badly infected were on low ground, with an abundance of infected goldenrod around them, so that conditions were unusually favorable for the development of the rust on both hosts.

Inoculation experiments in the greenhouse were made during 1906 and 1907 with spores of this Peridermium from different sources, and on three different occasions the Coleosporium was produced on plants of *Solidago rugosa*. The II stage of the

Coleosporium generally showed inside of two weeks after the spores were placed on the leaves, and later in the season the III stage appeared in two cases. In van Tieghem cell tests of the spores their germination was never abundant, and in some cases entirely failed, though the spores were fresh. From these observations and experiments, there can be no question but that this Peridermium has for its alternate host in Connecticut *Solidago rugosa*, and presumably other species of Solidago and Aster on which the Coleosporium occurs. So far the attempts to infect the other species have not succeeded; but these were made only with one other species of Solidago and a species of Aster, and possibly not under favorable conditions. It is possible, however, that the Peridermium does not infect all of the hosts upon which the Coleosporium occurs, but that some of these may have become infected originally through the uredinial stage.

The infection of the pine leaves, so far as was determined, takes place in spring, and if then, only through the leaves of that year's growth. If this is correct, it is the year after infection before the aecial stage appears, as in all the cases examined the leaves of the present year's growth did not show the Peridermium. The other possibilities are that infection takes place in the late fall, or in the very early spring, before the leaves of the year appear. The first sign of the fungus was detected early in November on a few leaves which had fully developed pycnia, the aecia apparently following the next spring. The pycnia (O, Plate XXVI, b) are prominent, few in number, situated on a yellowish spot (not shown in the illustration), and open by a longitudinal slit.

While Arthur and Kern (5, p. 414) list only six collections of this Peridermium from the United States, one of which was from Connecticut, and limit it to a small area along the Atlantic Coast, this does not necessarily mean that the fungus is very rare, since collections have been made from five different localities in Connecticut alone during the past two years. These were all on the leaves of *Pinus rigida*, as follows: South Manchester, May 28, June 6, June 29, 1906, May 29, 1907; Rowayton, June 4, 1906; Rainbow, June 15, 1907; Storrs, July 22, 1907; Union, August 1, 1907.

II, III. Plate XXVII. On the other hand, the Coleosporium is a very common rust, widely distributed over North America on a large number of species of Solidago, Aster, and a few other closely related genera. Arthur (2, p. 91) lists over sixty of these hosts that have been reported so far. Even in Connecticut the Coleosporium is much more widely and commonly distributed than the Peridermium, as shown by the following collections made during the past two years: *Aster cordifolius*, Poquonock, II, July 20, III, Sept. 8, 1906; *A. diffusus*, S. Manchester, II, Sept. 8, 1906; *A. paniculatus*, Poquonock, II, Nov. 5, 1906; *A. vimineus*, New Haven, II, Nov. 26, 1907; *Callistephus hortensis*, Kent, II, Oct. 29, 1906, Storrs, II, Sept. 30, 1907, Westville, II, Aug. 28, 1902, II, Oct. 17, 1903, II, Oct. 25, 1905 (Britton); *Sericocarpus asteroides*, Centerville, II, June 6, 1907; *Solidago caesia*, Poquonock, II, Sept. 7, 1907; *S. canadensis*, East Haven, II, Sept. 22, 1877 (Herb. J. A. Allen), Kent, II, Sept. 29, 1906, Poquonock, II, Sept. 8, 1906; *S. juncea*, Centerville, II, Sept. 25, 1907; *S. lanceolata*, S. Manchester, II, June 29, 1906; *S. puberula*, Woodbridge, III, Sept. 13, 1879 (Herb. J. A. Allen); *S. rugosa*, Centerville, II, Sept. 25, 1907, Fair Haven, II, Oct. 8, 1906, Kent, II, Sept. 29, 1906, New Haven, II, Sept. 20, 1906, S. Manchester, II, June 29, 1906, II and III, Sept. 8, 1906, Westville, II, Nov. 3, 1906, II, Oct. 19, 1907, West Willington, II and III, Sept. 28, 1907; *S. sempervirens*, New London, II, Sept. 1, 1905, Woodmont, II, Aug. 1907. Besides the preceding hosts, Arthur (2, pp. 91-2) lists the following from this state upon which the fungus has not been observed by the writer: *Aster novae-angliae*, *Solidago serotina*, and *S. ulmifolia*.

The data in the preceding paragraph show the second stage to be by far the most frequent, and that this occurs more commonly in the fall than at any other time of the year. A microscopic examination of the uredinial spores also showed that there is a marked variation, especially as regards the abundance and coarseness of the echinulations, on the different hosts. The extremes in this respect are certainly as great as those which exist between the typical uredinial spores of this and other closely related species. Just what this variation means, we are not prepared to state.

A very interesting question concerning the fungus is how it passes the winter. We have seen that the first stage on the pine has not been collected very frequently, and then only in a limited region along the Atlantic Coast, while the stages on the goldenrod, etc., are very widely distributed over the country, and frequently collected. That the I stage is no more necessary for the appearance of the Coleosporium than is the I stage for wheat rust, is made certain by the frequency with which the Coleosporium is collected in Illinois, where the Peridermium has never been found. Since the III stage can infect only the pine, how does the Coleosporium carry over on the Solidago, etc., in regions where the Peridermium does not occur? These regions are often too remote for infection by wind-blown spores of the Peridermium, even if such were common enough for this method of infection, neither is it likely, in the writer's opinion, that such infection comes from the II stage gradually working northward from southern regions, where it may occur the year round.

The possibility of the mycelium of the fungus being perennial in the plants was not borne out by a microscopic examination of stems of infected specimens of *Solidago rugosa*. Badly infested specimens of these were also marked in the field, and after all their parts above ground were dead, their underground rootstocks were placed in crocks in the greenhouse. Half a dozen plants produced from these were kept under observation for nearly a year, and no rust ever appeared on them, so the mycelium is certainly not perennial. Of course it is barely possible in some cases, though this experiment seemed to show that it was not a common method, that a localized infection late in the fall might take place (by uredinial spores being washed down to the partially developed underground rootstocks) and thus carry the fungus over the winter.

In the writer's opinion, however, there is no question but that the fungus is commonly carried over the winter, in all parts of the country, by late fall infections of the II stage on the leaves which often occur in rosettes, especially in young plants, at the surface of the ground. We know that when more or less protected such leaves frequently survive the winter in Connecticut. Asters and goldenrod that are mowed late in the season send out great numbers of basal rosettes, and, in the fall as late as the first of December, the II stage often occurs as abundantly on these as at any time in the year. We have collected the II stage on such plants in December, January, February, March and April. Germination tests of the uredinial spores collected late in January gave as vigorous and abundant germinations as at any time of the year. No doubt some of these infections occur so late that the sori are not developed until spring, since by the first of April the mature sori found are not numerous. One of the earliest spring infections of Coleosporium we have found was on April 29th, on *Solidago sp.* and *Sericocarpus asteroides,* where the new sori occurred only on the lower leaves, indicating that these infections had come from sori or mycelia wintering over on the surviving basal leaves.

3. *Coleosporium Vernoniae* B. & C.

We have never found this species in Connecticut, but Arthur (2, p. 89) lists a specimen on *Vernonia noveboracensis* from this state. It is a rather common fungus on species of Vernonia in the Middle West, where these hosts are more common than here. The I stage is not known, and so far, apparently, no suggestions have been made concerning it, though the connections of related species indicate that it is a Peridermium on the leaves of some species of Pinus.

4. *Cronartium Comptoniae* Arth. (I. *Peridermium pyriforme* Pk.)

I. Plate XXVIII, a-b. Ever since proving the connection between the Peridermium on pine leaves and the Coleosporium on Solidago, we have been on the lookout for a Peridermium on the stems of pines to connect with the only species of Cronartium (on sweet fern) that occurs in this state, since the work of various investigators has shown that the corticolous forms of Peridermia occurring on pine are the aecial stages of Cronartia. Mr. Hawes, the state forester, gave the first clue to the occurrence of the Peridermium on pine trunks when, on questioning, he recalled that he had seen some fungus that worked on certain of the pine trees in the state plantation at Rainbow. He agreed to watch for this fungus, and early in June, 1907, sent specimens of *Pinus sylvestris* that were badly infected with a Peridermium that proved to be *P. pyriforme* Peck. The writer visited the plantation June 15th and found about a dozen trees, five or six years old, that were badly infected with the Peridermium. These trees were in a clearing near a small grove, but a careful search of this failed to show any rust on the sweet fern (*Comptonia asplenifolia*) growing there, or the Peri-

dermium on the native trees of *Pinus rigida* upon which *P. pyriforme* ordinarily occurs. As the rust had been noticed at least two or three years on the infected pines, and as they had been grown in seed beds, a mile or two away, very close to which the sweet fern occurred, there was no question but that they had been infected before transplanting while very young. A short time later the writer learned that this same Peridermium had been found at Storrs, on native specimens of *Pinus rigida,* by Mr. Graff, a botanical student, and on July 21st, through the kindness of Dr. Blakeslee and Dr. Thom, specimens were collected in this locality. On Aug. 1st, specimens were also found in the state forest at Union on the same host.

The Peridermium is perennial in the trunks of the infected host, and does considerable injury to the young specimens, stunting their growth, and probably, in severe cases, killing them. In all the specimens seen, the fungus occurred only on young trees, less than fifteen feet in height. In all of these it was confined to the lower branches, usually next the main trunk, and in the very young trees, to the base of the main trunk and its branches. It caused a slight swelling, and seemed to be confined chiefly to the bark and outer wood. When in its prime the Peridermium is conspicuous, the peridia being much larger than any of the other forms found here, and they are crowded together, encircling the infected stem and extending up some distance upon it. The interlocking teeth or spiny processes (see illustration, Plate XXVIII, b) that show when the peridia break open, are also a distinguishing character. The orange spore mass is gradually emptied, and the peridia flake away, finally leaving few signs by which the infected trees can be detected. This Peridermium is found from the first of June until the last of July.

Arthur (4), in a recent paper, mentions receiving specimens of the Peridermium from Dr. Thom of Storrs, and noting the possible relationship to *Cronartium Comptoniae,* suggests inoculation experiments by those favorably situated to prove this relationship. Some time before, however, the writer had already proved this connection by indoor inoculation experiments in two different tests. In each case spores from the peridia found on *Pinus sylvestris* were sown on the leaves of *Comptonia asplenifolia,* and in about twelve days the uredinia began to appear. Spores sown on species of Solidago and Quercus produced no result. Curiously enough in several germination tests in water in van Tieghem cells, the spores failed entirely to germinate. From our experience with the spores of the different species of Peridermia, however, we have always found them difficult to germinate in this way. The relationship of the Peridermium and Cronartium was plainly indicated both at Storrs and Union, since the infected pitch pine trees were surrounded by sweet fern upon which the rust was common, while it was not found elsewhere in the neighborhood at that time. This, and our infection experiments, also show that the Peridermia on the pitch and Scotch pines are the same species.

II, III. Plate XXVIII, c-d. This Cronartium has been found along the Atlantic States from Canada to North Carolina, but only on the sweet fern and a related species. In this state, the II stage begins to appear about the middle of July, while the telial stage can be looked for about the end of August. The uredinia show as very small, dusty, yellowish pustules on the under surface of the leaves, while the telia are slender, reddish, hair-like growths, more or less clustered into tufts, as shown somewhat poorly in the illustration. So far, in Connecticut, we have seen the Cronartium on the sweet fern only in the neighborhood of infected pine trees. This, and its somewhat limited distribution, indicate that the rust does not commonly carry over the winter on this host, and so would depend each year on renewed infection from the aecial stage. So far as we know, too, the leaves of the sweet fern do not survive the winter, so that the II stage would not be carried over on them.

This rust has been commonly known in this country as *Cronartium asclepiadeum* (Willd.) Fr., a species which occurs in Europe. This is probably the correct view rather than that of Arthur, who considers it as strictly an American species. The infection experiments made in Europe by Klebahn and others have shown that the aecial stage can produce the Cronartium on a number of hosts not very closely related, one of which is an African plant from a region in which the fungus never has been found. This wide range of hosts, and the facts that the different stages of the *Cronartium asclepiadeum* in Europe are at least similar in appearance to those of the American Cronartium, and that *Pinus sylvestris* is a host for the aecial stage in both places, all indicate

the identity of the species. However, successful inoculation of one of the European telial hosts with the American Peridermium is needed to decide the matter finally.

5. *Kuehneola albida* (Kuehn) Magn.

The above rust is commonly known under the name *Chrysomyxa albida* Kuehn. There seems to be some doubt as to its exact systematic position, since some botanists think that it is more closely related to Phragmidium than to Chrysomyxa (Melampsoropsis of Arthur). The writer inclines to the Chrysomyxa relationship, since the telial spores are thin-walled, colorless, and septate like those of Chrysomyxa, and the uredinial stage is not provided with paraphyses, as are the uredinia of Phragmidia on Rubus species. Studies were made to determine its first stage, so that this question could be settled more definitely, but unfortunately the results were not conclusive. If closely related to Chrysomyxa, the I stage no doubt is some species of Peridermium (*P. Peckii*, for instance), while, if closely related to Phragmidium, such an aecial stage is improbable, and might be supplied, as has been suggested, by *Uredo Muelleri*. We give a discussion of these two fungi before proceeding to the known stages of the Kuehneola.

? I. Plate XXIX, a. *Peridermium Peckii* Thm. has for its host *Tsuga canadensis*, and is apparently confined to North America, while *Kuehneola albida* has a much wider distribution. The Peridermium occurs on the under side of the leaves in two parallel rows, one on either side of the midrib, and forms slender, white, fragile peridia that usually split into temporary filaments upon their dehiscence. Ordinarily this aecial stage does not occur abundantly, usually only one infected leaf showing on a branchlet. According to Arthur and Kern (5, p. 434), who report only seven collections, *P. Peckii* has so far been reported only from the Eastern United States. The writer has found this species, while not usually abundant, still not uncommon in Connecticut, the following specimens having been collected here: Coventry Lake, July 20, 1907; Stafford Springs, July 31, 1907; Storrs, July 22, 1907; Union, Aug. 1, 1907; Westville, July, 1888 (Thaxter), July 12, 27 and 28, Aug. 4, 1907. In some of these collections only a very few infected leaves were found, but at Storrs the fungus was very common on certain trees. In practically all of the cases the leaves near the ground were the ones infected, but on one very badly infested tree the fungus was found as high as twenty feet from the ground.

As soon as this Peridermium was found a search was commenced for the stages on the alternate host, but without finding anything suspicious until at Storrs the swamp blackberry (*Rubus hispidus*), underneath abundantly infected hemlock trees, was found infested with *Kuehneola albida*. Examples were seen here where the two hosts almost touched each other, each infected with its fungus, and in general the swamp blackberry had its rust only when situated beneath infected hemlock trees. A few days later, at Stafford Springs, another case was found where infected leaves of the hemlock were close to rusted leaves of the swamp blackberry, while other specimens of the blackberry further away were free. As no other rust was at any time found so situated as to suggest a probable relationship, the writer became convinced of the connection of these two.

Infection experiments in the greenhouse, using spores from this Peridermium on leaves of *Rubus hispidus,* were tried on three different occasions, but no infection resulted, except possibly in one case when one sorus of the II stage of this Kuehneola appeared about sixteen days afterward. As the plants used were recently transplanted, most of the leaves finally dropping off, this might explain the failure to infect the host; but on the other hand, as the plants came from an infected region, though from a spot apparently free from the rust, the single sorus that finally developed may not have come from the spores used, but from a previous outdoor infection.

The most unfavorable point against the relationship of *Peridermium Peckii* and *Kuehneola albida,* however, is that with this Peridermium on the hemlock leaves there occurs a pycnial stage, while with the Kuehneola on the Rubus host there is sometimes found a uredinial stage known as *Uredo Muelleri* also having pycnia. This Uredo is believed by some, though its exact relationship apparently has never been proved by cultures, to be merely the primary uredinium (II′) of the Kuehneola. If it really is, then the Peridermium probably has no relationship to the Kuehneola, since no rust is known that has pycnia connected with more than one of its stages. From these considerations it

readily appears that further infection experiments are necessary to determine the relationship, if any, of *Peridermium Peckii, Uredo Muelleri,* and *Kuehneola albida*. Farlow (10, p. 72) has also suggested a possible relationship of *P. Peckii* to *Calyptospora Goeppertiana;* and it is barely possible, though not likely, that it is connected with the Necium discussed later.

II′. Plate XXIX, b. *Uredo Muelleri* Schroet. differs from the II stage of *Kuehneola albida* in having its sori in groups usually on the upper side of the leaves, a few large uredinia and pycnia occurring together there, while the smaller uredinia of Kuehneola occur scattered on the under side of the leaves and without pycnia. Mueller, who first described the species as *Uredo aecidioides,* according to Schroeter (Krypt. Fl. Schl. III[1]: 375) thought that it might possibly be the aecial stage of *Chrysomyxa albida,* since both were found together. That they have some relationship is further indicated by the fact that not only have they been found together in Europe and also in America, but on several different species of Rubus. In the specimens collected in Connecticut on *Rubus hispidus,* both at Storrs and Stafford Springs, this Uredo occurred on the same plants with the II and III stages of *Kuehneola albida.* The two have also been found elsewhere in New England associated on this same host. Dietel (Hedw. 44: 122. 1905) has recently suggested that *Uredo Muelleri,* instead of being the aecial stage of *Kuehneola albida,* is a primary uredinial stage of it that merely functions as the aecial stage.

II, III. Plate XXIX, c. The II or uredinial stage of *Kuehneola albida* is the more common and injurious of these two stages. It has been reported on several species of Rubus from the United States, and extends over a wide district. While not a very common fungus, when it does occur it is often abundant. The sori are very small, and show as yellowish circular outbreaks scattered over the under side of the leaves. The telial sori often occur on the same leaves with these, but are easily distinguished by their white color. The telial spores found here last summer had all germinated before the middle of July. In the specimens first found on the swamp blackberry both of these stages occurred on the old leaves (the III being limited to these) that had lived over the winter, and as we have also found the II stage as late as November 30th, we have no doubt but that on this host the fungus carries over the winter through the uredinial stage, and so the I stage is not essential for its appearence the next year. The collections so far made in this state are as follows: *Rubus hispidus,* Storrs, II and III, July 22, II, Oct. 18, 1907; Stafford Springs, II and III, July 31, 1907; Westville, II, Nov. 30, 1907; *Rubus villosus,* Storrs, II, July 23, II, Sept. 30, 1907.

6. *Melampsoridium Betulae* (Schum.) Arth.

Plate XXXI, b. (From a specimen in Seym. Econ. Fungi *231, b*). This is a fungus that is not very often collected in the United States, but apparently occurs as frequently in New England as anywhere. Though careful search was made for it in Connecticut the past season, it was not found. The writer, however, is indebted to Professor Farlow for specimens collected on September 20, 1890, by Setchell at Norwich, on *Betula populifolia.* Only the II stage occurs on these. While both the II and III stages have been found in the United States, the I stage has never been seen here. According to Klebahn (Zeitschr. Pflanzenkr. 9: 18. 1899) this stage occurs on the leaves of Larix, and has been found in several places in Europe. A careful search for this [*Peridermium Laricis* (Kleb.) Arth. and Kern] on wild and cultivated larches in this state last year gave no evidence of its presence. Just how the fungus passes the winter in this country and reappears on the Betulae is unknown. As the leaves of the Betulae do not survive the winter, reinfection from the II stage on them is not probable. Though not known, possibly the uredinia sometimes occur on the young twigs, and by this means carry over the fungus.

7. *Melampsoropsis Cassandrae* (Pk. & Clint.) Arth.

(I. *Peridermium consimile* Arth. & Kern.)

I. Plate XXX, a. The writer (7) has recently shown the relationship of *Peridermium consimile* on *Picea nigra* to *Melampsoropsis Cassandrae* on *Cassandra calyculata.* Both of these fungi were found in Connecticut for the first time last year. The only locality in which the Peridermium was found was in a spruce swamp along the railroad just beyond West Willington toward Stafford Springs. When first seen there on July 31st,

the aecia were just beginning to shed their spores, and when seen again on September 28th, they were far beyond their prime. The aecia occur irregularly in one or two rows on the leaves, usually four to eight on each leaf. The infected leaves are discolored yellowish, and look as if they would be shed prematurely, but there is no indication of a witches' broom formation. The peridia, as shown in the illustration, are somewhat flattened, and about as long as high. They break open irregularly at the top to shed the orange-colored spores, and then gradually wear away. A striking feature of this species is the very conspicuous reddish-brown pycnia, which show plainly in the illustration as the small black specks.

The only rust suitable for the alternate stages found in the vicinity of this Peridermium during the season was the II stage of *Melampsoropsis Cassandrae* on the leather leaf under the infected spruce trees. Specimens of the leather leaf from the edge of the swamp, away from the infected spruces, were collected and transplanted in crocks in the greenhouse. These were watched carefully, and two or three plants, upon which a sorus or two of the Melampsoropsis appeared, were discarded. Other specimens apparently entirely free from the rust were inoculated with the spores of the Peridermium, and about sixteen days later the uredinial sori appeared on a number of the plants. This experiment was repeated a short time later, using spores from leaves for a short time in a damp chamber, and the infection took place in this case in about eight days. Infection experiments with the spores on *Rubus hispidus* and *Pyrola elliptica* failed to produce anything. While necessity compelled the use of *Cassandra calyculata* from the infected locality, the results indicated that the sori obtained came from the Peridermium spores used in the experiments. It is hoped, however, to repeat the inoculations again the coming year with plants entirely above suspicion.

II. Plate XXX, b. The uredinia occur as minute orange-yellow dusty outbreaks on the under side of the leaves. So far we have been unable to find any suggestion of the telial stage on this host, though a careful search was made for it during July, September, October, January and February.* Arthur describes this stage, but apparently from other hosts. Last October the II stage was found on the leather leaf in Beaver Swamp, at

*See addenda, p. 396.

Westville, and as no spruce trees are anywhere near, there is no doubt that the fungus can survive without the aid of the aecial stage. In January a careful examination of the plants in this locality was made, and a few old uredinia were found on the living leaves, which largely remain on the plants over the winter. Some of the branches, after the infected leaves were removed, were placed under a bell jar indoors, and a few new uredinia soon appeared, no doubt from nearly matured sori. No others showing during the next week, the branches were left undisturbed for about a month, when an examination revealed several hundred uredinia present. These observations show that the fungus can pass the winter, on the old but living leaves that adhere to the plants, through the more or less matured uredinia, or no doubt in some cases, when infection takes place late in the season, through localized mycelia which gives rise to the uredinia in the spring.

8. *Melampsoropsis Pyrolae* (DC.) Arth.

Plate XXXI, a. This is commonly known as *Chrysomyxa Pyrolae,* and occurs in the United States chiefly in the Northeastern States and the Rocky Mountains on various species of Pyrola. So far in this state only the II stage has been found, and this is striking when once detected, since the under surface of the infected leaves is thickly covered with brightly colored uredinia. The collections for this state are as follows: *Pyrola elliptica,* Storrs, May, 1904 (Graff); *Pyrola rotundifolia,* Pine Rock in Westville, May, 1894 (Sturgis, Fungi, Col. *1814*); West Rock, 1902 (Clinton); Vernon, May 25, 1907 (Weatherby). No aecial stage has yet been discovered for this species. According to Arthur and Kern (5, p. 432), Rostrup has suggested that *Peridermium conorum-Piceae* (Reess) Arthur and Kern may have this connection, since both are found in somewhat the same localities in Europe and America. A search for this Peridermium failed to reveal its presence in Connecticut, though possibly it occurs in the northwestern part of the state since it has been found in New York and Northern New England. Apparently the aecial stage is not necessary for the appearance of the rust, as the leaves of the Pyrolae frequently live over the winter and could easily carry over the uredinial stage.

9. *Necium Farlowii* Arth.

This species, found on hemlock, *Tsuga canadensis,* has recently been made the type of a new genus by Arthur (2, p. 114), who bases his description on material furnished by Farlow, and collected by Seymour at Chebacco Lake, Mass., and by Farlow at Lake Sunapee, N. H. Arthur describes only the telial stage, and characterizes the genus as having only telia and possibly pycnia. He neglects to state, however, that Seymour collected at the same time, and possibly on the same trees, a species of Caeoma which might very well be the aecium of this fungus. Farlow (9) was the first to call attention to these fungi. He says:—"Besides our common Chrysomyxa on Pyrola, a species was found on *Abies Canadensis* at Chebacco Lake, Essex Co., Mass., by Mr. A. B. Seymour, in June, 1883. This is probably the same as *Chrysomyxa Abietis* of Europe, although, as the spores were not quite ripe, one cannot be certain. If there is a difference, it is to be found in the fact that the teleutospores are arranged in threads, which branch less than the European forms. But at a later stage of development, this supposed difference might disappear. At the same time and place Mr. Seymour found another interesting species of Urediniae, also on *Abies Canadensis,* not on the same branches as the species last mentioned, nor on the same trees, as far as can now be ascertained. Spermagonia were abundant on both sides of the leaves, on whose under surface were elliptical or elongated sori of a pale yellow color, arranged in two rows parallel to the midrib. The spores were globose, or somewhat elliptical, about 13-17 μ in length, and appeared to be borne in chains, composed of a small number of spores. It is possible that this form is *Caeoma Abietis-pectinatae* Reess, of which I have seen no specimens. From the description of Reess, however, this species has larger spores than ours, and no mention is made of spermagonia. It may be well to designate our form under the name *Caeoma Abietis-Canadensis* until more exact information can be obtained."

The writer is indebted to Professor Thaxter for a specimen of this Necium collected by him on the cones of hemlock at Hamden, Conn., July 18, 1889, and for another on the branches and leaves from North Carolina. While these specimens show only the telium, Thaxter wrote on the label of the Hamden specimen, "teleutospores of Caeoma on hemlock cones," and in a letter written to Professor Farlow, July 12, 1890, said: "I sent you yesterday fresh cones with mature teleutospores, one having both Caeoma and teleuto forms side by side. I found a quantity of material at New Hartford, Conn., but a careful examination of the leaves on branches where the infected cones were hanging by dozens revealed nothing. The 'Chrysomyxa' which I formerly sent you from North Carolina on the same host occurred only on young shoots, running from them into the leaves. Though very common in North Carolina, I did not find it on the leaves of any but affected shoots. I find nothing of the sort here, though I have looked for these affected shoots, which are conspicuous. I have found the Caeoma on shoots, of which I sent you a specimen, twice only." The writer has never collected this Necium in Connecticut, though Thaxter found it not uncommon at the time of his collections, but has seen a specimen of *Caeoma Abietis-canadensis* found by Dr. Britton very sparingly in June, 1906, on hemlock leaves in Westville.

Arthur describes the Necium as occurring on the leaves, while Thaxter's specimens show the telia on the cones and young stems as well, thus indicating that it is sometimes perennial. On the cones and twigs, at least, the spores seem to originate beneath the epidermal cells instead of in them, as stated by Arthur. The sori on these parts are also often crowded together so that the spores from a continuous layer (especially on the cone scales), across the entire microscopic section. (Plate XXXII, 5.) This gives them the general appearance of being an epidermal layer of the plant tissues, though they are quite unlike the true epidermal cells. The sori, where distinct, range from 60—120 μ in depth by 70—300 in length. The simple, slightly tinted oblong spores are very closely compacted together, so that in mature sori they are narrower and more elongated than in the immature. Frequently they are slightly broader and more deeply tinted at the apical end, and very rarely have a septum above their base. They seem to be somewhat larger than those on the leaves, as given by Arthur, since they vary from 40—85 μ in length by 6—14 μ in width, the shorter and broader often being immature. They arise from septate basal cells of about equal diameter, which in turn develop from the mycelial threads that ramify through the plant tissues beneath. In sections of the stem the mycelium shows very abundantly and no doubt is responsible

for the distortion of the young stems, which are slightly swollen and sometimes more or less curved. The fungus gives a reddish tinge to both the infected stems and cones, due to the superficial colored sori.

While not exactly like *Chrysomyxa Abietis,* which has septate spores, and even less like *Calyptospora Goeppertiana,* this species has perhaps more the characters of the Melampsora-like genera, so everything considered, it will perhaps rest easiest for the time being in the new genus created for it by Arthur. While there is no positive proof that *Caeoma Abietis-canadensis* has any connection with the Necium, the fact that a Caeoma has been found on the leaves, cones and stems, and in some cases associated with the Necium, very strongly indicates a relationship. If this is so, or if Arthur is correct in believing that the Necium has no other stage, of course the fungus does not really come within the limits of this article. It is included here because of the possibility that it may have for its aecial stage some species of Peridermium. For example, *Peridermium Peckii* occurs on the same host, and there is a bare possibility that the two are connected, since Professor Farlow writes that he found them near together at Lake Sunapee.

10. *Pucciniastrum Agrimoniae* (Schw.) Tranz.

Plate XXXI, c. So far no aecial stage has been found for this fungus, which in its uredinial stage is rather common in Europe and America. Presumably if it possesses an aecial stage, this is one of the Peridermia since, where known, species of this genus have such connection. The uredinia occur on the under side of the leaves of various species of Agrimonia, forming numerous, scattered, pale-orange or yellow, minute outbreaks, as shown in the illustration. The uredinia of this genus have a rather definite peridium, which opens by a pore, guarded by more or less differentiated neck cells. In this species the peridia are not sunken very deeply in the tissues, and are held in place by the overlapping epidermis. In general they are lenticular to subcircular in cross section, and vary from 90—180 μ in height by 160—360 μ in width. The neck cells are somewhat differentiated, but are not nearly so characteristic as in some of the other species (*P. arcticum americanum,* see Plate XXXII, 3), being somewhat larger, thicker walled, and more spore-like in appearance than the other peridial cells, which are frequently rather indistinct and semi-gelatinized. The spores are rather sparsely covered with inconspicuous echinulations, vary from ovoid to subspherical, occasionally flattened or more irregular, and are 15—20 μ, rarely 24 μ, in length.

The telia of this fungus were first described by Dietel (Hedw. **29**: 152) in 1890, but are not commonly recognized, probably because they develop late in the season, and in the specimens we have collected do not show to the naked eye. In cross sections of the leaf of one of the collections made on October 17, this stage was shown to be present. The sori occurred beneath the epidermal cells, and were characteristic of true Pucciniastrum telia; that is, in cross section the spores showed as twin cells, but when viewed from above, as four cells firmly bound together (see illustration, Plate XXXII, 4). Where the sori are abundant, the individuality of the cells is almost entirely lost by being crowded together. The compound spores vary from oval to subspherical, and are about 19—28 μ in length.

11. *Pucciniastrum minimum* (Schw.) Arth.

Neither the aecial or telial stage is known for this fungus according to Arthur. We found its uredinal stage on cultivated Azalea sp., August 14th, 1902, in a Westville nursery, where it was very abundant. No clue was obtained to its other stages, and as these plants were soon disposed of, it has not been seen since. The aecia show as very minute orange-yellow outbreaks on the under side of the leaves. The peridia are slightly imbedded in the tissues, are hemispherical to conical flattened, and about 70—85 μ high by 140—180 μ wide. The neck cells are thick-walled, and not especially marked or prominent. The spores are ellipsoidal or occasionally more elongate, minutely echinulate, and 16—25 μ in length.

12. *Pucciniastrum pustulatum* (Pers.) Diet.

In Europe the above species has been connected by Klebahn (Zeitschr. Pflanzenkr. **9**: 22-6. 1899) with a Peridermium on *Abies pectinata,* but so far the aecial stage has not been found in this country. Possibly *Peridermium balsameum* Pk., a related species on *Abies balsamea,* is this stage, though according to Farlow (10, p. 20) it has been conjectured that this Peridermium belongs to the American species of the Calyptospora on Vaccinia. Blakeslee sent the writer, in August, 1907, *Peridermium balsameum* from the Adirondacks, where the only suspicious alternate forms found were the II and III stages of *Pucciniastrum arcticum* var. *americanum* Farl. on *Rubus strigosus.* (Described in Rhodora **10**: 13. Ja. 1908.) Thus, while the specific ties of this Peridermium are doubtful, it seems certain that it is connected with some Pucciniastrum (in the wide sense, including Calyptospora).

The II and III stages of *Pucciniastrum pustulatum* occur on various species of Epilobium scattered over the United States. Only one collection, and then only of the II stage, has been made in this state, on Epilobium sp., at Hartford, Oct. 20th, 1902. The peridia seem to be composed of plant and fungous cells, and are hemispherical or decidedly flattened, slightly immersed in the tissues, and about 45—115 μ high by 165—300 μ wide. The neck cells, while somewhat more prominent than the other peridial cells, have no especial markings, and seem to be rather fugacious.

13. *Pucciniastrum Pyrolae* (Pers.) Diet.

This is another species of Pucciniastrum widely distributed over the United States, whose aecial stage is unknown, but which, like the others, is supposed to be a Peridermium. The only specimens collected in this state were of the II stage, found at Storrs, July 24, 1907, on *Pyrola elliptica.* This is a much less conspicuous fungus than the *Melampsoropsis Pyrolae* which occurs here on the same host. Apparently the fungus carries over the winter through the uredinia on infected leaves. While no clue to its aecial stage was obtained, it is not likely to be either *Peridermium Peckii* or *P. balsameum,* since infection experiments with these species on this host failed to give results.

SPECIES NOT YET REPORTED BUT PROBABLY OCCURRING IN CONN.

The following species have not yet been found in this state, but very probably will be collected here sometime as they have been listed from adjacent states.

1. *Calyptospora columnaris* (Alb. & Schw.) Kuehn (*C. Goeppertiana*) on Vaccinium sps. (I. *Peridermium columnare* (Alb. & Schw.) Schm. & Kze. on Abies sps. Not yet

reported in America. *Peridermium Peckii* and *P. balsameum* have been suggested as possibly belonging to this Calyptospora.)

2. *Coleosporium Helianthi* (Schw.) Arth. on Helianthus sps. (Peridermium unknown.)
3. *Coleosporium Senecionis* (Schum.) Fr. on Senecio sps. (I. *Peridermium oblongisporium* Fckl. on leaves of *Pinus sylvestris.* Not yet found in America.)
4. *Cronartium Comandrae* Pk. on *Comandra umbellata.* (Peridermium unknown.)
5. *Cronartium ribicola* Waldh. on Ribes sps. cult. (I. *Peridermium Strobi* Kleb. on branches of *Pinus Strobus.* Liable to be introduced on white pine imported from Europe.)
6. *Melampsorella elatina* (Alb. & Schw.) Arth. (*M. Caryophyllacearum*) on Caryophyllaceae. (I. *Peridermium elatinum* Alb. & Schw., Schm. & Kze. on *Abies balsamea.*)
7. *Pucciniastrum arcticum americanum.* Farl. on *Rubus strigosus.* See Pl. XXXII, 3. (Peridermium unknown but possibly *P. balsameum*; see page 393.)
8. *Pucciniastrum Myrtilli* (Schum.) Arth. (*P. Vacciniorum*) on *Gaylussacia* sps. and Vaccinium sps. (Peridermium unknown.)

LITERATURE.

The following are a few of the American references relating to our Peridermia and their probable alternate stages:

1. **Arthur, J. C.** Peridermium on *Pinus rigida.* Journ. Myc. **11**: 52. Mr. 1905.
   Failed to infect leaves of *Lobelia syphilitica* with spores of above fungus.
2. **Arthur, J. C.** Uredinales. North Amer. Flora. **7**: 85–123. Mr. 1907.
   Gives within these pages the heteroecious rusts of N. A. having Peridermia for their aecial stage, describing all the stages so far as known.
3. **Arthur, J. C.** *Cronartium Quercus* (Brond.) Schroet. Journ. Myc. **13**: 194. S. 1907.
   Produced above fungus on *Quercus velutina,* but not on *Q. alba,* by using spores of *Peridermium cerebrum* from *Pinus virginiana.*
4. **Arthur, J. C.** *Peridermium pyriforme* and its probable alternate host. Rhodora **9**: 194–5. S. 1907.
   Suggests from observations made by Dr. Thom of Conn., that the above is the aecial stage of *Cronartium Comptoniae.*

5. **Arthur, J. C. and Kern, F. D.** North American species of Peridermium. Bull. Torr. Bot. Club **33**: 403–38. Au. 1906.
   Give general discussion, keys, descriptions, synonyms, hosts, and distribution of thirty species.
6. **Clinton, G. P.** *Peridermium acicolum,* the aecial stage of *Coleosporium Solidaginis.* Science **25**: 289–90. F. 1907. (Also note in Ann. Rep. Conn. Agr. Exp. Stat. **1906**: 320. My. 1907.)
   Proves by observations and inoculation experiments the relationship of the above rusts.
7. **Clinton, G. P.** Notes on certain rusts with special reference to their Peridermial stages. Science **27**: 340. F. 1908.
   Proves by infection experiments the relationships of *Peridermium pyriforme* to *Cronartium Comptoniae* and *P. consimile* to *Melampsoropsis Cassandrae,* and suggests possible relationship of *P. Peckii* to *Chrysomyxa albida.*
8. **Farlow, W. G.** Appalachia **3**: 239–43. Ja. 1884.
   Gives notes on Peridermia of the White Mountains.
9. **Farlow, W. G.** Notes on some species of Gymnosporangium and Chrysomyxa of the United States. Proc. Amer. Acad. Arts Sci. **20**: 322–3. 1885.
   Gives notes on *Chrysomyxa Ledi,* II, III, and *Uredo Ledicola,* on Ledum, and suggests Peridermium (probably *P. Abietinum*) on *Abies nigra* may be associated with former; thinks *Aecidium pseudo-columnare* of Kuehn may be the same as *P. balsameum* of Peck; also gives notes on *Chrysomyxa Abietis* (?) and *Caeoma Abietis-Canadensis.*
10. **Farlow, W. G.** Aecidium sps. Bibl. Ind. N. A. F. S. 1905.
   Gives bibliography of the species of Peridermium (under the form genus Aecidium) with notes upon the following: *Aecidium Abietinum* (p. 13), *A. balsameum* (p. 20), *A. carneum* (p. 25), *A. cerebrum* (p. 27), *A. conorum-Piceae* (p. 35), *A. decolorans* (p. 38), *A. deformans* (p. 39), *A. elatinum* (p. 40), *A. ornamentale* (p. 71), *A. Peckii* (p. 72), *A. Pini* (p. 75).
11. **Farlow, W. G. and Seymour, A. B.** Prov. Host Index Fungi U. S.: 158–170. 1891.
   List, under the various hosts, species of Peridermia that have been reported for the U. S.
12. **Freeman, E. M.** Minnesota Plant Diseases: 275–7. Jl. 1905.
   Gives notes on pine stem rust, leaf rust of pines (suggests relationship to rusts on asters and goldenrod), and witches' broom of balsam fir.
13. **Kellerman, W. A.** Pine rust, *Peridermium Pini.* Journ. Myc. **11**: 32. Ja. 1905.
   Sowed spores of *"Peridermium Pini"* obtained from Ohio on *Campanula Americana* outdoors and produced urediniospores, thus proving the fungus on the pine to be the aecial stage of *Coleosporium Campanulae.*

14. **Peck, C. H.** *Peridermium pyriforme* Pk. Bull. Torr. Bot. Club **6**: 13. F. 1875.
Describes this as a new species on pine branches, probably from Newfield, N. J.

15. **Seymour, A. B.** *Peridermium Pini* Lév. var. *acicolum* Wallr. Eco. Fungi *223*. 1893.
States that this species on *Pinus rigida* is commonly associated with Cronartium on *Myrica asplenifolia.*

16. **Shear, C. L.** *Peridermium cerebrum* Pk. and *Cronartium Quercuum* (Berk). Journ. Myc. **12**: 89–92. My. 1906.
Gives results of outdoor inoculation experiments by which the Peridermium is shown to be the aecial stage of the Cronartium; gives hosts and distribution of each.

17. **Underwood, L. M. and Earle, F. S.** Notes on pine-inhabiting species of Peridermium. Bull. Torr. Bot. Club **23**: 400–5. O. 1896.
Give notes on three species from Eastern U. S., and mention three others from the western part which they have not examined.

ADDENDA.

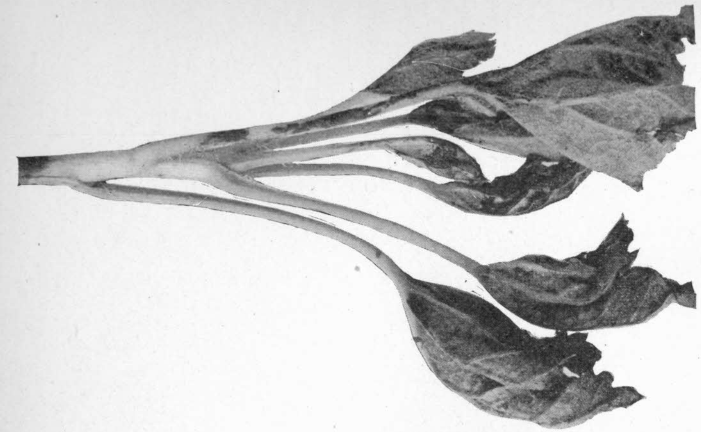
(1) See *Kuehneola albida,* p. 383. The writer is indebted to Professor Farlow for calling his attention to an infection experiment with this rust by Ernest Jacky, published in the Cent. Bak. Par. Infek. **18**: 91-3. February, 1907. This writer claims to have produced *Uredo Muelleri* on *Rubus fruticosus* from *Phagmidium* [*Kuehneola*] *albidum* on the same host. As this experiment was conducted in the woods merely by laying infected leaves on the plants, and as these leaves came from plants which also contained *Uredo Muelleri* at that time, there may be some question about his conclusion. In a late more careful experiment, using *Uredo Muelleri* he produced *Uredo Muelleri,* apparently as he claims.

(2) See *Melampsoropsis Cassandrae,* p. 386. On May 4, 1908, just as this paper was going to press, the writer succeeded in finding the III stage of the above fungus on *Cassandra calyculata,* at Beaver Swamp, Westville, on the same plants that the II stage was found on during the previous fall and winter. The sori are small, about one-eighth of an inch or less in diameter, are situated on the under surface of the leaves (though also discoloring the upper surface) and show to the naked eye as slightly elevated, waxy, chestnut-red areas. These may be distinct or somewhat run together, and under a hand lens seem to consist of more minute divisions really caused by the leaf venations. The sori at this time were scarcely mature, but undoubtedly some of them would mature very shortly. Their season, apparently, is from May to June, which is the only time of the year I had not before looked for this fungus.

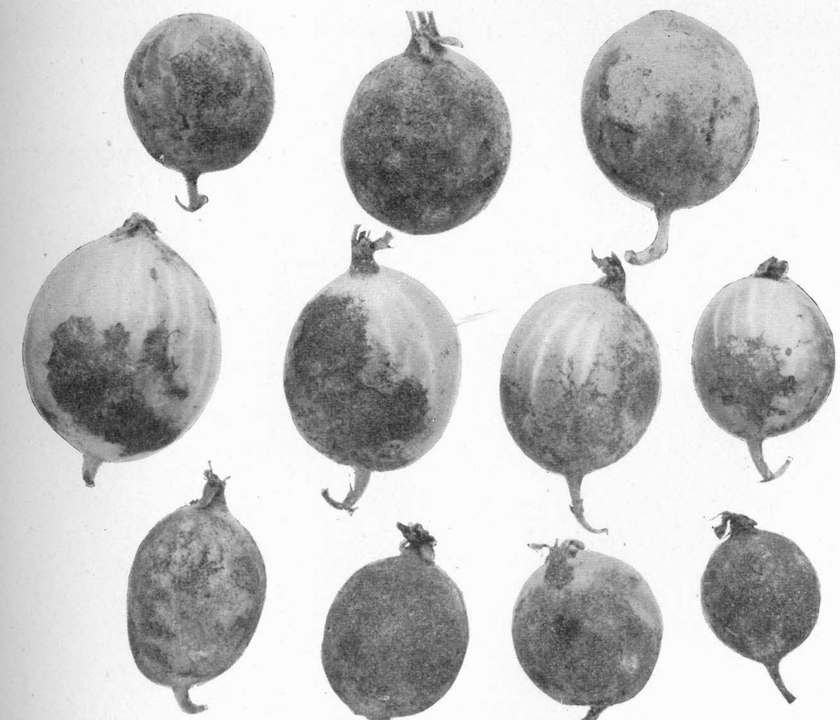
a. Baldwin Spot, p. 340.

b. Spray Injury, p. 342.

TROUBLES OF THE APPLE.



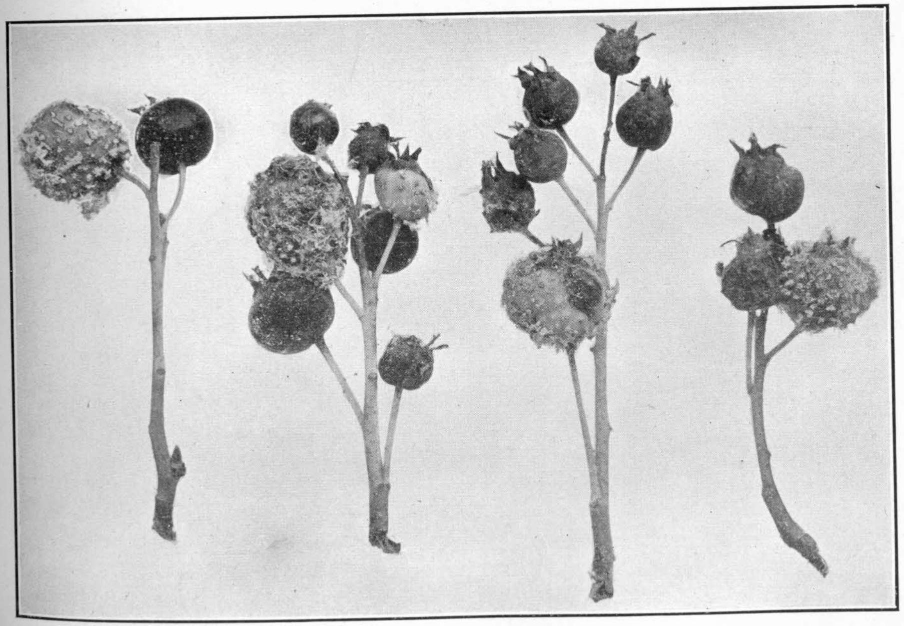
a. On young Currant shoot.



b. On fruit of Gooseberry.

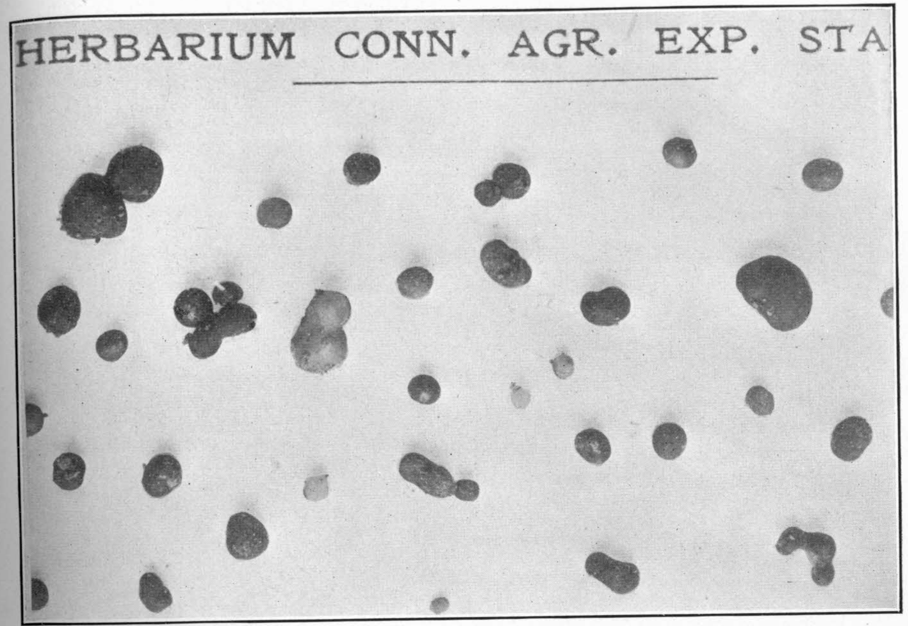
POWDERY MILDEW, *Sphaerotheca mors-uvae*, p. 348.

a. Leaf Scorch of Farleyense Fern, p. 349.

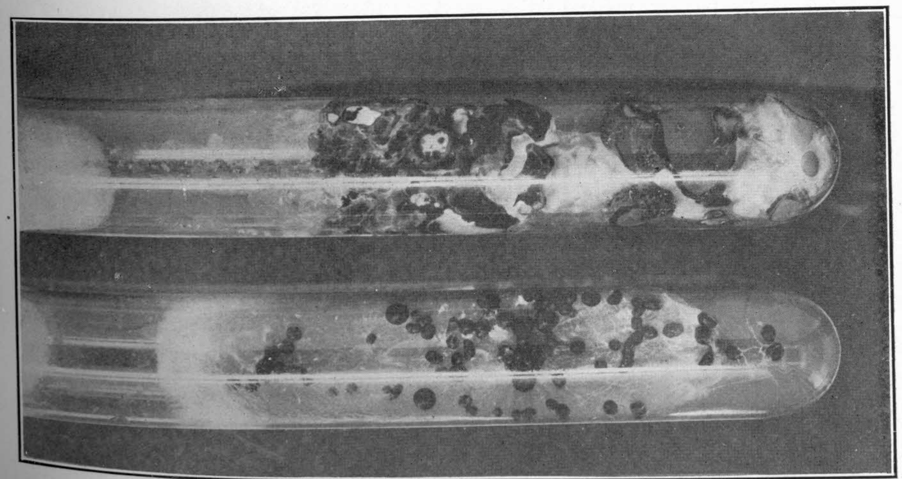


b. Rust of Juneberry, p. 351.

DISEASES OF FERN AND JUNEBERRY.



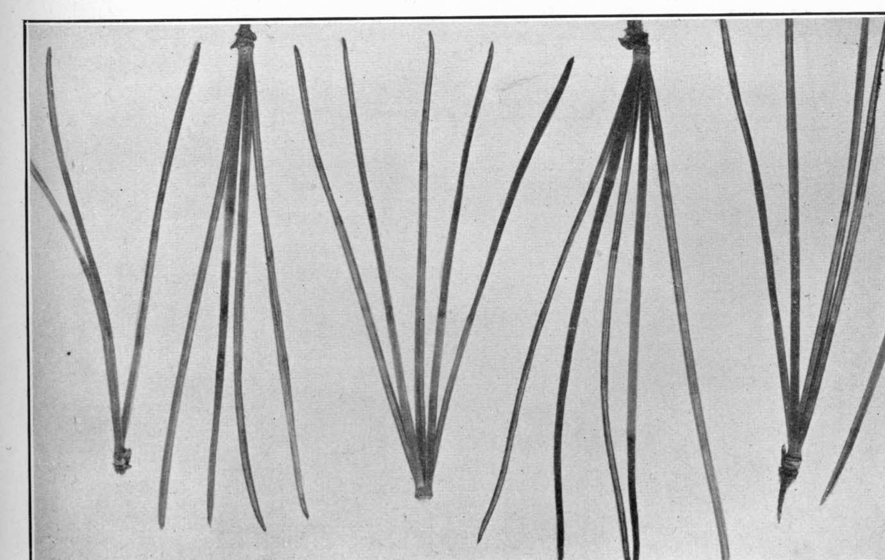
a. Sclerotia from the soil. × 2.



b. Artificial cultures on corn meal and agar.

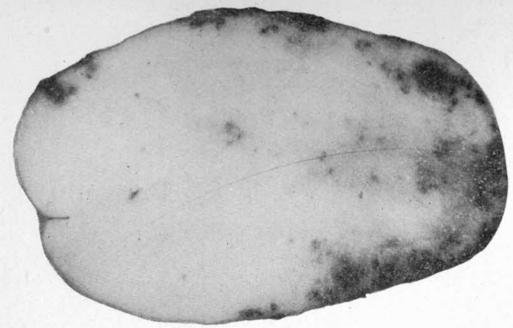
STEM ROT FUNGUS OF HERBACEOUS PLANTS, p. 351.

a. Showing effect on size of leaves.



b. Showing injury to leaves. × 2.

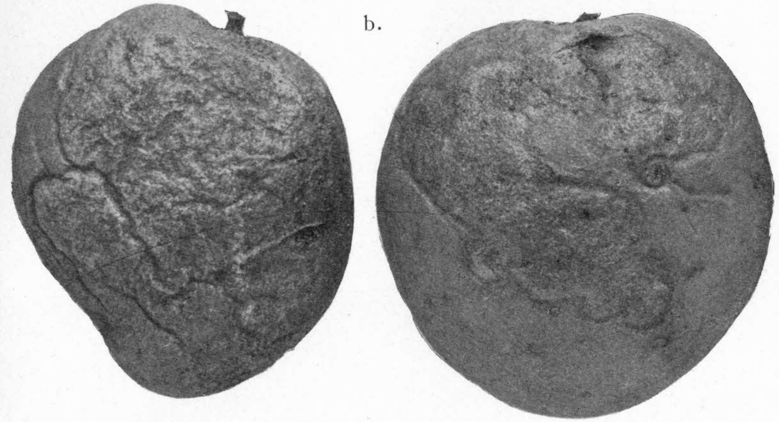
BLIGHT OF WHITE PINE, p. 353.



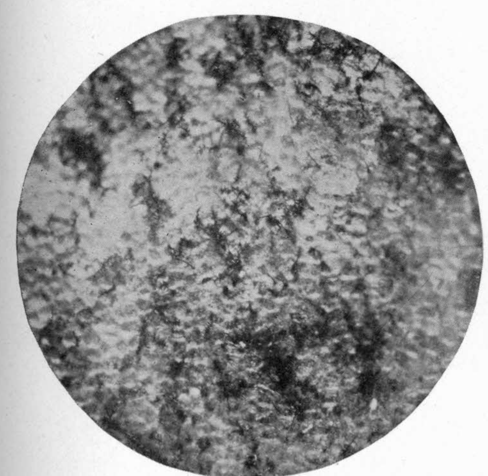
a. Internal Brown Spot, a physiological trouble, p. 355.

b–d. Scurf, caused by *Spondylocladium* fungus, p. 357.

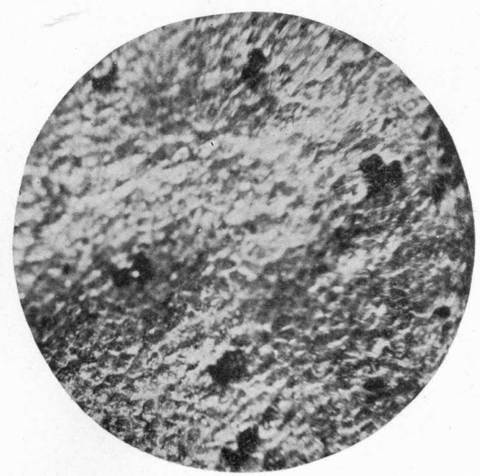
b.



Surface of tubers greatly ×.



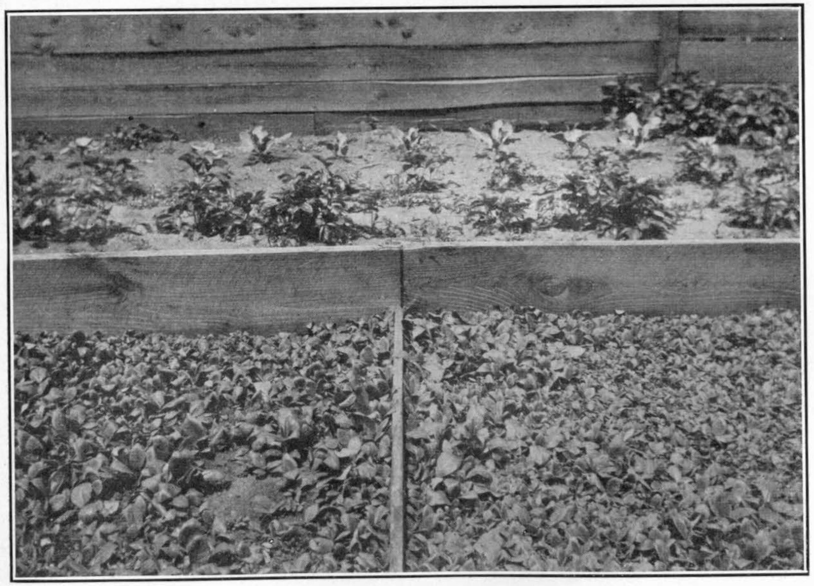
c. Spore stage.



d. Sclerotia.

DISEASES OF POTATO TUBERS.

a. Formalin. (Plot 1) b. *Steam. (Plot 2)

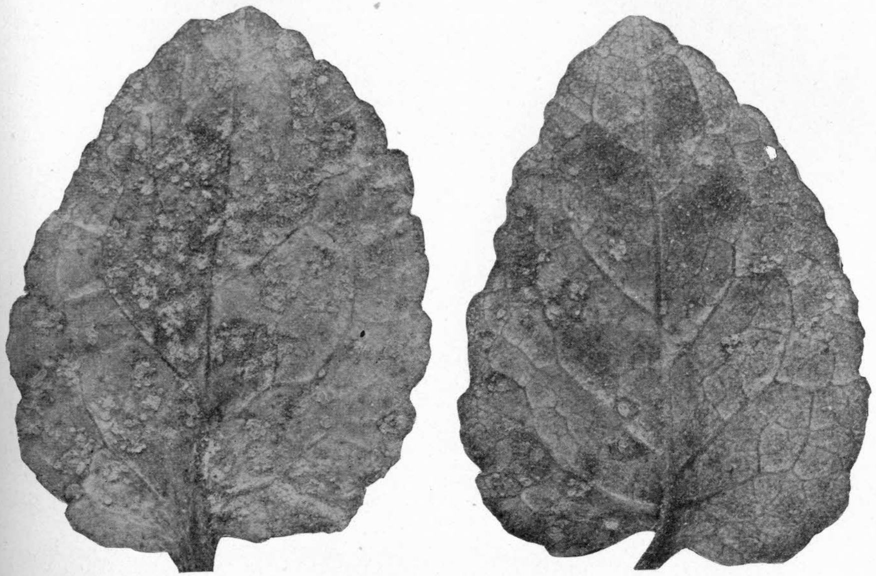


c. Weak formalin sprinkled. (Plot 5) d. Check, no treatment. (Plot 6)

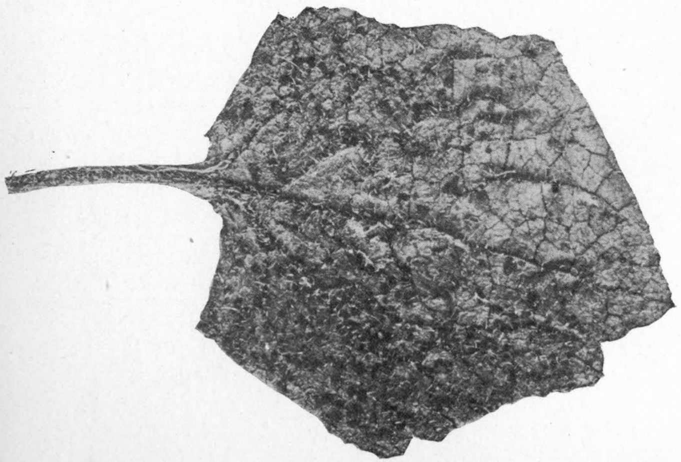
(*Shortly before photographing, the best plants were pulled, so this should really show somewhat better than *a*.)

TREATMENT OF TOBACCO SEED BEDS FOR ROOT ROT, p. 365.

a. I on *Pinus rigida*. × 4.

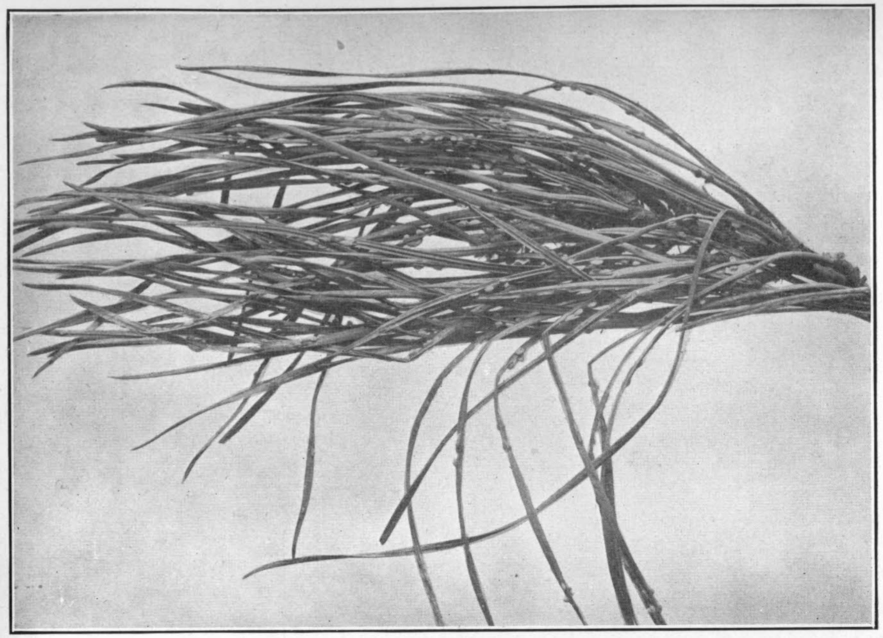


b. II on *Campanula rapunculoides*. × 2.



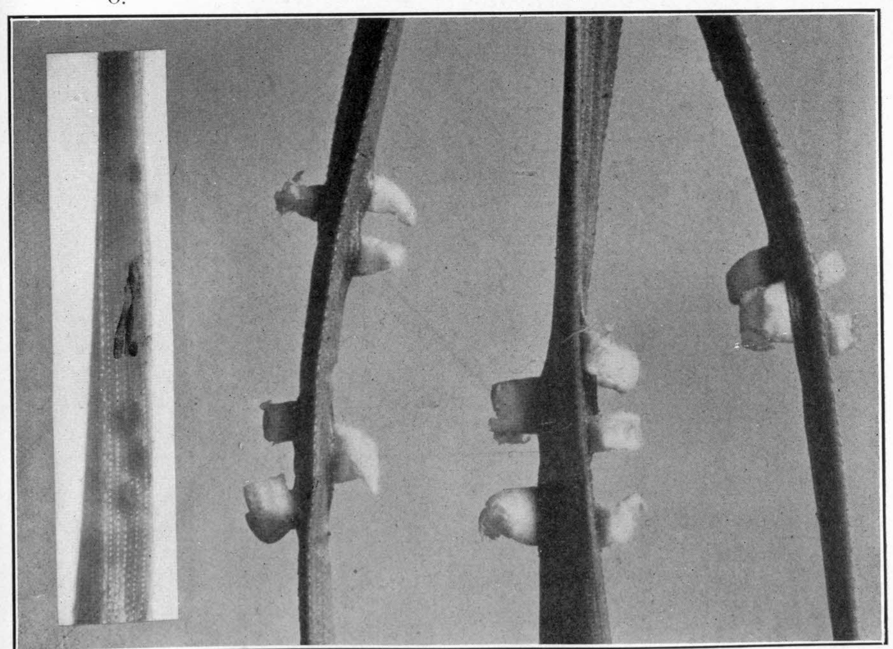
c. III on *Campanula rapunculoides*. × 4.

I (*Peridermium Rostrupi*), II, III STAGES OF *Coleosporium Campanulae*, p. 374.



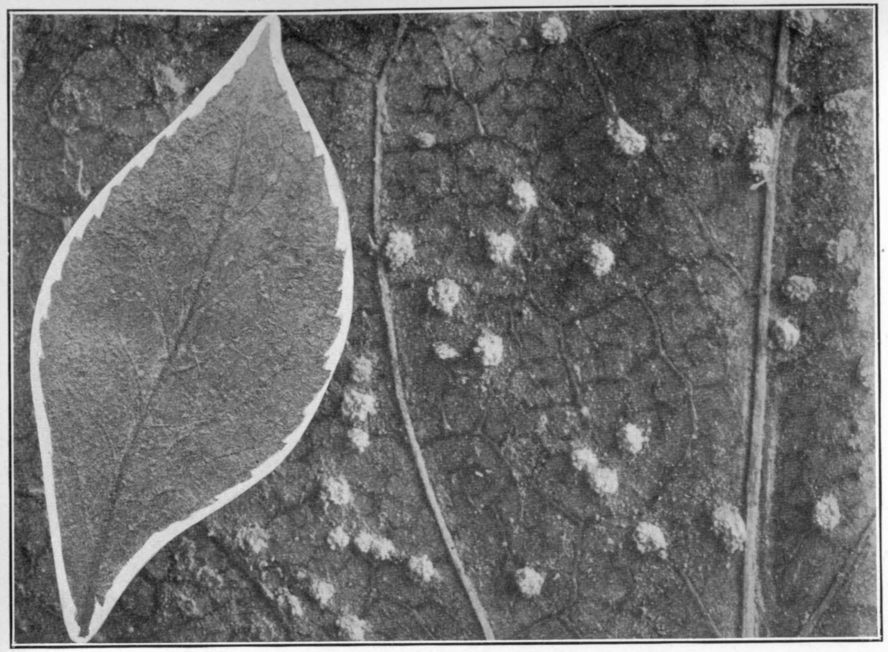
a. Showing a bunch of infected leaves natural size. I.

O. I.

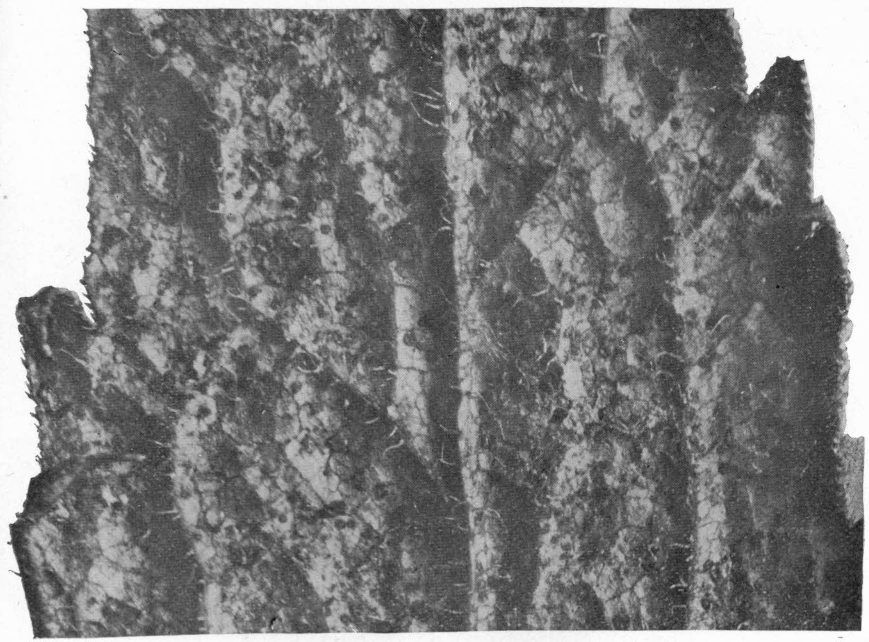


b. O, I on *Pinus rigida*. × 8.

O, I (*Peridermium acicolum*), STAGES OF *Coleosporium Solidaginis*, p. 375.



a. II on *Solidago rugosa*. Natural size and × 8.

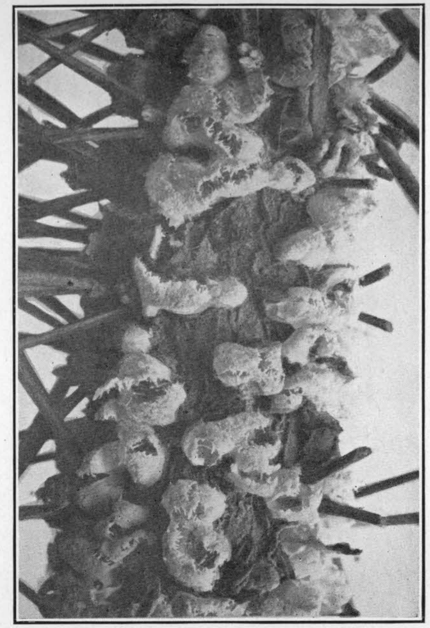


b. III on *Solidago rugosa*. ×6.

II, III STAGES OF *Coleosporium Solidaginis*, p. 377.

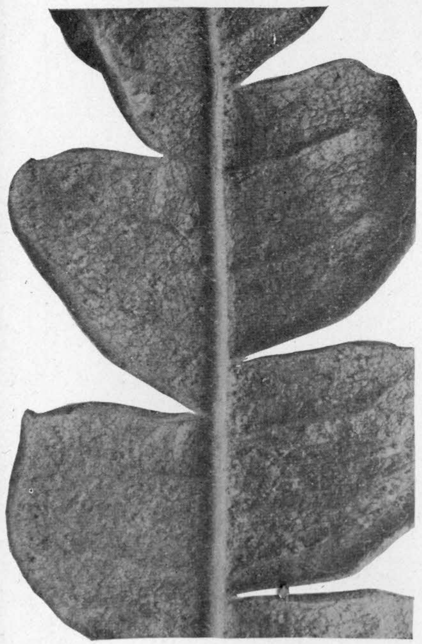
On *Pinus sylvestris.*

a. I natural size.

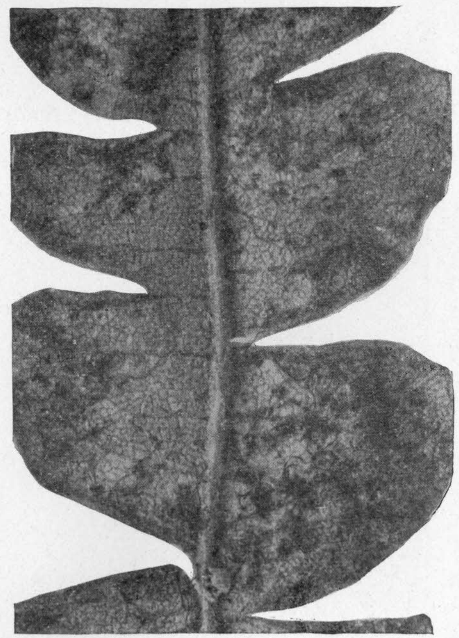


b. I × 2.

On *Comptonia asplenifolia.*



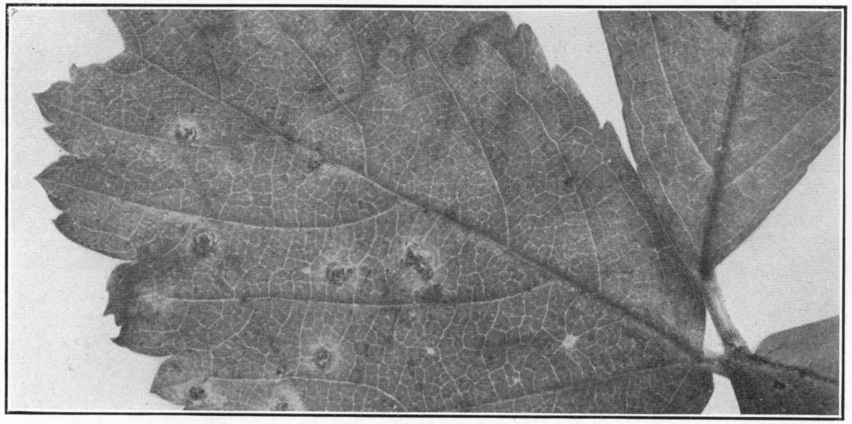
c. II × 4.



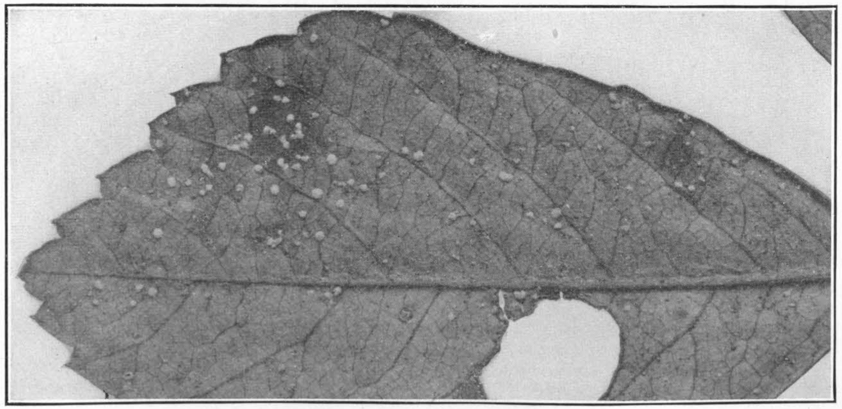
d. III × 4.

I (*Peridermium pyriforme*), II, III STAGES OF *Cronartium Comptoniae*, p. 380.

a. I *Peridermium Peckii* on *Tsuga canadensis*.

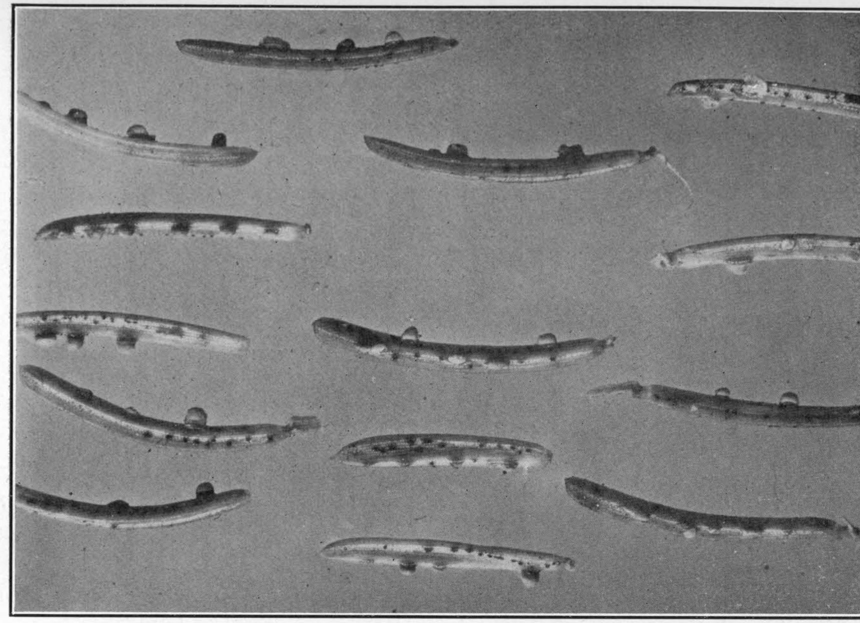


b. II' *Uredo Muelleri* on *Rubus hispidus*.

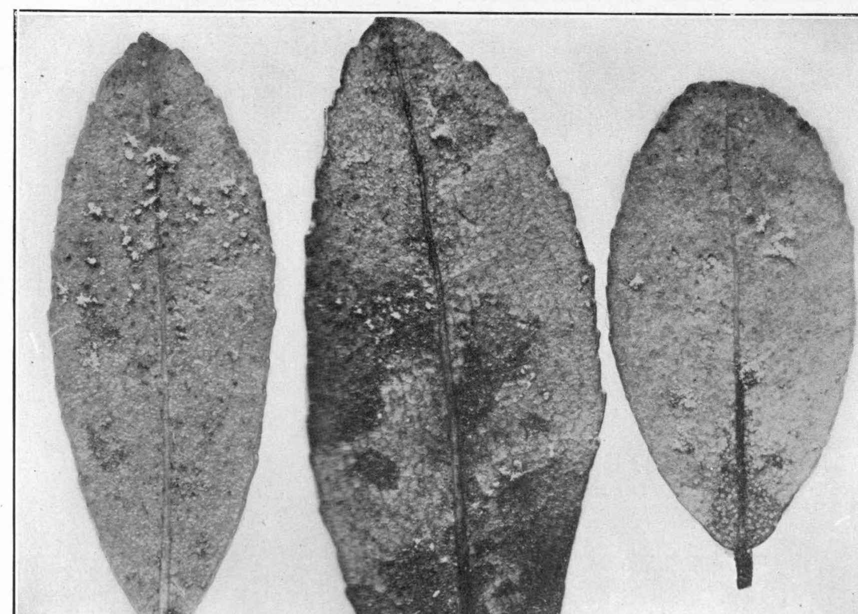


c. III *Kuehneola albida* on *Rubus hispidus*.

I, II', III STAGES (× 4) POSSIBLY OF THE SAME RUST, p. 383.



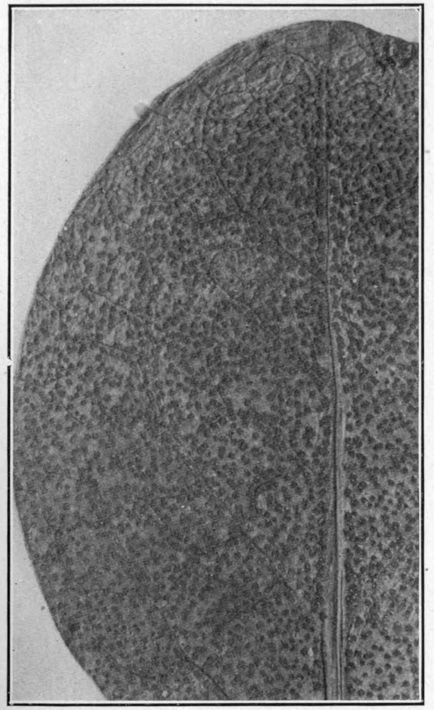
a. O, I on *Picea nigra*.



b. II on *Cassandra calyculata*.

O, I (*Peridermium consimile*), II STAGES (× 4) OF *Melampsoropsis Cassandrae*, p. 386.

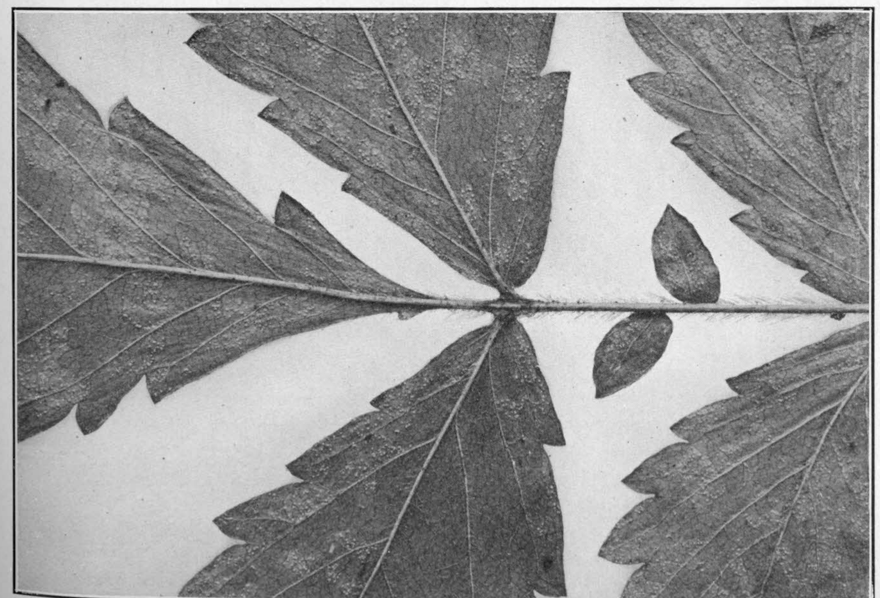
Melampsoropsis Pyrolae, p. 388.



a. On *Pyrola rotundifolia*. × 4.

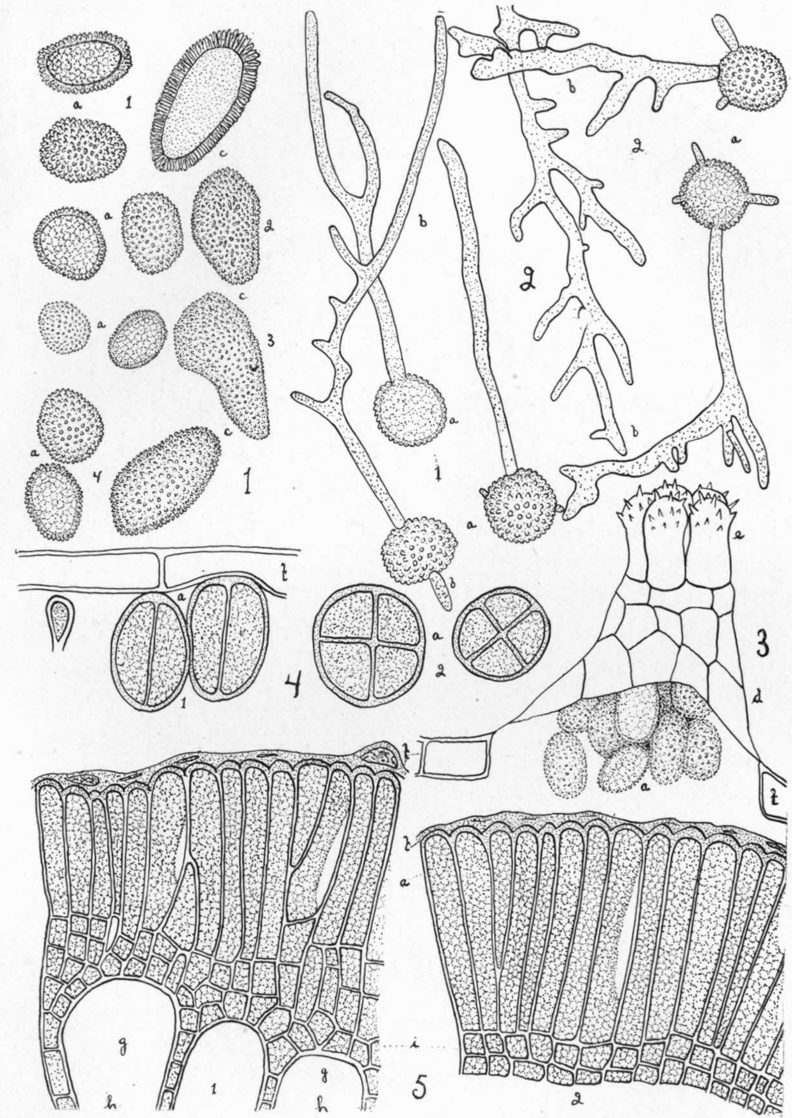
Melampsoridium Betulae, p. 386.

b. On *Betula pumila*. × 2.



c. *Pucciniastrum Agrimoniae* on *Agrimonia* sp., p. 391. × 2.

II STAGE OF THREE HETEROECIOUS RUSTS.



a. spores; b. germ tubes; c. peridial cells; d. peridium; e. neck cells of peridium; f. epidermal cells of host; g. parenchymatous cells of host; h. mycelium; i. fertile cells of mycelium. 1^{1-4} (1) *Peridermium acicolum;* (2) *P. pyriforme;* (3) *P. Peckii;* (4) *P. consimile.* 2^{1-2} Germination of II spores of (1) *Coleosporium Solidaginis* and (2) *C. Campanulae.* 3. Partial section through peridium of *Pucciniastrum arcticum* var. *americanum.* 4^{1-2} Compound spores, III, of *Pucciniastrum Agrimoniae*, shown in longitudinal (1) and cross (2) section. 5^{1-2} Cross section through telia of *Necium Farlowii* on stem (1) and on cone (2).

I, II, III SPORE STAGES OF CERTAIN RUSTS.

PART VII.

REPORT OF THE AGRONOMIST,

EDWARD M. EAST, PH.D.

I. THE PROSPECTS OF BETTER SEED CORN IN CONNECTICUT.

At the current prices for grain, dairying is a business with a small margin of profit. Largely because of these high grain bills, the acreage devoted to corn in Connecticut will be materially increased in the next few years. In no other field crop is there so much net gain to the feeder.

Greater care in the future production of the crop, however, would double the yield without increasing the land at present devoted to its culture by a single acre. Good seed, good soil and proper cultivation are the three factors needed to reach this end; and good seed holds out the greatest promise of raising the average yield with the smallest additional cost to the farmer.

About 12,000 bushels of seed corn are used annually in Connecticut, nearly all of which is saved by the growers themselves. Perhaps no other state yields the palm in the number of varieties in use. Nearly two hundred different kinds are grown, and many of them have been originated within its limits. Yet this fact is more of a curse than a blessing. At least ninety per cent. of these varieties should be discarded because they produce smaller yields than other existing varieties; but, in spite of this fact, too many corn growers hold to a poor variety through misplaced loyalty to some early ancestor who originated it.

Every corn grower does not have the desire, the ability, nor adequate opportunity to breed high grade seed corn. The production of seed in a commercial way demands time, attention and knowledge in the producer. For these reasons, this station does not recommend that every farmer should continuously save his own seed. It is far better that the man who grows from one to ten acres of corn should purchase his seed from some *neighboring corn breeder* who is producing a variety adapted to the soil of that locality. Neither is it recommended that every farmer should go into corn breeding as a business. It seems quite possible, however, for some ten or fifteen farmers to make a commercial success of raising and selling seed corn. These men should not expect to succeed in such work without growing a very good quality of seed. When this is done, there is no doubt but that Connecticut could furnish seed for the whole of New England, as it is possible to breed only very early varieties successfully in latitudes more northern than our own state.

Seed Corn for Different Purposes.

Dent Varieties. As a consequence of the growing favor of the silo, one of the primary needs in Connecticut is a dent variety with a tall, stout, succulent stalk which produces two medium sized ears. Two ears upon one stalk will mature at practically the same time as will one ear of the same average size. This we have shown by many notes, taken upon several different varieties, as to the maturity of the ears upon one-ear and two-ear stalks. If corn is planted three stalks to the hill, three and one-half feet apart each way, every stalk of a perfect stand must produce only two very small, four-inch ears, weighing about five ounces each, in order to yield one hundred bushels of shelled corn to the acre. So we see that it does not take large ears to produce a large crop when perfect, vigorous seed is used.

We have, at present, several tall silage varieties yielding large, *single* ears. They are composed of mixtures of strains which produce ears with various numbers of rows and other characteristic differences of little importance to the eye of the casual observer. These differences *are important,* however, because they distinguish various strains, some of which are better in every way than others. The same statement might be made about all varieties, although some have many more of these strains in their make-up than others. If a prospective corn breeder is situated upon rich soil and low land in the southern part of the state, he cannot do better than begin to breed out the poorer types that partially compose one of these large silage varieties. In other localities, the production of the smaller two-eared type is preferable, since it is in the last few weeks before corn is put into the

silo that the great gain in dry matter is made, and we must not lose this additional yield by growing a corn that must be ensilaged while yet in the milk, in order to avoid frost. Any corn of which the majority of ears reach the proper stage for ensilage—the kernels beginning to dent—before danger of frost, can be bred for seed, if proper care is used in curing.

Flint Varieties. Although ensilage varieties are increasing in favor, there is and always will be a demand for corn which will mature and can be husked and stored in cribs. In this respect the flint varieties are a heritage from our forefathers that should not be neglected in Connecticut. A number of varieties possessing desirable qualities have been developed, but even these can be improved. Their principal faults are the difficulty of husking the ears, due to their large shanks, the propensity for the growth of "suckers" which produce no ears, and the great length of the ear-shank which thereby tends to break too easily. There is also little doubt that strains could be isolated which have a much greater tendency to produce two or more ears upon each of their stalks than have the varieties grown at present.

We wish to call especial attention to the possibilities of flint corns, for we believe that flint varieties can be produced that, with the same growing period, will compare favorably in yield with dent varieties. They possess a slightly higher feeding value than dent varieties, due to their higher protein content; yet very little selected flint seed corn is for sale at any price.

Sugar Varieties. The sweet corn interest in the state is largely in producing a seed supply for more northerly regions, where it is grown for canning purposes. The type desired by these growers is a medium large variety, with straight rows and long kernels. A cylindrical ear is not especially necessary, because tapering ears can now be cut with the improved machinery. Varieties having too large an ear are undesirable, because, in the short season of some of the Maine districts, they will not mature sufficiently to give a satisfactory canning weight per bushel. Straight rows are demanded because of greater ease in silking, and only varieties with white kernels are accepted.

There is also a demand for early sweet corn by those who grow trucking crops to sell at nearby cities. On account of the number on the market, and the limited demand for the seed, these varieties offer the least inducement to a farmer to become a specialist in their production. Yet even in this case, the market is not entirely local, because of the penchant of New Jersey and Maryland growers for Connecticut seed.

In an ear-to-a-row test of Stowell's Evergreen, we found a row with a manifest tendency to cover the ear with several thicknesses of husk; that is, the number of short nodes on the shank was greater than usual, as is illustrated by the ear at the left, in Plate XXXIII, a. These ears remained in table condition for over a week, while ears like the one shown at the right of the figure remained in prime condition only one day.

If similar thick-husked strains were developed in those varieties used exclusively as table vegetables, there should be a great demand for them owing to their keeping quality.

Different Localities.

The soil of Connecticut is a glacial drift. It is not uniform, and at present no recommendations can be made as to the proper varieties for growing upon different soil types. The only divisions possible are based upon the differences in climatic conditions. Along the southern coast line, and in the Connecticut River valley, there are many districts where a constant supply of moisture during the summer season makes it possible to grow a large amount of forage per acre. These are districts primarily fitted for breeding seed corn for silage purposes. On the other hand, the hills in the northern part of the state demand an early corn, and varieties should be grown which are adapted to their soil and climatic conditions.

Corn Breeding in Progress at Present.

There are several men who have started work in corn breeding from the commercial standpoint. A short description is given here to show what these men are doing along these lines. This does not mean, however, that all corn breeding work is preempted, for such is not the case. There is not nearly enough good seed corn for sale to supply the present demand, and the demand for good seed corn will increase rapidly if farmers will awaken to the greater possibilities lying within the use of better seed.

Newgate Flint. Mr. F. B. Walker, of Granby, has been breeding Newgate flint for two years. This corn is supposed to have originated from a cross between a variety of the Canada type and a dent variety. It has a stalk nearly as large as most dent varieties, and yet the ear as shown in Plate XXXIII, b, is characteristically an eight-rowed flint. In the season of 1907, Mr. Walker's breeding plot, fertilized by about eight tons of manure and five hundred pounds of corn fertilizer per acre, produced 113 bushels of shelled corn per acre. The writer made a count of forty hills taken at random in this breeding plot, and found that there was an average of 2⅓ ears per stalk.

Longfellow Flint. Mr. George A. Hopson, of Wallingford, has been breeding this well-known variety for two years. A selected sample of his corn is shown in Plate XXXIV, b. Mr. S. M. Foster, of Westport, has also had a breeding plot of this variety for two years.

Leaming Dent. Mr. F. H. Stadtmueller, of the Vinehill Farm, Elmwood, is breeding this variety for greater yield of both ears and stover. A selected sample of his corn is shown in Plate XXXV, a.

Early Sharon Dent. Mr. Charles S. Phelps, of Grassland Farms, Chapinville, is breeding this variety with the idea of adapting it to produce the largest possible yields compatible with maturity, upon the high lands of the northwestern portion of the state.

Stowell's Evergreen Sweet. This station has a breeding plot of this variety on S. D. Woodruff and Sons' farm at Orange. A strain has been developed, as shown in Plate XXXV, b, that with care matured a very high yield of good ears, even in the poor season of 1907.

Caring for Seed Corn.

In seasons where there is some doubt as to whether the seed will mature, the old practice of "topping" is recommended. Care should be taken, however, never to top the corn before it has begun to dent. The procedure will not be necessary in the case of flint varieties.

The kind of ears desirable for seed corn, and methods for their selection have already been discussed in some of our previous publications. (See Bulletin No. 152, "The Improvement of Corn in Connecticut," and Bulletin No. 158, "The Relation of Certain Biological Principles to Plant Breeding.") But even after properly selecting seed corn in the field, improper treatment will render it worthless. If a successful seed corn business is to be conducted, nothing is more important than proper seed-houses. Even mature field corn has at time of harvesting a very high moisture content, and on this account is likely to be injured, both by fermentation and by freezing. If sweet corn, in particular, is brought into a warm room without proper ventilation, fermentation takes place, and various moulds begin to grow, rendering a great deal of it incapable of germinating, and reducing the vigor of the remainder. With other corns there is greater likelihood of premature germination than of fermentation.

It is not a great mishap if seed corn freezes, provided it has been properly cured beforehand, but if it freezes when full of moisture it is ruined. Corn, when thoroughly dry, is not affected by cold; but, on the other hand, with our open winters and sudden changes from snow to rain, or from temperate to below zero degrees, corn which has once been thoroughly dry is likely to absorb sufficient moisture to make it again subject to injury from freezing. This is a great argument against leaving seed corn in indiscriminate piles in seed-houses, even after it has been thoroughly cured. There is probably no necessity for continuous artificial heat, but seed corn should be stored during the entire winter so that there is a proper circulation of air around each individual ear. The ear figured in Plate XXXVI, a, is an illustration of what can actually be done by proper care. This ear of Stowell's Evergreen was picked when it was in prime table condition, and yet, after being carefully dried, ninety-five per cent. of its kernels germinated and produced healthy sprouts.

Plate XXXVI, b, shows a very desirable type of seed-rack for flint and dent varieties. Laths are nailed to the timbers as shown, leaving only sufficient space to lay the ears in rows. There is a circulation of air around every ear with the exception of the two points at which they touch the laths. If arranged in tiers so that two ears can be laid end to end, a large number of ears can be accommodated in a limited space, besides allowing for narrow aisles to facilitate handling the crop.

The ideal manner to render such a house rat and mouse proof is to have a raised cement floor, using extending strips of sheet iron as protectors. For an inexpensive seed-house, nothing is better than wooden post foundations guarded by tin extensions half way up to the floor. If care is taken not to unload any of the rodents when bringing in the crop, but little trouble may be

expected. In any case, however, a good cat is an aid not to be despised.

A still more desirable type of curing-rack is shown in Plate XXXVII. This rack is merely to illustrate the type of the dryer, and should be changed in detail to make a practicable seed-house for a commercial seed grower. The one shown in the figure is three feet square by nine feet high, and holds 2,000 ears. Nails are driven directly through at intervals of three inches each way. They are then bent slightly upward. Ears of corn will dry perfectly upon such a rack, because there is complete circulation of air around each ear. This is the only practicable rack for drying ears of large-eared varieties of sweet corn. In other types of racks, where the ears rest upon something,—be it wood or wire netting,—they must frequently be turned over, and still run a great chance of becoming mouldy.

To arrange a large seed-house after this plan, frames are built of any size desired, and made so they can be hooked to the ceiling. One frame can be filled after another, until the whole seed-house is full. There is little trouble from rats when they are suspended in this manner. If the seed-house is mouse proof, however, these frames can be slipped into grooves on the ceiling and floor and manipulated more easily than when suspended.

No farmer should go into the seed corn business without a good, well-ventilated curing-house, with some arrangement in it for artificial heat.

The Preliminary Germination Test.

Mr. J. W. T. Duvel states that out of 3,300 ears of farm-selected seed tested by the U. S. Department of Agriculture, more than one-half of the samples were unfit for seed. In view of this fact every ear of corn grown in Connecticut should be sampled and its vitality tested before planting time. This is work that can be done in the winter when plenty of time is available, and will repay the labor many times. There is no doubt but that this alone would increase our yield at least ten per cent., and perhaps a great deal more.

Many men believe that they are able to pick out the kernels that will not grow by examining their germs. This is merely an egotistical fallacy. Nearly all of Illinois' great exhibit of seed corn at the St. Louis Exposition was composed of ears which would not grow. They were sent there just because they were valueless as seed corn, although they were large in size and beautiful in appearance. But even if ears with dead germs could be rejected by their appearance, there would be just as good reason for testing them as before. The ears which will germinate, but which germinate poorly and produce small, weak, barren stalks, should also all be discarded. They cumber the ground and receive their proportion of cultivation, but render no return. The preliminary germination test is the place to detect and remove all such impostors.

Many methods for making germination tests have been described in various publications. Any farmer has sufficient ingenuity to fit up something to answer the purpose with material at hand. The points to be observed are: first, sufficient, but not an excess of moisture; second, proper aeration, for without air seeds cannot germinate; and third, a constant temperature of about 80° F.

For a seed corn specialist who expects to test a large number of ears, a good method is to cover a wooden box with an inch of sawdust, and fit it with a removable wire netting with meshes large enough to allow the kernels of corn to pass through. A large number of ears can be germinated according to this scheme in quite a small box, by placing the kernels in series in the moistened sawdust through the meshes of the netting, and afterwards covering with a wet cloth and keeping in a place having the proper temperature.

For the farmer who grows only from five to twenty acres of corn, probably the easiest method of testing the ears is the dinner-plate method, illustrated in Plate XXXVIII. Fill a common dinner plate with clean, white sand. Such sand is less likely to mould and thus interfere with the test than if it contains organic matter. Moisten the sand thoroughly with water, but do not saturate it. Many failures are due to the fact that the sand is too wet, and the corn fails to germinate through lack of air. Having moistened the sand, mix it up well with the fingers to aerate it, and press it gently into form in the plate. It should be loose enough to allow the kernels to be pressed in easily with the fingers.

Now separate the sand into divisions by pieces of cardboard as shown in Plate XXXVIII, b, and the plate is ready for the samples. Lay the ears to be tested in order, on a bench where they will not be disturbed. Then take up each ear in succession and take from it three kernels. Take one kernel from about one inch from the butt; turn the ear one-third around and take one kernel from the middle; again turn the ear one-third of the way around and take one kernel from about one inch from the tip. This is the least number with which it is possible to make a fair test. It would be much better if five or six kernels were tested from each ear. Press the kernels firmly into the sand until flush with its level. Leave the space of one kernel between kernels from different ears, in order the better to enable you to make the count of the germinating kernels. Sample each ear in like manner. Lay the sampled ears back on the bench in the same order in which they were sampled, and you will then be able to reject all individual ears which do not prove their growing power by sending up vigorous sprouts.

When the plate is full invert another plate over it to hold the moisture, and set it underneath the kitchen stove or in some other convenient place where the variation in temperature is not greater than between 75° and 95°. Watch the plate to see that there is enough moisture for proper germination, and in from 30 to 60 hours the germinated kernels will be ready to count. When ready to make the count take a sheet of blank paper and put down consecutive numbers for all the ears sampled. Cross off any ear whose kernels have not germinated, or whose sprouts are below the normal in vigor.

Purchase of Seed Corn.

Just a word about the purchase of seed corn. Much seed corn is bought as shelled corn. This should never be done. Seed corn purchased in the ear brings a slightly higher price, but it is well worth this difference. Many times the seedsman purchases the entire crop of a farmer who raises good corn, and no selection is made except possibly to separate the kernels of different sizes. As seed corn sent out in the ear is an advertisement of the sellers' product, only the best ears are shipped in this manner; and if these ears are not satisfactory to the purchaser he can reject and return them. Further, a mixture of shelled corn may give a low percentage of germination, but there is no means of rejecting poor kernels. On the other hand, when the corn is in the ear, each ear can be given a preliminary germination test, and all ears falling below the standard can be discarded.

II. PRACTICAL USE OF MENDELISM IN CORN BREEDING.

A number of corn growers in Connecticut have made natural crosses between varieties of corn that possess quite distinct characters. This has been done by planting two varieties in alternate rows, and detasseling one variety before it begins to shed its pollen. By selecting from these crosses,—the detasseled rows,—several varieties have been obtained that are believed by their originators to possess superior merit. Unfortunately, a lack of knowledge of the way in which certain prominent characters are inherited has left these strains with such a "mixed" appearance that there is absolutely no market for them as seed corn. For example, I recall a grower who has crossed a yellow and a white race of flint corn; and has combined the ability to produce an ear with well filled, regular rows possessed by one of the original strains, with the large stalk characteristic of the other strain. But the combination strain that he now possesses produces heterogeneous mixtures of yellow and white kernels. The problem that he wishes to solve is, how to produce a strain that will be uniform in appearance, in the most direct way possible.

The writer has been engaged for several years in studying the behavior of certain characters of the corn plant after crossing. The data are not sufficiently complete for a final report on the subject, but we propose to discuss at this time the proper method of procedure to obtain uniform marketable seed corn from a cross between two varieties that differ in striking characters, such as color.

Correns (1), Webber (2) and Lock (3) have each discussed this work from the scientific point of view, but none of them have indicated any practical use of the knowledge. From our crosses between varieties differing in a large number of characters, we

(1) Correns, C. Untersuchungen über Xenien bei *Zea mays*. Ber. Deut. Bot. Ges. **17**: 410. 1899. Also, Ueber Bastarde zwischen Rassen von *Zea mays*. Ditto **19**: 211. 1901. (2) Webber, H. J. Xenia in Maize. Bul. 22, Div. Veg. Phy., U. S. D. A. 1900. (3) Lock, R. H. Studies in Plant Breeding in the Tropics. III Experiments with Maize. Annals of the Roy. Bot. Gar. Peradeniya **3**: pt. 2, 95-184. 1906. (4) For a more extended explanation of Mendelism see Bulletin No. 158 of this station,—"The Relation of Certain Biological Principles to Plant Breeding."

have selected for discussion only those which interfere with the production of marketable seed corn. The work corroborates that of Correns and of Lock, and no claim is made for many new features. It is believed, however, contrary to Lock's statement, that there is no "reversal" of dominance in cases where the blue color does not appear as xenia (immediate change in a kernel due to foreign pollen) in white (female) x blue (male) crosses. The blue color is present, although latent, and there is reason to believe that this latency is due to another heritable factor which, when present, does not allow the manifestation of the blue color. Further, it is believed that the wrinkled, sugary character never appears as xenia when the pollen of sweet varieties is applied to the silks of flint or dent varieties, as has been stated by Webber (2). Webber himself has stated in a personal communication to the writer that he believes his former statement to be in error.

Inheritance of Characters in Corn.

The prominent characters which differentiate varieties of corn obey a law of heredity that has but recently been corroborated and accepted, after remaining unnoticed for thirty-five years in the files of an European scientific journal. It is known as Mendel's (4) law.

Mendel's work supports the theory that characters are actually inherited as units. That is, such a character as flinty kernels, in corn, is either present or it is not present. There may be minor differences in the appearance of the grains, but this character is inherited as a unit. If a sweet corn is crossed with pollen from a flint corn, the resulting kernels are all flinty in appearance. This is because the endosperm, or part of the kernel surrounding the embryo, partakes of its hybrid character. The flinty appearance of the kernel is due to the possession of some character that produces the hard, translucent endosperm. When this character is absent the kernels dry up without maturing their starch, giving the wrinkled appearance common in sweet corn; the presence of the character causes the full development of starch that is normal in flint corn.

Pairs of characters such as these, affecting a certain plant structure, are called contrasted or allelomorphic pairs. The first law of Mendel concerns this appearance, and is called the law of dominance.

The Law of Dominance.

If two contrasted characters which have previously bred true are crossed, one only, the dominant character, appears in the first hybrid generation; the other, the recessive, is present but is hidden by the dominant character.

Since, in most cases there is not complete dominance when two contrasted characters are crossed, the law is not general. In corn, however, there is almost complete dominance in the characters that we will discuss.

Mendel's second law treated of the way in which such contrasted characters are transmitted in succeeding generations.

Mendel's Law of Inheritance.

In the generations succeeding a cross, self-fertilized plants grown from its hybrid seeds reproduce both contrasted characters in the proportion of three of the dominant character to one of the recessive character. Furthermore, inbred plants bearing the recessive character continue ever after to breed true, while those plants bearing the dominant character are one-third dominants which ever after breed true to the dominant character, and two-thirds hybrid dominants which contain the recessive character in a hidden condition.

The theory supposes that when a dominant and a recessive character meet in a cross, the germ cells which are produced in the hybrid do not blend these characters, but possess either the one or the other; and as the possession of either character is a matter of chance, on the average 50 per cent. will bear the dominant and 50 per cent. will bear the recessive character. In a plant, for example, 50 per cent. of the pollen cells would bear the dominant and the other 50 per cent. would bear the recessive character. One-half of the egg cells, likewise, contain the dominant, and one-half the recessive character.

Now, if we could pick out at random any one hundred pollen or male cells to fertilize any one hundred egg or female cells, we can see that there are equal chances for four results. A dominant male cell might meet a dominant female cell, a dominant male cell a recessive female cell, a recessive male cell a dominant female

cell, and a recessive male cell a recessive female cell. In an abbreviated form it amounts to this:

Male cells		Female cells
D	⟶	D
D	╲╱	D
R	╱╲	R
R	⟶	R

We have (D+D), (D+R), (R+D) and (R+R) plants formed in equal quantities, but as the two middle terms are the same, we can reduce the formula to one (D+D) to two (D+R) to one (R+R). But wherever there is a D present in the germ cell, the dominant character shows while the recessive character is hidden. The one part or the 25 per cent. of the individuals showing the character (D+D) will appear to be just like the two parts or 50 per cent. of the individuals having the character (D+R). Therefore, there will be 75 per cent. of the individuals which will show the dominant or D character, while 25 per cent. will show the recessive or R character. These 25 per cent. showing the R character will ever after breed true, because they contain nothing but the recessive character; while of the 75 per cent. showing the dominant character, one-third or those having the pure (D+D) character will breed true in succeeding generations, while the other two-thirds having the (D+R) or hybrid character will again split in the next generation.

This is Mendel's original exposition of the theory, but modern biologists have given a somewhat different interpretation of the facts. Instead of 50 per cent. of the germ cells bearing the flint character and 50 per cent. bearing the sweet character in the sweet × flint corn cross; the better explanation is that all of the germ cells contain the faculty for producing sweet corn grains, but that 50 per cent. of them contain in addition the *presence* of a flint producing character. If we could wipe out the flint producing character from flint corn, we would have left the sweet producing character; that is, the "flint" character is superimposed upon the "sweet" character. The pure flint corn produces germ cells bearing two factors, one for flintiness (F) and one for sweetness (S). When it is self-fertilized or fertilized from another flint plant, an individual is produced whose germ cells have the formula F S; but the individuals resulting from these germ cells always have the flint character through the presence of the flint factor F. In the same way the pure sweet corn produces germ cells carrying two factors, one for sweetness (S) and one for *absence* of flintiness (f).

In cross breeding, germ cells F S from the "flint" plant meet germ cells f S from the "sweet" plant, and the resulting hybrid has a constitution F S f S. In appearance it is like a pure flint because of the presence of the "flint" character. This hybrid produces germ cells F S and f S in equal quantities, which, when meeting by chance upon self-fertilization, give the following results:

$$\begin{array}{lcl} & F\,S \longrightarrow F\,S & \\ \text{pollen} & F\,S \times F\,S & \text{egg} \\ \text{cells} & f\,S \times f\,S & \text{cells} \\ & f\,S \longrightarrow f\,S & \end{array}$$

There results one part pure flint kernels (F S F S), to two parts hybrid kernels (F S f S), to one part pure sweet kernels (f S f S).

Dominance of Characters in Corn Breeding.

We will consider six pairs of characters that are very striking in appearance, and which if not "pure" are likely to render our seed unmarketable, even though some of them are of little importance in themselves. After crossing, the pairs have been found by experiment to behave in the following manner:

Flint	Dominant to	Sweet
Flint	" "	Dent
Dent	" "	Sweet
Purple	" "	No Purple, or White
Yellow	" "	No Yellow, or White
Red	" "	No Red, or White

Flint-Sweet Crosses.

If a variety of sweet corn is used as the female parent and a variety of flint corn as the male or pollen parent, the resulting ear contains kernels exactly like the flint parent. (Notice the two hybrid kernels caused by flint pollen, near the tip of the ear in Plate XXXIX, a). This result, caused by the pollen of the current year, is called xenia. It has been shown to be due to the fact that the endosperm is hybridized as well as the embryo; and as there is presence of the dominant character, flintiness, the result shows in the first year. There is evidently something

introduced by the pollen of the flint corn that enables the sweet corn kernels to proceed further in their starch development and produce kernels with the characteristic appearance of flint varieties.

On the other hand, if the flint corn is used as the female parent and the sweet corn as the male parent, no apparent affect is produced upon the flint kernels of the current year. The flint variety already contains the dominant character and introduction of the recessive character can produce no change visible to the eye.

The use of this fact to the commercial seed grower is as follows. Since the effect of flint corn is *always* visible in the first year, no extreme care need be used in isolating sweet corn plots from flint corn. After harvesting, the corn can be inspected, and any kernels showing the flint character can be discarded. All kernels showing the sugary character are "pure" for this character.

This fact is especially important in Connecticut because a large amount of the sweet corn grown is used entirely for commercial seed. The flint corn crop, however, is generally consumed upon the farm. The flint seed for the succeeding year, therefore, should be taken from plants as far as possible removed from the sweet corn plot, for there is no way of detecting and rejecting possible hybrids of flint corn pollinated by sweet corn; but any kernels from the other plot showing only the sugary type are absolutely certain to be pure in this character. Even where sweet kernels had one grandparent belonging to the flint type, if characteristic in appearance, they will come true to the sweet character.

Dent-Sweet Crosses.

The same rule will hold good for dent-sweet crosses. The dent character is dominant in the effect of its pollen upon sweet corn. Dent corn as well as flint corn, however, should be entirely isolated from the influence of sweet corn, if it is intended for seed purposes.

Flint-Dent Crosses.

In crosses between flint and dent races of corn, the flint character is dominant over the dent, but this dominance is hardly striking enough to be used as a distinguishing character in making selections. If dent and flint corns of the same color are grown upon the farm, it is desirable that they should be entirely isolated from each other. Possibly an expert in the matter might always distinguish pure dent kernels from the hybrids, so that carefully inspected seed could be used with impunity upon the home farm; but it should not be offered for sale in the open market as seed corn. Flint corn grown in proximity to dent corn should under no circumstances be used or offered for sale, because there is absolutely no difference in appearance between pure flint kernels and hybrid flint-dent kernels. Of course the very early flints and very late dents shed their pollen at different times, but there are always a few plants in each variety which overlap in their time of flowering, thereby exposing them to possible cross-pollination.

Yellow-White Crosses.

When white strains of corn are crossed with yellow strains, the product is in every case yellow. That is, yellow is *always* dominant to absence of yellow or white. The yellow color of such races of corn is due to an ether soluble compound that is distributed all through the starchy portion of the endosperm. Since this color is present in the endosperm, it is apparent in the current season of the cross, and the kernels of *all white races* will show the *yellow* color, if they are hybrid in this character through cross-pollination with a yellow variety. Therefore, white kernels may be planted with assurance of their giving white in the succeeding season. On the other hand, pure yellow flint kernels are not distinguishable from the hybrid in the case of a yellow flint variety that has been pollinated by pollen from a white flint variety. A slight change in appearance may be caused, but only in certain cases.

The same thing is true when a white dent variety is pollinated with pollen from a yellow dent variety. The yellow color always appears and hybrid kernels may be rejected with unfailing precision. When yellow dent varieties are pollinated from white dent varieties, however, the case is different from that which occurs in flint varieties. Everyone has noticed the appearance of kernels with white caps in yellow dent varieties. These kernels we have shown in every case to be hybrids, but at the same time, there are hybrid kernels upon the yellow ear thus pollinated, which do not show this characteristic white cap. We hope soon to show that

we are considering here two separate pairs of contrasted characters, each of which is inherited independent of the other; but even now our data is sufficiently conclusive to show that yellow and white dent varieties must be isolated from each other if the seed of the yellow is to be used, since all hybrid yellow-white kernels will not be distinguishable from pure yellow kernels.

In Plate XL, a, are shown two flint varieties that apparently differ only in color, the one being yellow and the other white. Between these two ears is shown an ear of the white variety that has been pollinated with pollen from the yellow variety. The ear which was thus produced is exactly like the yellow parent in appearance. However, when kernels from this ear were planted and self-fertilized by hand, the ears were all similar in appearance to the mosaic ear shown in the figure. On the average, three yellow kernels appeared to one white kernel. This is a nice illustration of the complete dominance of the yellow character; also of the complete separation of the two characters, according to Mendel's Law.

Purple-White Crosses.

Perhaps the only important purple variety of corn is the Black Mexican sweet corn, although both dent and flint varieties of this color are grown as curiosities. A purple variety of pop-corn has also been on the market in Connecticut for a great many years. This purple color, as shown in Figure 7, is always due to a purple dye, which is deposited in a single row of cells underneath the hull or pericarp, called by botanists the aleurone layer. On account of the location and the darkness of this color, it obscures a possible yellow coloration such as is found in yellow varieties, because the latter lies deeper in the starchy endosperm. Thus, we may have a variety of purple colored corn, which would prove to be a mixture of yellow and white, if this aleurone layer were scraped off.

The purple color is dominant to no purple, and as its location is in the endosperm, it becomes apparent the first year. Therefore, in all white and yellow varieties of either dent, flint or sweet corn, which show purple kernels, these colored grains will be found to be hybrids. This character, however, behaves somewhat differently from the yellow color, which is *always com-*

pletely dominant in its crosses. Kernels are found completely covered with purple dye, so that they appear almost black; while other kernels possess the color in all gradations of decreasing amounts, until there are found only a few light purple spots which would pass unobserved without a careful examination. Some kernels have even proven to be hybrids, which show no purple coloration. Recent investigators have explained this as a reversal of dominance, but this I do not believe to be the true explanation. There is latency of the purple character, probably induced by an inherited factor which excludes the development of the purple color.

It has been definitely shown that it is not safe to furnish seed corn which has been grown in proximity to purple races, even

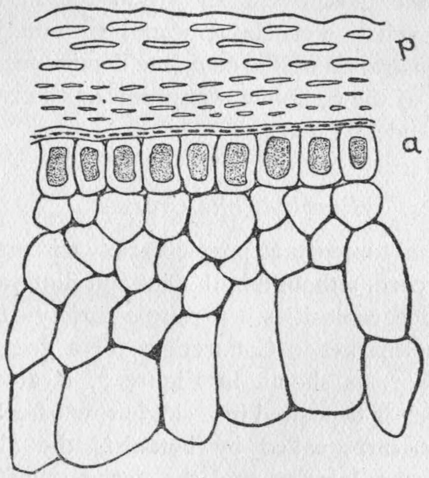


FIG. 7.—Portion of Cross Section of Corn Kernel (much enlarged). *p*. Pericarp, where the color of red races is located. *a*. Aleurone cells, where the color of purple races is located. *s*. Starch cells.

though all purple kernels have been rejected. Such rejection does away with most of the hybrid kernels, but does not entirely exclude the danger. Purple varieties also, which are being grown for seed, must be entirely isolated from other varieties, unless they differ in characters other than the color. If a Black Mexican variety is fertilized with pollen from either white or yellow sweet corn, there is no* apparent effect, and hybrid

* In rare cases the purple character does seem to be prevented from developing, when pollinated by white varieties.

kernels cannot be rejected. But of course, if the varieties planted near the Black Mexican are dent or flint, hybrid kernels can be rejected, because of the complete dominance of the flint and dent characters over the sweet characters.

Red-White Crosses.

Hitherto, we have been dealing with characters that effect the endosperm, which is, botanically speaking, a different and younger generation than the plant or cob on which it appears. If a paper bag is placed upon an ear at silking time to prevent fertilization, and the ear examined after the silks have fully developed, it will be found that the ovules which would have developed had they been fertilized, consist almost entirely of hull or pericarp. The hull of a kernel of corn is therefore a portion of the mother plant, and belongs to an entirely different generation from the kernel. It is in this pericarp that the dye is deposited which forms all red races of corn. For this reason, we never find red races of corn with mixed kernels such as we find in the case of other different kernel characters. There may be hybrid races in which some ears are red and some white, but the kernels of each ear will be uniform in color, because they have developed from maternal tissue. There are varieties with red striped kernels, commonly called "bloody butcher" varieties; but in these cases the striking differences shown by the various kernels are not actual color differences, but are due to and inherited as a general color pattern characteristic of the ear. It is much the same thing as the color pattern inherited by animals, their patterns being inherited as a whole, rather than as colors of single hairs.

When a pure red variety is pollinated by a different variety, be it flint, sweet, dent, yellow or white, no visible change is produced, because the red hull obscures the changes that take place in the endosperm beneath it. Neither are there any apparent changes if other varieties are fertilized with pollen from red varieties, unless the strains also differ in other characters. After cross-fertilization has been produced upon a red race, ears will be developed that will appear true to the race to which they belong; but upon planting these apparently pure kernels, they will be found to produce a hybrid race in the second generation. The red ear is dominant to the no red or white ear, but this does not help us in rejecting cross bred kernels.

Since the red color is *always* present in the pericarp, there is good and sufficient reason for advising corn growers never to propagate a red variety; because handsome seed ears,—apparently uniform in their red color,—may be sold to other growers, and these ears yet produce hybrids showing different characters in the succeeding season. As an illustration of this fact, carefully examine Plate XXXIX, b. The ear from which this photograph was taken was a handsome red ear of a variety called Kissing corn. The rows of which we catch a glimpse at either side show the dark kernels characteristic to the red ear. From the other two rows, the pericarp or hull has been entirely removed, and beneath it were found seventy yellow kernels, in appearance exactly like yellow flint, and twenty-three white kernels. This ratio, it will be noticed, is exactly the ratio of three dominant to one recessive that is expected in Mendel's Law. Thus we see how we may have an apparently pure red ear that actually consists of hybrid kernels, but whose condition is obscured by the red color of the hull.

This fact should make it apparent to every grower, that there is a scientific reason why red varieties have never found favor on the market. Several growers have told me that they did not grow red varieties, because they were not easy to keep pure; but they did not know the reason for their own statement. Other growers, with a greater reliance upon their own ability, have produced red varieties, thinking that their care in selection would keep them pure, and give them a distinct variety for selling as seed corn.

There are now grown in Connecticut some twenty-five or thirty red varieties. These varieties should either be discarded, or the red character bred out by crossing with related white varieties.

Summary.

In general, it may be stated that when there is complete dominance of one endosperm character over another, the variety bearing the recessive character can be kept pure without the strict* isolation from the variety bearing the dominant character,

* Of course this does not mean that the varieties may be planted together. We are speaking of the possibility of rejecting *chance* hybrid kernels.

that is necessary in all other cases. Such instances are the flint and dent characters that are always dominant to the sweet character; and yellow color which is always dominant to white or absence of color. In all other cases, to keep the variety pure, there must be complete isolation.

In case a cross has been made between a yellow and a white variety, the quickest method of procedure to obtain a uniform variety is to select and plant only the white kernels. These will breed true. Likewise, those kernels which clearly show the dent character in a flint-dent cross, or those kernels which distinctly show the sugary character in a flint-sweet or dent-sweet cross, will breed true in succeeding generations.

In all other crosses, pure varieties can be obtained by self-pollination. This will give a pure variety in the second generation after the cross, while ordinary field selections will take several times as long with only a relative probability of reaching the same end. Self-pollination is the fertilization of the silks of an ear by pollen which grew upon the same plant. It is performed most easily as follows: A paper bag is placed over the ear just as it begins to shoot its silks. At the same time another bag is placed over the tassel of the same plant. After three or four days the pollen will have been shed into the bag over the tassel, and the silks will be ready for fertilization. Take the first bag off of the tassel and quickly adjust it over the silks in place of the bag which has served to keep out foreign pollen. Tie the mouth of the bag containing the pollen to keep it in place on the ear, and again place a bag over the tassel to collect more pollen. On the third day from this time, again replace the bag over the ear with the bag containing the fresh pollen. Two such pollinations are usually sufficient to produce a fairly good ear.

If kernels of the first generation after the cross, which show only one of the characters in question, have been planted, and a dominant character is sought; then on the average every third ear pollinated will be "pure" in the character and will ever after breed true.

To make the matter plainer, let us suppose that a yellow flint has been crossed upon a white flint, and a yellow variety is desired. The crossed kernels are planted and allowed to fertilize naturally in the field. In this season, there will appear about three yellow kernels to one white kernel. The white kernels being the recessive will breed true without further trouble. Of the yellow kernel, on the other hand, there will be one pure yellow to every two hybrid. If only yellow kernels are then planted and a number of resulting ears are self-fertilized, then, wherever a pure yellow kernel has been planted by chance, the kernels of its self-fertilized ear will be pure yellow and will ever after breed true to yellow. The same thing is true of the other dominant characters.

If it is a case where a recessive character that is not certainly distinguishable from a hybrid, is desired, the method is the same. The pure recessives that chance to have been planted will breed true when self-fertilized.

In all of such work it is important to self-fertilize a large number of ears, so that several pure ears may be allowed to cross naturally in the succeeding season and thus keep up the vigor of the variety by cross-fertilization.

It is hoped that the corn growers of the state will not cast aside the foregoing article as being too technical for practical use. The time has come when the seed corn producers of the United States, who are to be successful in their work, will be the men who study and apply the underlying principles of variation and heredity, and among these laws, Mendel's Law of Dominance is worthy of consideration. Its use in corn breeding is very simple, and its study should prevent many fallacious proceedings, and render the work of corn improvement more methodical.

III. INBREEDING IN CORN.

The scientific corn breeding of the present day may be said to have begun when the Illinois Agricultural Experiment Station (4) introduced Vilmorin's Isolation Principle into the work about twelve years ago. This principle uses the average condition of the progeny of a plant as the index of that plant's productiveness, and, in corn breeding, is commonly called the ear-to-the-row method. The method was immediately accepted by workers at many of the agricultural experiment stations, and also by several commercial corn breeders. The basis of this work was the general belief in the efficiency of Darwin's selection principle. It was thought that by selecting extreme fluctuations of any character possessed by a variety, the type would be gradually changed, and would continue to be changed until the unknown physical limit was reached. The ear-to-the-row method was used because it was thought to be the most rapid means of making the desired change in type.

Since this time there have been many modifications of method, but only three contributions have been made that involve important ideas.

The first change was concerned with decreasing the error due to comparing widely separated rows, which had grown on non-uniform soil. Hunt (6, p. 195) duplicated rows from the same ears in different parts of the field. Williams (10) compared his rows to be tested, not with each other, but with check rows which were made up of the same number of kernels from certain selected ears, and were planted between every five experimental rows. Hopkins (5) and his associates compared with each other only those rows which grew upon one-quarter of the breeding plot.

The next change was the introduction of a method of planting to decrease the injurious effect which inbreeding or close-breeding appears to produce. Hopkins (5) and his associates reported experiments in which inbreeding was shown to be detrimental to vigor; and a plan was suggested whereby "blood" relationship between the plants was kept as far apart as is possible in an open field breeding plot.

The third suggestion was made by Williams (10) to obviate the possibility of selecting from good rows, seed which has been cross-pollinated from inferior plants. Only one-half of the kernels of the ears to be compared were planted. The remnants of the most efficient ears, uncrossed by inferior pollen, were then intercrossed in the succeeding season.

So much for changes in methods; now let us consider the trend of thought concerning the principles underlying corn improvement. Those who undertook selection with the Darwinian idea of bringing about continuous changes in types, found that marked progress was made during the first few years, but that these changes soon diminished in amount. Selection did not appear to affect the extent of the fluctuations, but there was gradually a greater regression toward the average of the race. That is, the average of the progeny of selected mothers was, in later years, nearer to the race average and not so near to the average of the selected seed, as it had been in the beginning. This condition of affairs was not explained until 1901, when De Vries (2) published his Mutation theory. In this epoch-making work the author showed, by a mass of evidence, that selecting fluctuations produces only a limited and a temporary change in type. Permanent changes are made by actual additions or losses of characters. When a character is thus added, it is transmitted as an entity to succeeding generations, although attended by the inevitable fluctuating variation. Fluctuations were held to be due to the action of environment, and since such influences did not actually change the heredity *character formula* of the germ cell, they had no permanent effect on the organism. It is perfectly obvious,—when once attention has been called to the point,—that selection of fluctuations can never originate one of these unit characters, for there is no basis upon which it can work. The character is either present or it is absent.

Later, there has been a careful experimental study of fluctuations by Johannsen (7). His work has been done with such plants as beans, that could be self-fertilized for several generations. A family when thus continuously selfed he calls a "pure line." Without going into details, Johannsen's most important conclusion is that when extreme fluctuations of a pure line are selected, the progeny regress almost, if not completely, to the type or modal value of that line.

A commercial variety, of beans for example, is made up of numerous distinct types, biotypes, as he calls them. The entire variety may fluctuate normally about a varietal mode; but at the same time each biotype may be separated from the mixture and will fluctuate around its own specific mode. Any permanent improvement that is made by selection is merely the separation of one of the extreme biotypes. When an extreme line is entirely separated, however, selection of *its* extreme fluctuations causes no change (or at least no permanent change) of type, because there is almost complete regression to the mode of its line.

These variations are evidently mutations; the only difference being that here the unit character is very small and the change is the addition or subtraction of a unit like one already possessed, while in what we think of as "sports" the change is a visible differentiation. In two biotypes there exist inheritable differences, although each may have fluctuations which cross the fluctuations of the other. On account of these fluctuations there is great difficulty in separating biotypes in the open field, because of intercrossing and lack of selective indices. To be specific, there are several biotypes in corn distinguished by their different modal values for numbers of rows. I have seen an eight-rowed biotype varying from four to fourteen rows, and a sixteen-rowed biotype varying from eight to twenty rows; but when extremes of each of the lines were selected their progeny returned closely to their own types.

In an earlier publication the writer (3) considered at some length the bearing of these questions upon the technique of corn breeding. It was pointed out that corn breeders should discard the idea of forcing improvement along paths where nothing has been produced by nature, and should endeavor to reject the bad and isolate the good from such types as are available. The all-important idea from the present point of view is to have a large number of biotypes from which to select. It was recommended that from three hundred to five hundred ears should be planted in the first ear-row test, using only one-half of the kernels of each. The remnants of the best ears can thus be planted in the succeeding season and crossed only with other good ears, as in Williams' method. According to our recommendations the remaining kernels from the *four* most superior ears were *either* to be planted in a fluctuation breeding plot, *or*, an attempt made to further isolate a more uniform type. The first plan was given preference, because fear of the dangers of inbreeding led me to think that the foundation stock should not be reduced too strictly to type.

I was not able to give a reason for this belief beyond the common credence of the detrimental effects of inbreeding, due, partly, to Darwin's (1) great work, and partly to my own experience with inbreeding in corn. In common with others, both biologists and breeders, I thought that this was generally due to the establishment and enhancement of poor qualities common to the strain, and that certain superior individuals might remain vigorous even under self-fertilization. Such an idea has been prevalent, although Darwin (1, p. 445) expressly denies the conclusion in the following words:

"Before proceeding further, the view which has been maintained by several physiologists must be noticed, namely, that all the evils from breeding animals too closely, and no doubt, as they would say, from the self-fertilization of plants, is the result of the increase of some morbid tendency or weakness of constitution common to the closely related parents, or to the two sexes of hermaphrodite plants. Undoubtedly injury has often thus resulted; but it is a vain attempt to extend this view to the numerous cases given in my Tables."

A recent paper by Dr. George H. Shull (9) has given, I believe, the correct interpretation of this vexed question. His idea, although clearly and reasonably developed, was supported by few data; but, as my own experience, and the experiments of many others are most logically interpreted in accordance with his conclusions, I wish here to discuss some corroboratory evidence.

Shull's arguments were briefly as follows:

1. The theory that the evil effects of inbreeding are due to the accumulation of deleterious individual variations, is questionable from the very fact that many cosmopolitan species, such as wheat, normally self-fertilize, while certain vigorous plants, as the dandelion, have given up sexual reproduction, and regularly produce seed without fertilization. Further, injurious effects are about as common,—in maize at least,—when superior parents are chosen, as when inferior parents are used.

2. The extremes in pairs of characters in different selfed rows from the same original stock (pairs of characters such as wide and narrow leaves, tall and short stems) could not both have been due to self-fertilization. Deterioration then must be an indirect and not a direct effect of inbreeding.

3. It is an established fact, although the cause is unknown, that *crosses between nearly related types are more vigorous than either of the types alone.* Self-fertilization in corn, therefore, simply isolates biotypes; and these by themselves are generally less vigorous than the hybrids continually formed in nature by intercrossing.

It is obvious that if further investigation bears out these conclusions, the proper procedure in corn breeding will be, not to select too strictly to one uniform type, but to keep up a continuous state of hybridization between two or more superior types. It is even suggested that it may be possible to breed two uniform but distinct types, and obtain the best results by crossing them each year.

At first thought it seems as if the question had merely been turned around, and instead of saying there is a loss of vigor through inbreeding, we say there is an increase of vigor from hybridizing. The statement is, indeed, merely a reversal of words if we hold to the Linnæan idea of species and the Darwinian principle of selection; but with the conception of biotypes within a species, there is a radical change in the thought.

Darwin (1, p. 264) found that garden peas, *Pisum sativum,* were perfectly self-fertile, and were not benefited by crosses between different plants from the same stock; on the other hand, crosses between different strains were marked superior to either strain self-fertilized. This is clearly explained by the existence of biotypes which thrive better in combination. Shamel (8) has found the same to be true of tobacco. Darwin also states (1, p. 449) that Fritz Müller found his Bignonias almost sterile among themselves, but highly fertile with pollen from a distant plant. Indeed, with trials made upon five different genera, belonging to four different families, he (p. 299) found but one instance (Digitalis) where crossing the flowers on the same plant proved to be better than self-fertilization; although in most every case distinct strains of the same variety were benefited by crossing.

There is one point which Shull's argument does not touch. If there is a deterioration directly due to inbreeding, under the old hypothesis, continued inbreeding should have brought about further degeneration. By the present theory, when once the biotype has been extracted, no further deterioration will take place, provided the plant is not diseased and its environment is normal.

A reconsideration of the data given in Darwin's (1) work upon the subject throws a great deal of light upon this question. In the first place if we discard the work on *Reseda odorata, Dianthus caryophyllus, Lobelia fulgens and Beta vulgaris* from the table of comparative heights of cross and self-fertilized plants, on account of conflicting results in different years, we find that it is not exceptional to find no increase in vigor due to crossing. In the fifty-one species remaining, the crossed plants proved superior in thirty-three species, the selfed plants superior in eight species, while ten species showed no difference after allowing an error of plus or minus five per cent. Now it may be that certain species do not show an increase in vigor upon crossing nearly related forms; but besides this possibility, there is the presumption that out of all of Darwin's comparisons, he should in some cases have compared a very excellent biotype self-fertilized with a poor type cross-fertilized, and the latter was not able to make up the handicap even with the aid of the stimulus of cross-fertilization. Further, it is noticeable that in his comparisons between plants which had been selfed for several generations and the same outcrossed with other stock, there were greater differences than when comparisons were made between cross and self-fertilizations within a type, these having practically been made uniform by close breeding.

These experiments with crossed and self-fertilized plants of the same species, were continued with *Ipomoea purpurea* for ten generations. The ratio of heights of crossed to heights of selfed plants varied from 100 to 68 in the third generation, to 100 to 86 in the fourth generation; but in the ninth generation it was 100 to 79, which is a higher ratio than in the first generation. The tenth generation was, indeed, low, but it may, with all fairness, be rejected, as Darwin states that the plants were diseased. Darwin, himself, took notice of this point. He says (p. 55):

"As the plants which were self-fertilized in each succeeding generation necessarily became much more closely interbred in the later than in the earlier generations, it might have been expected that the difference in height between them and the crossed plants would have gone on increasing; but, so far was this from being the case, that the difference between the two sets of plants in the seventh, eighth and ninth generations taken together is less than the first and second (and third? E. M. E.) taken together."

He also states that all of the ten generations of crossed flowers varied in color, although the later were more uniform than the earlier generations. The selfed generations, however, were so uniform in color that his gardener said, "They did not need to be labeled." All of these points are in strict accord with the modern theory.

In this species as well as in *Mimulus luteus, Nicotiana tabacum* and a few other less marked cases, there appeared vigorous self-fertile types. Whether these were the result of dormant possibilities which were already present in the germ cells of Darwin's original plants, or were new mutations, we cannot now conjecture. They serve only to illustrate the frequency of such appearances even in species showing marked stimulation by crossing.

Very few experiments were carried on with other species for a large number of generations. Several were continued for three generations, but the results were irregular. In *Mimulus luteus* the irregularity was caused by the appearance of the above-mentioned tall, self-fertile variety. The other cases of irregularity may have been due to experimental errors or to unknown physiological causes. For example, in *Petunia violacea* the height ratios of crossed and selfed plants were as follows:

1st generation	100 to 84
2d generation	100 to 65
3d generation	100 to 131
4th generation	100 to 69
5th generation	100 to 61

There is a decrease in the ratio, so the plant appears weaker at the fifth than at the first generation; but it is questionable how definite a conclusion can be drawn from this fact since the third selfed generation is so remarkably vigorous. Considering all of the experiments, it seems clear that with continued inbreeding there is no accumulation of detrimental characters.

As stated before, several years ago an experiment (5) was conducted at the Illinois Agricultural Experiment Station which showed that inbreeding in corn was deleterious to its vigor. In this experiment a breeding plot was planted by the ear-row method, and every alternate row detasseled at flowering time. The best ten of the detasseled rows were selected to plant in the rows to be detasseled in the succeeding season, and the best ten tasseled rows were selected to be planted in rows which should remain tasseled. Thus the product of the detasseled rows had been crossed in each previous season, while the product of the tasseled rows were more or less inbred. The same plan was used upon a second plot in order to duplicate the work. On the first plot there was an average increase on the detasseled rows of 1.6 bushels per acre the first year, 10.1 bushels per acre the second year, and 9.3 bushels per acre the third year. On the second plot there was an average increase on the detasseled rows of 5.9 bushels per acre the first year, 14.7 bushels per acre the second year, and 11.8 bushels per acre the third year. Thus it was manifest that the superiority of crossed over inbred seed was not on the increase. I do not know what the yields have been in succeeding years, but I venture to predict upon theoretical grounds that continued selection will also, though more slowly, isolate a uniform type upon the *crossed* rows, which will bring the yields of tasseled and detasseled rows closer together.

There have been several experiments where the yield of corn, inbred by artificial pollination, has been compared with that obtained by natural pollination. The results were markedly in favor of the natural pollination, and it was concluded that this was entirely due to inbreeding. Such a conclusion is unfair. The first year in which I experimented with artificial pollination of corn, my work resulted in poor ears, both upon crossed and selfed plants. The experiments were continued, however, and in succeeding years with better technique, excellent ears were obtained by artificial pollination, both when the ears were crossed and when they were selfed. Rows grown from ears which had been selfed for two and three generations were exceedingly uniform in all of their botanical characters, and while they did not yield as well as the crossed rows, nothing was seen that could be called degeneration. The plants were perfectly healthy and normal in all of their functions.

But, as Shull (9) states, the correct answer to this problem must be obtained from exact experiments in the field. Our breeding plot cultures of corn, however, give us some idea of what we may expect. I have been repeatedly struck with the fact that in our corn plots the type was not uniform. There are always several types in a breeding plot, no matter what is the variety. This is due to selecting rows from which to propagate, solely by their yield. In several cases there have been types which I wished to reject because they were different from the remainder in appearance, but they were sometimes finally retained because of their vigor. Such a type has several times been planted in such a position as to pollinate or be pollinated by rows of another type. (We detassel alternate rows.) *There are always some of the rows from such crosses that are so vigorous that they are selected because of their yield, and the odd type, therefore, remains.*

In 1905, a breeding plot of Stowell's Evergreen sweet corn was planted. At harvest time it was clear that there were two types; one with a smooth, full kernel, and the other with a thin, peaked kernel. The two types are shown in Plate XL, b. The breeding plot of 1905 was small, and each type, therefore, furnished quite a number of ears for the 1906 plot. In certain cases ears of the same type were planted side by side so that they were intercrossed. This brought out the types still more strongly in 1906. In the 1907 breeding plot, part of the ears of each type were planted so that they would be fertilized by the same type, and part were planted so that *one type would pollinate the other type.*

Rows were selected by yield only, and in every case but one, rows in which the two types had been crossed were the ones selected. The crosses between the types thus proved to be more vigorous than either type alone.

Much work is yet necessary upon this problem; but we feel that the evidence is sufficiently conclusive for us to recommend more strongly than in our Bulletin No. 158, that out of all the types of the variety under experiment, several of the best yielding types be selected, and the variety then be kept at its best by selecting fluctuations and giving them the best possible environment. Shull's suggestion of two pure strains to be crossed each season is worthy of trial, particularly on account of its theoretical importance, since it is to be feared that such a method, even though desirable, would not be practicable.

LITERATURE CITED.

1. **Darwin, Chas.** Cross and Self Fertilization in the Vegetable Kingdom. N. Y. Appleton Reprint. 1902.
2. **De Vries, Hugo.** Die Mutationstheorie. Leipsig. Veit. Erster Band. 1901. Zweiter Band. 1903.
3. **East, E. M.** The Relation of Certain Biological Principles to Plant Breeding. Conn. Agr. Exp. Sta. Bull. **158:** 1–93. 1907.
4. **Hopkins, C. G.** Improvement in the Chemical Composition of the Corn Kernel. Ill. Agr. Exp. Sta. Bull. **55:** 205–240. 1899.
5. **Hopkins, C. G., Smith, L. H.,** and **East, E. M.** Directions for the Breeding of Corn, Including Methods for the Prevention of Inbreeding. Ill. Agr. Exp. Sta. Bull. **100:** 601–625. 1905.
6. **Hunt, T. F.** The Cereals in America. N. Y. Orange Judd. 1904.
7. **Johannsen, W.** Ueber Erblichkeit in Populationen und in reinen Linien. Jena. Fischer. 1903.
8. **Shamel, A. D.** The Improvement of Tobacco by Breeding and Selection. Yearbook U. S. D. A. **1904:** 435–452. 1905.
9. **Shull, G. H.** The Composition of a Field of Maize. American Breeders' Assn. Report **4:** In press.
10. **Williams, C. G.** Pedigreed Seed Corn. Ohio Agr. Exp. Sta. Cir. **42:** 1–11. 1905.

IV. SOME ESSENTIAL POINTS IN POTATO BREEDING.*

Some time ago, we made a rather wide inquiry into the present status of potato improvement in the United States. From our replies it was clear that very little systematic work in potato breeding is in progress. A generation ago, many gardeners were potato fanciers, and took a great deal of pride in their potato seedlings raised from cross-bred seed produced by their own hands. The work generally did not have the definite aim of combining the good points possessed by different varieties; but it was followed up with patience and skill and was productive of many valuable commercial strains. To-day, there still are growers who are raising seedlings from natural fruit berries with the hope of chancing upon something of value; but the number who are carrying on methodical plant breeding is surprisingly small.

The fact is contrary to what should be expected, because the potato is the only important agricultural crop whose recent domestic production has been insufficient to supply the demand. The per capita consumption in the United States has been three and one-half bushels for the past thirty years, and for several seasons there has been a considerable shortage. The annual addition to our population demands a yearly increase in production of from three to five million bushels; and plant breeders should make an effort to supply the market without greatly increasing the acreage, by the origination of better varieties.

The different varieties of the potato are reputed to be difficult to cross, and it may be that this difficulty is largely the cause of waning interest in the origination of new varieties. With the hope of overcoming the difficulties in question and thereby arousing new interest in potato breeding, we have paid especial attention to the technique of crossing in our investigations. The work has included taking field data too bulky to be presented here. Conclusions could be drawn only upon certain points, and the total figures upon these points are submitted.

* A preliminary paper giving some of these results, entitled "Technique of Hybridizing the Potato," was published in the 1907 Report of the Society for the Promotion of Horticultural Science. Final revision of the data has made slight changes in some of the figures but not in the results.

Variety Variation in Flowering.

Potato varieties vary markedly in ability to produce flowers and the idea is prevalent that many varieties never bloom. According to Fraser (4), Mark Catesby, who was in this country in 1772 and 1776, writes that "in Virginia and to the north thereof, they [potatoes] are annuals and produce no flowers, while in Carolina and the Bahama Islands they produce flowers." This quotation shows that the belief in non-flowering varieties was common at an early date. It is not odd that this should be the case, for there are certainly many varieties that do not flower every year, and conclusions have generally been drawn after but a short period of observation. It is also possible that there are varieties which grow for a long term of years without flowering, in localities where the soil and climate are unfavorable for sexual reproduction. At least this fact would account for the tenacity with which what I believe to be a wrong idea, is held.

Fraser states that out of three hundred varieties that he had observed, there was seldom a variety that did not bloom at some period in its life, and many of the heaviest yielding varieties bloomed as freely as those of inferior merit. From our experiments, and from the data that we have collected by correspondence, we should go further than Fraser and make the statement that *every variety* in normal physical condition blooms when environmental conditions are favorable.

Among 721 varieties, part of which have been under observation but one year, only 31 varieties have shown no signs of flowering. The plants of all varieties that did not bloom were quite small. Some were affected by the internal brown spot disease which is thought to be a symptom of malnutrition. Even those plants which appeared perfectly healthy were stunted in growth, and seldom produced tubers over twenty-five grams in weight. The average size of the tubers was probably not over ten grams. In fact, every non-flowering variety appeared to be ill-adapted to soil and climatic conditions, although generous quantities of manure and commercial fertilizers were used, and other varieties in neighboring rows produced vigorous plants and large sets of tubers. It seems as if apparently healthy varieties may reach a physical condition in which growth takes place with difficulty under conditions favorable to varieties in

their normal condition. When the plants are thus unable to utilize the essential elements of fertility, there is no tendency toward sexual reproduction. The potato plant, therefore, does not support the theory that organisms propagating asexually return to sexual reproduction when in a starved condition.

An attempt was made to find whether the thirty-one non-blooming varieties ever flowered in other places. Relying on published reports and on correspondence, records of twenty-six varieties were found, all of which bloom under the conditions to which they are native. Some of these records were obtained from catalogues of European seedsmen, but they are probably reliable upon such a point.

No data have been obtained concerning, Drop d'Or de la Reine d'Angleterre, Belle de Pièrre Caye, Violette de Ireland, La Pera Mart and Zemis Collobe. I do not believe, however, that these five varieties are exceptions to the general rule, and it is quite probable that they would flower under conditions in which they would make a normal growth.

Although it seems a reasonable conclusion that all varieties do bloom under conditions of environment to which they are adapted, nevertheless, varieties which were listed as flowering do not necessarily open their buds. All varieties were classed as having flowered, that had produced a flower stalk with buds. There are also other characteristic differences that concern the flowers, by which potato varieties can be arbitrarily divided into four classes:

(1.) Varieties whose buds drop off without opening.

(2.) Varieties in which a few flowers open, but which immediately fall.

(3.) Varieties whose flowers persist several days, but which rarely produce viable pollen.

(4.) Varieties which under most conditions always produce viable pollen.

This classification is arbitrary and all gradations of these groups are to be found. Of the 721 varieties under observation, in 487 varieties, or 67 per cent., the buds fell off before opening. In about 70 per cent. of the remaining varieties the flowers remained on the stems for more than one day. Conditions of environment have so much to do with blooming, that fluctuations of these characters obscure the inherited varietal tendencies; but

I believe that there are biotypes in *Solanum tuberosum* L. that inherit actual characters which affect the capacity for flowering in something of the above manner.

It is a noteworthy point that with unselected two-year-old seedlings the percentage of varieties that retain their flower, and of those whose buds fall off, has been found to be nearly the same as in named varieties, namely, 40 per cent. and 60 per cent., respectively. It is generally believed that the majority of seedlings invariably produce blossoms and generally produce fruit during the first few years when their growth is largely vegetative; but that later there is a deterioration of sexual functions due to increased tuber production. This approximately equal percentage of the different classes, both in seedlings and in older named varieties, indicates that certain sexual differences are inherited as distinct characters and are not entirely due to increased tuber production in later years. This conception of the mutual exclusiveness of tuber production and seed production was promulgated by Knight (6) at the beginning of the nineteenth century. He claimed that non-seeding varieties could be forced to seed by removing the earth from around the stolon, thus preventing tuber formation. His idea seemed to be that the phenomenon was purely physiological; and if the energies of the plant were artifically turned away from tuber formation, the sexual organs immediately responded to the stimulus. That is, they obeyed the law of physiological compensation of growth.

We have made several experiments upon this point. Tubers were prevented from forming on plants of several different varieties. In those varieties of which the flowers fall off before opening, the treatment appeared to force a more vigorous growth. In one early variety, the Extra Early Eureka, there may have been a slightly greater tendency for the treated plants to blossom; but there was no chance to try pollinating the flowers, because no pollen was mature before the flowers fell. In varieties that produce some viable pollen, such as Rural New Yorker No 2, Irish Lemon, and Green Mountain, there appeared to be no increase of viable pollen over untreated plants, when the grains were examined under the microscope. The table shows the number of successful fertilizations when fifty treated and fifty untreated plants were pollinated.

TABLE I.—EFFICIENCY OF PREVENTION OF TUBER FORMATION IN STIMULATING SEED PRODUCTION.

Variety.	Number of successful pollinations out of 50 attempts.	
	Treated.	Untreated.
Rural New Yorker No. 2	6	4
Green Mountain	9	8
Irish Lemon	2	4

In most cases there was an increasing vigor of growth, but it did not greatly affect the formation of healthy pollen. Why there was not a greater fluctuation I do not know. In some cases there must be a sufficient fluctuating variability in the production of viable pollen to make a great difference in the amount of natural seed berries produced. I have seen tubers from the same stock of Rural New Yorker No. 2 grown in two different climates; in one locality it fruited freely, and in the other climate formed no natural seed balls. But, of course, this variety always produces some healthy pollen, and a small per cent. of hand-pollinations are successful in any climate.

As far as our experiments go, they point to two conclusions:

1. There are characteristic differences in seeding power which are inherited by different varieties.

2. Fluctuations in these characters are large, and may be increased artificially by changing environmental conditions; but no ordinary* treatment will force a variety across its critical point into another biotype.

From these results there is no reason to believe that artificial treatment can change the natural tendencies of varieties whose buds fall off, far enough to allow their being used as parents in originating new varieties. Even if we should grant that the thing is possible, it cannot be practical.

* We leave out of consideration changes that may possibly be brought about by heroic treatments such as Dr. MacDougal (7) gave his Raimannia plants. In his experiments, dilute solutions of such chemicals as zinc sulphate were injected into the ovaries of the plant immediately before fertilization. A small per cent. of the plants thus treated formed seeds that produced plants entirely different from the mother species. The treatment had evidently caused an abnormal cell division which was apparently inherited by succeeding generations.

The idea that the non-seeding of varieties is largely due to the diversion of the plants' energies to the storing of food material in tubers, has been interwoven with another idea, which, though it appears to be similar to the first, is in fact fundamentally different. It is the Lamarckian belief that continued improvement in tuber formation has led to degeneration of the sexual functions. This conception also is without a sufficient foundation. The varieties that naturally have seeded most freely with us are Chenango, Keeper, and Seedling from Nova Scotia. They are none of them very good croppers, but there is another explanation of the fact. Inability to produce viable pollen may be a natural character belonging to an elementary species of *S. tuberosum,* such as De Vries (1) has found in some of his Œnothera mutations, or it may be due to the hybrid condition of the varieties, as this feature is often characteristic of hybrids. At least we know that some varieties naturally possess the power to mature healthy pollen, while other varieties lack this ability. We also know that there is an intimate relation between the functions of the plant organs whereby energy devoted to seed formation cannot be devoted to the production of tubers. That is, there *is a fluctuating variation* of power of seed production that is influenced by tuber production and other internal plant relations, as well as by environment. It is therefore likely that in comparative trials those seedlings would be selected to become commercial varieties that were using their strength in growing tubers; and these varieties would more probably be non-seeding varieties. The greater chance of non-seeding varieties in competition has allowed more of them to survive, but no Lamarckian hypothesis is needed to account for the fact. Indeed, many of our best varieties furnish enough pollen so that they are comparatively easy to cross. Among these are Rural New Yorker No. 2, Sir Walter Raleigh, Carmen No. 3, Green Mountain, Irish Lemon and Ionia Seedling.

The Flowers.

The floral axis of the potato is a cyme, which is generally divided into two parts as is shown in Plate XLI, b. The flowers close slightly about dusk and open in the morning between five and six o'clock. Hand-pollinations seem to succeed better when made at this time, probably because there is a loss of moisture during the day from both pollen and stigma, making it more difficult for the pollen to germinate.

The large fleshy anthers open normally with small terminal pores, but in those varieties producing the best pollen they generally split down the whole side. Even in these cases, however, most of the pollen is retained, and the best means of obtaining it for artificial pollination is to split the epidermis of the anther down the side, if it has not opened naturally, and lightly brush its interior with a camel's hair brush.

The pollen appears to be in the best condition for use on the second day of blooming. This may be due to the greater amount of exudation from the stigma at that time, giving more of a stimulus to the growing pollen tube.

The flowers produce no nectar and are very rarely visited by nectar-seeking or pollen-eating insects. Müller (8) observed *Eristalis tenax* L., and *Syritta pipiens* L., visiting potato flowers, but with careful watching we have not noticed any probable pollination by insects. An aphid, probably *Nectarophora solanifolii* Ashmead, is numerous on most varieties, but they probably rarely assist in fertilizing the blossoms. The small amount of natural pollination is anemophilous, and it is likely that a majority of natural seed balls are self-fertilized.

If we may judge from work with only two varieties, the potato is naturally more fertile with its own pollen than when crossed with other pollen. Reciprocal crosses were made between Chenango and Keeper, both of which produce fruit freely. Self-pollinations were also made upon each variety, and these were much more successful than the crosses.

The flowers which are the most easy to cross are not those produced at the upper end of the plant stem but those produced at the next lower axils. Of such pollinations on naturally seeding varieties, 52 per cent. were successful, of those upon the uppermost cymes 28 per cent. were successful, while on the lowest clusters only 18 per cent. were successful. The reason for such a fluctuation in successful pollinations on single plants is unknown.

Pollen.

A study of the structure of the anthers and the viability of the pollen of eighty-seven varieties brought to light several facts that may aid work in potato improvement. It is characteristic of some varieties that the pores that should open at the end of the anther do not do their duty. In other varieties these pores open but soon the tissues dry together so that little pollen is shed. It was found that in such varieties the pollen is never very good and only an occasional successful pollination could be made. Some healthy pollen is produced, however, and with sufficient care such varieties *can be used* as pollen parents. Pollen for our hand-pollinations was collected by opening the anthers with a knife and scraping the interior over a watch glass.

A microscopical examination of the pollen of these different varieties showed that there is a great variation in the character of the pollen produced by each, despite a considerable fluctuation within each variety. Normal healthy pollen is round, and about 0.036 mm. in diameter, while pollen which will not produce tubes is seldom over 0.020 mm. in diameter and is shriveled and irregular. In Keeper and Chenango (which naturally set large quantities of fruit) among a larger proportion of round grains, others were noticed with one, two, three, four and even five slight protuberances (Figure 8). When placed in seven per

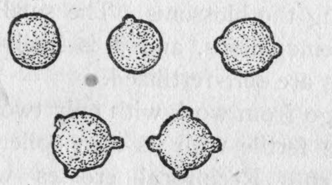


FIG. 8.—Potato pollen (much enlarged).

cent. sugar solution these grains were the first to germinate, and their pollen tubes grew faster and appeared stronger than those from the round grains. A pollen tube germinated from each of these protuberances, showing that these grains each contained several nuclei. It was noted that the viability of all of the pollen and ease of making successful pollinations and of obtaining mature berries in other varieties, varied directly with the number of these multi-nucleate pollen grains as is shown in Table 2. It is obvious that the number of pollen grains necessary to fertilize the two hundred or more ovules in the ovary is divided by two or three such varieties. In fact, it is easy to predict the relative ease of making crosses by a short preliminary examination of the pollen under the microscope, noting its relative amount, size and viability, and the number of multi-nucleate grains that are present.

TABLE II.—POTATO POLLEN IN 1907.

Variety.	Amt. Pollen.	Per cent. Healthiest. Healthy, estimated.	Poli-nucleate.	Fruit Production.	Remarks.
Admiral Dewey	Medium	60	5%	Untried	
British Queen	Very small	5	None	Untried	Anther openings dry together.
Burpee's Ex. Early	Small	25	None	None	
Blue Christy	Med. large	60	10%	Med. difficult	
Chenango	Large	80	30%	Easy	Natural fruits.
Carman No. 3	Small	50	5%	Med. difficult	
Colburn's Seedling	Small	20	None	None	
Cortenbling	Very small	10	None	Untried	
Coo's No. 2	Very small	50	10%	Untried	
Cracker Jack	Very small	10	None	Untried	
Capital	Medium	75	10%	Untried	Promising.
Colebrook	Very small	10	None	Untried	
Charter Oak	Small	40	10%	Difficult	One berry obtained.
Delaware	Small	20	A few	None (?)	Not healthy stock.
Express	Very small	10	A few	None	Anther openings dry together.
Ex. Early Pioneer	Medium	50	5%	Difficult	
Essex	Very small	10	None	None	Anther openings dry together.
Endurance	Very small	10	None	Untried	
E. Manistee	Medium	60	10%	Med. difficult	
Empire State	Small	10	None	Untried	
Early Everitt	Very small	10	None	Untried	Healthy pollen very large, .042mm.
Exp. Station No. 3	Medium	80	25%	Untried	From seeds of same cross.
Exp. Station No. 6	Medium	40	5%	Untried	From seeds of same cross.
Exp. Station No. 4	Medium	85	25%	Medium	From seeds of same cross.
Exp. Station No. 11	Medium	80	20%	Medium	From seeds of same cross.
Exp. Station No. 10	Small	30	None	None	From seeds of same cross.
Exp. Station No. 12	Medium	80	25%	Medium	From seeds of same cross.
Exp. Sta. No. 12a	Medium	80	25%	Medium	From seeds of same cross.
Exp. Sta. No. 12b	Medium	80	25%	Medium	From seeds of same cross.
Exp. Sta. No. 12c	Medium	80	25%	Medium	From seeds of same cross.
Fremont	Very small	10	None	Untried	
Factor	Very small	5	None	Untried	
Gov. La Follette	Very small	40	None	None	
Garnet Chili	Small	40	2%	Untried	
Gold Coin	Small	20	None	None (?)	Not healthy stock.
Green Mountain	Small	50	5%	Difficult	
Hay's Beauty	Small	5	None	Untried	Anther openings dry together.
Houlton Rose	Small	20	None	None	
Ionia Seedling	Medium	50	5%	Difficult	

TABLE II.—POTATO POLLEN IN 1907—*Continued.*

Variety.	Amt. Pollen.	Per cent. Healthiest. Healthy, estimated.	Poli-nucleate.	Fruit Production.	Remarks.
Island Queen	Small	10	None	Untried	
Irish Lemon	Medium	70	20%	Medium	
Johnson's Seedling No. 101	Very small	5	None	None	
Johnson's No. 7	Very small	10	None	Untried	
Kelley	Very small	10	None	None	Anther openings dry together.
Keeper	Large	90	40%	Easy	Natural fruits.
Late Puritan	Very small	5	None	None	Anther openings dry together.
La Czarina	Medium	75	20%	Easy	A few natural fruits
Louis Botha	Very small	25	None	None	
Lake-side Champion	Medium	40	None	None	
Merrill	Small	40	2%	Untried	
Magnum	Very small	20	None	Untried	
Major Neve	Small	20	None	Untried	
Max Eyth	Small	50	10%	Difficult	
Nova Scotia Seedlings	Large	90	25%	Easy	
Old Glory	Very small	10	None	None	
Pat's Choice	Small	40	None	None (?)	Only two flowers tried.
Parkhurst's Prize	Very small	10	None	None	
Polaris	Small	25	2%	None	
Presley's No. 16	Very small	20	None	Untried	
Presley's No. 47	Very small	10	None	Untried	
Quarantania de la Halle	Small	40	5%	Untried	
Rose of Erin	Very small	10	None	Untried	Retains pollen.
Rural New Yorker No. 2	Medium	60	10%	Difficult	
State of Maine	Small	40	2%	Untried	Anther openings dry together.
Sport from 'Buffalo'	Small	10	None	None	
Sensation	Small	25	None	None	
Seguin	Small	60	10%	Difficult	
Scottish Triumph	Small	5	None	None	
Silver Hill	Med. large	75	20%	Easy	
Seedling No. 150	Small	25	None	None	
Scotch Rose	Very small	5	None	Untried	
Scott's No. 13	Very small	None	None	Untried	
Scott's No. 8	Medium	80	5%	Untried	
Scott's No. 9	Medium	40	5%	Untried	
Scott's No. 10	Small	10	None	Untried	
Scott's No. 19	Very small	5	None	Untried	
S. tuberosum (Mexican)	Small	30	None	None	
St. Lawrence	Medium	70	20%	Medium	
The Bruce	Very small	10	None	Untried	
Table Talk	Very small	10	None	None	
The Diamond	Medium	60	10%	Medium	
The Daniel	Medium	60	5%	Difficult	

TABLE II.—POTATO POLLEN IN 1907—*Concluded.*

Variety.	Amt. Pollen.	Per cent. Healthiest. Healthy, estimated.	Poli-nucleate.	Fruit Production.	Remarks.
Tremendous	Very small	None	None	Untried	Stock unhealthy.
Table Talk (Dif. Stock)	Very small	5	None	Untried	
Up-to-Date	Very small	10	None	Untried	
Victoria Augusta	Small	10	None	Untried	
Webber's Early	Very small	10	None	None	
What's Wanted	Very small	5	None	Untried	
50 assorted seedlings	Not examined	--	----	Found no natural fruits.	

These facts are illustrated in the three following tables which have been compiled from the data contained in Table 2. They have been put in the form of correlation tables, although coefficients of correlation have not been calculated, because the classification is more or less arbitrary, since they were estimated from only three or four examinations in each variety.

Table 3 shows the association between a large production of pollen, and pollen which is healthy and will perform its proper function.

TABLE III.—THE RELATION BETWEEN AMOUNT AND VIABILITY OF POLLEN.

Viability.	Amount.			
	Very small.	Small.	Medium.	Large.
0– 25 per cent. healthy	30	16	--	--
26– 50 per cent. healthy	2	11	5	--
51– 75 per cent. healthy	--	1	9	2
76–100 per cent. healthy	--	--	8	3

Table 4 is compiled only from the varieties on which artificial pollination was actually attempted. These fifty varieties show clearly that it is useless to attempt using as a "sire," a variety of which less than 25 per cent. of the pollen will grow. In fact, the percentage of viable pollen should be above 50 per cent., for the six difficultly fruiting varieties, which belong in the class producing from 26 to 50 per cent. of healthy pollen, are all at the upper limit of this class.

TABLE IV.—THE RELATION BETWEEN PERCENTAGE OF VIABLE POLLEN AND FRUIT PRODUCTION.

Viability.	Fruit Production.				
	None.	Difficult.	Med. Dif.	Medium.	Easy.
0– 25 per cent. healthy	20	--	--	--	--
26– 50 per cent. healthy	5	5	1	--	--
51– 75 per cent. healthy	--	2	3	3	2
76–100 per cent. healthy	--	--	--	6	3

Table 5 shows the relation between multi-nucleate pollen and fruit production. No fruit was obtained from varieties producing no multi-nucleate pollen grains, and those varieties which produced fruit easily or medium easily, all but one produced above 16 per cent. of this kind of pollen.

TABLE V.—THE RELATION BETWEEN MULTI-NUCLEATE POLLEN AND FRUIT PRODUCTION.

Multi-nucleate Pollen.	Fruit Production.				
	None.	Difficult.	Med. Dif.	Medium.	Easy.
None	22	--	--	--	--
1– 5 per cent.	3	4	1	--	--
6–10 per cent.	--	4	2	1	--
11–15 per cent.	--	--	--	--	--
16–20 per cent.	--	--	--	3	2
21–25 per cent.	--	--	--	5	1
Above 25 per cent.	--	--	--	--	2

The Growth of the Seed Berry.

After fertilization has taken place the troubles of the potato hybridizer are not yet over. There is a great tendency for the berries to drop off before maturity. It is the same thing that occurs with so many varieties that drop their buds before they open. Layers of tissue dry up at the end of the pedicel or stem

of the individual flower, so that sap fluid cannot reach the immature fruit. It ceases to grow and soon falls.

Most potato breeders (5) have recommended pollinating but one or two flowers upon a single axis, under the supposition that the strength of the plant would then be utilized by only a few growing fruits. We have found this to be poor advice. When four or five flowers are fertilized, it acts as a stimulus, and produces great growth activity in the cyme. The peduncle becomes larger and stronger as is shown in Plate XLI, c, and there is a much greater probability that the berries will be retained on the stem until maturity. We, therefore, advise fertilizing a number of flowers on one cyme. Then, when partially matured, it may be best to remove all but two berries, although the propriety of this procedure is doubtful.

Counts were made of the number of seeds and of unfertilized ovules in berries from several different varieties that had been dropped at different stages of their development. The results appear in Table 6. They show that while the number of seeds in normal berries differs widely in different varieties, still, there is a close relation between the relative persistency of the berries on the vine and the number of ovules fertilized. In general it may be concluded that if less than 50 per cent. of the ovules are fertilized, the berries are dropped in less than eight days after fertilization. The persistency of the berries then increases directly with an increased percentage of fertilized ovules.

The frail styles of the potato flower pistils usually dry up and fall off after the first application of pollen. I have never been able to make more than two pollinations, so that the importance of applying enough live pollen grains to carry the fruit past the critical point is evident. Here it is that the value of multinucleate pollen grain is so manifest.

TABLE VI.—RELATIVE NUMBER OF FERTILIZED OVULES NECESSARY TO MATURE THE FRUITS.

(Data from Five Naturally Fruiting Varieties.)

Variety.	Size of fruit when dropped.	Number ovules fertilized.	Nmmber ovules unfertilized.	Per cent. ovules fertilized.
Chenango	½ normal	36	52	53
Chenango	½ normal	42	50	46
Chenango	½ normal	32	40	45
Chenango	Full normal	66	21	77
Chenango	Full normal	67	31	68
Chenango	Full normal	80	16	83
Charter Oak	½ normal	45	60	43
Charter Oak	½ normal	50	42	54
Charter Oak	¾ normal	73	22	77
Charter Oak	¾ normal	70	9	89
Charter Oak	Full normal	109	38	74
La Czarina	¾ normal	143	12	92
La Czarina	Full normal	180	5	97
Nova Scotia Seedling	¼ normal	44	33	57
Nova Scotia Seedling	¼ normal	48	37	57
Nova Scotia Seedling	½ normal*	66	24	73
Nova Scotia Seedling	Full normal	137	68	67
Nova Scotia Seedling	Full normal	140	30	82
Silver Hill	¾ normal	102	30	77
Silver Hill	¾ normal	88	26	77
Silver Hill	Full normal	150	20	88

* Possibly broken off mechanically.

Summary of Procedure in Hybridizing.

Examination of Pollen. If possible, before making crosses between two varieties, the pollen of the prospective male parent should be examined under the microscope. This inspection will give a very good idea of the relative ease or difficulty of making the cross. As there are several varieties possessing each of the important desirable characters, knowledge of the pollen will often affect the choice of the parent varieties.

It is scarcely worth attempting a cross unless 40 per cent. of the pollen grains are normal in appearance. If part of the grains are multi-nucleate, the probability of success increases at a *greater* rate than does their proportion.

Preparation of flowers. Select a floral axis on which several flowers are in bloom at the same time. There is more growth activity in such a cluster.

In commercial breeding it is not necessary to cover the flowers; the chance of natural cross-pollination is slight. Neither should

the calyx and corolla be cut away when the flower is in the bud; the style is quite delicate and it is impossible to do much cutting without injuring it. It is sufficient to remove neighboring cymes, and then pull off the anthers of the flowers selected for pollination. This should be done before the anthers open; using a small pair of tweezers.

Pollination. Plenty of pollen should be collected before attempting an artificial pollination. If sufficient ovules (50 per cent., at least) are not fertilized, the berries will not reach maturity. It must also be noted that the pollen can scarcely ever be applied more than once to a single flower, owing to the falling of the pistil.

Care of Growing Fruit. We have found that there is considerable mechanical loss of immature berries. This can be materially aided by supporting the fertilized flowers from the ground, by fastening the cymes so that they will not be whipped by the wind, and finally by screening the plant behind a temporary wind-break.

Correlations between Characters.

De Vries (2) has laid great stress upon the importance of associations of characters in plant improvement. He presents evidence of his own bearing upon wild plants, but relies chiefly upon the work of Nilsson and his colleagues at Svalöf, Sweden, to illustrate their value in breeding agricultural crops. At the above agricultural station, Mr. Lundberg has made detailed studies concerning correlations between the botanical characters in the potato. Unfortunately only fragments of his work have been published, and these in Swedish; hence, it has not been available to the writer.

A number of other writers have also reported vague ideas concerning characters which they held to be correlated. These alleged correlations have generally been considered only as additional scientific facts, although their practical use has sometimes been suggested. It is doubtful whether these cases need even be considered for criticism, for as far as the writer can ascertain, no figures concerning the actual per cent. of correlation have ever been reported. It has merely been stated that characters A and B are correlated. The question of the minimum degree of correlation necessary in order to use the relative character as the selective index of the subject character, has not been considered. Neither has the influence of environmental factors upon specific characters been differentiated from the influence of one character upon another.

In a recent paper, the writer (3) has endeavored to classify the numerous phenomena to which the term correlation has been applied collectively, and to suggest the relative possibilities of the practical use of these different classes. There are correlations in the potato that belong to the class in which an heritable character directly influences the development of a quality; for instance, the dependence of table quality upon homogeneous tuber structure. These cases, however, are few; and the occurrence of examples of other groups of correlations in the potato is yet unproved.

In 1907 an attempt was made to determine the exact degree of correlation of different characters in *Solanum tuberosum*, by classifying the characteristics of all of the different varieties that were growing in our garden. Data were taken at different times during the season upon the leaves, stems, flowers and tubers of about seven hundred varieties.

As there was little trouble with fungus diseases during the season, a study of possible correlations of botanical characters with resistance to fungus parasites could not be made. The coefficients of correlation that have been calculated are those between characters belonging to aerial plant parts and tuber characters. This was done because of the importance of any facts by which tuber characters could be known from their association with other plant marks, and thereby the rejection of undesirable seedlings be facilitated.

The method used was that of Yule (9). If we are considering the presence and absence of two characters, M and N, we arrange the numbers of each in their proper group according to the following plan:

	M Present	M Absent
N Present	a	b
N Absent	c	d

The formula which shows the correlation between the two characters is $\frac{ad-bc}{ad+bc}$. The answer can vary between -1 (perfect negative correlation), 0 (no correlation), and 1 (perfect positive correlation). The relative probability of the answer found being the true correlation increases with the number of individuals considered.

The results were nearly all so low that they are of no practical value, and we will not take space to describe them. Perhaps it will be of value, however, to give the characters considered, in order that the work will not be needlessly duplicated in the future.

Colored vines and colored flowers were each paired with color and absence of color in tubers. The same vine characters were each paired with round and with oblong tuber shapes. Those varieties having tubers with a round-flat shape were classed as "round"; and those tubers having oblong-flat shapes were classed as "oblong."

Erect and procumbent vines, and tall and dwarf vines, were also each paired with presence and absence of color, and with the two different classes of shapes. The color of tubers,—color and no color, purple and no purple, red and no red, were also paired with the two shapes.

Taking into consideration the 88 varieties whose pollen was studied, two classes were made. Twenty-nine varieties having 50 per cent. or more of good pollen were classed as "good pollen" varieties, and 59 varieties having under 50 per cent. of good pollen were classed as "poor pollen" varieties. The following characters were paired with them; round and oblong shapes, deep and shallow eyes, rough and smooth skins, tall and dwarf plants, and colored and uncolored stems.

Out of all of these correlation tables only four showed correlations higher than the probable error, and these were all correlations where color is manifested on different parts of the plant.

Out of 240 varieties with colored stems, 57 varieties had colored tubers, and 183 varieties had colorless tubers. Out of 460 varieties without colored stems, 86 varieties had colored tubers, and 374 varieties had colorless tubers. The coefficient of correlation between colored stems and colored tubers equals

$$\frac{(374 \times 57)-(183 \times 86)}{(374 \times 57)+(183 \times 86)} = .15 \pm .025.$$

Out of 69 varieties with colored flowers, 32 varieties had colored stems, and 37 varieties had colorless stems. Out of 156 varieties without colored flowers, 48 varieties had colored stems, and 108 varieties had colorless stems. Therefore, the coefficient of correlation between colored flowers and colored stems equals

$$\frac{(108 \times 32) - (48 \times 37)}{(108 \times 32) + (48 \times 37)} = .32 \pm .041.$$

Out of 69 varieties with colored flowers, 16 varieties had colored tubers, and 53 varieties with colorless tubers. Out of 163 varieties with colorless flowers, 29 varieties had colored tubers, and 134 varieties had colorless tubers. Therefore, the coefficient of correlation equals

$$\frac{(134 \times 16) - (53 \times 29)}{(134 \times 16) + (53 \times 29)} = .165 \pm .042.$$

I believe that the lower limit at which the coefficient of correlation will be of any value whatever in making selections, is somewhere about .50; and to be a valuable assistant in breeding work it must be much higher than this.

As the highest degree of correlation between characters in the potato that is reported above, is so much lower than our limiting figure, it is hardly probable that we will ever find correlations that will be of practical value.

There has been found only one case,—the relation of dark purple stems with dark purple tubers,—where the coefficient of correlation is high. Out of 24 varieties with purple tubers, 19 varieties have purple stems, and 5 have not purple stems. On the other hand, out of all of our other varieties, which had not purple tubers, 221 varieties had purple stems, and 455 varieties had green stems. The coefficient of correlation is .77 ± .01, but it is doubtful whether even here there is cause to draw a conclusion as to its utility, on account of the small number of purple varieties under observation.

It would hardly be rash to conclude that no valuable correlations will be found in this species.

Literature Cited.

1. **De Vries, Hugo.** Species and Varieties: Their Origin by Mutation. pp. 1–847. Chi. Open Court. 1905.
2. **De Vries, Hugo.** Plant Breeding. pp. 1–366. Chi. Open Court. 1907.
3. **East, E. M.** Organic Correlations. American Breeders' Assn. Report **4**: In press.

4. **Fraser, Samuel.** The Potato. pp. 1–177. N. Y. Orange Judd. 1906.
5. **Fruwirth, C.** Die Züchtung der landwirtschaftlichen Kulturpflanzen. Band 3. pp. 1–201. Berlin. Paul Parey. 1906.
6. **Knight, Thos.** A selection from the Physiological and Horticultural Papers published in the Translations of the Royal and Horticultural Societies. pp. 1–379. London. 1841.
7. **MacDougal, D. T., Vail, A. M.,** and **Shull, G. H.** Mutations, Variations, and Relationships of the Œnotheras. Carnegie Inst. of Washington. Pub. **81**: pp. 1–92. 1907.
8. **Mueller, Hermann,** Trans. **Thompson, D'Arcy.** The Fertilization of Flowers. pp. 1–669. London. Macmillan. 1883.
9. **Yule, G. U.** On the Association of Attributes in Statistics. Philosophical Trans. Roy. Soc. **194**: 257–319. 1900.

APPENDIX.

EXTENSION WORK IN AGRONOMY.

There are certain problems in Connecticut agriculture that are very complicated in their analysis. Of these problems, none is more important than that which relates to the productiveness of the soil. The topography of the country and the glacial origin of the soils have given us many types of very different agricultural value. Permanent methods of soil treatment, for some of these types, from those which will keep other types at their highest productivity.

The Agricultural Station, therefore, cannot conduct experiments concerning soil fertility that will be of general value. The problems which are local in character can be undertaken with profit only by the individual land owner himself. He is familiar with the present differences on small areas, and with the past agricultural history of his different fields. He, alone, can give the work the especial attention necessary to bring to light the small points which, when collected, give a knowledge of soil needs, and become a valuable asset in practical work.

For these reasons, we outline some of the important questions that are of immediate practical interest to the farmer, and will coöperate with him, as far as lies in our power, in conducting simple experiments to solve his problems. These experiments are not intricate or costly; nor will they require a large amount of his time. He is expected to provide land, labor and fertilizers. The station will suggest plans, help supervise the work, and aid in drawing the proper conclusions. As the experiments are planned to give definite answers to local problems, it is expected that the farmer will take a personal interest in the work, and that he will carefully observe and record such data as are necessary to produce clear and exact results.

The experiments are here simply outlined. A complete plan of any of them will be sent to any farmer wishing to take up the work.

Experiments with Fertilizers.

EXPERIMENT 1. This is a test of the immediate need of the soil for the three essential elements of fertility: nitrogen, phosphorus and potassium. Some soils are found to be in especial need of only a single element, such as potassium; other soils respond to nitrogen more quickly than to phosphorus or potassium. When something has been determined concerning the *relative* needs of the soil for these elements of fertility, fertilizers with the proper composition for obtaining maximum crops upon the soil can be more intelligently selected. Money is not wasted in buying too largely of a fertilizer constituent not especially needed.

One-half to one acre of ground is laid off in ten long, narrow plots. If the land is rolling, these plots must run up and down the declivity. Fertilizers are applied to each plot according to the following scheme, and then a single kind of crop is planted on all of the plots.

This plan tests the actual increase in weight made by the crop when nitrogen, phosphoric acid and potash are each applied separately, when they are applied in the three possible combinations of two elements, and finally when all three are applied together. There are also three check plots, where no fertilizer is applied.

Plot 1.....Check. No Fertilizer
Plot 2............Sodium Nitrate
Plot 3............Superphosphate
Plot 4............Potassium Chlorid
Plot 5.....Check. No Fertilizer
Plot 6............Sodium Nitrate—Superphosphate
Plot 7............Sodium Nitrate—Potassium Chlorid
Plot 8............Superphosphate—Potassium Chlorid
Plot 9............Sodium Nitrate—Superphosphate—Pot. Chlorid
Plot 10.....Check. No Fertilizer

EXP. 2. This experiment is to test the relative needs of a soil for phosphoric acid and potash. That is, we generally may take it for granted that with continued cropping most of the light, loose soils of Connecticut need the application of nitrogen, either by plowing under a legume, or in the form of a commerical product. In this test, nitrate of soda is added to the whole piece of ground, and the relative response of the soil to phosphoric acid and potash is determined with the use of only five plots.

The plan is as follows:

Plot 1.....Check. No Fertilizer
Plot 2...........Superphosphate
Plot 3...........Potassium Chlorid
Plot 4...........Superphosphate+Potassium Chlorid
Plot 5.....Check. No Fertilizer

EXP. 3. This is an experiment to test the value of a legume plowed under, in furnishing nitrogen to the soil. Only two plots are necessary, but the experiment must be carried on for at least two years. Fertilize the whole piece with a complete fertilizer the first year. On Plot 1 plant rye, and on Plot 2 plant red clover. Seed in the fall. During the next summer, cut the clover once and also cut the rye. In the second spring plow under the rye stubble and the clover, and fertilize the whole piece with superphosphate and muriate of potash. If there was greater net profit in the rye than in the clover, then add to the rye plot an amount of nitrate of soda equal in value to this excess. Plant corn on both of the plots and determine yield of both grain and stover upon each plot.

EXP. 4. This experiment is to determine the value of fine ground phosphate rock, or "floats," in connection with manure. Three plots are to be used. Each plot is to be fertilized with equal quantities of stable manure and muriate of potash. On one plot, however, superphosphate is to be applied, while on the other plot will be applied an equal money value of "floats" that has been intimately mixed with the quantity of manure intended for that plot. No phosphate is added to the third plot, in order that there may be a check upon the action of phosphates on the soil.

Experiments with Legumes.

EXP. 5. This experiment is to test a possible need of lime and of inoculation for growing alfalfa successfully. Four plots are necessary. The whole piece is fertilized alike with superphosphate and muriate of potash. Alfalfa is planted in the fall, after a hoed crop or after a grain crop that has been sufficiently thick not to permit the growth of weeds. The treatment of each plot is as follows:

Plot 1...............Lime
Plot 2...............Check
Plot 3...............*Inoculation
Plot 4...............Inoculation, Lime

EXP. 6. The comparative cost and efficiency of clover, vetch, cowpeas and soy beans in putting nitrogen into the soil.

EXP. 7. The effect of lime and inoculation on the growth of either clover, vetch, cowpeas or soy beans.

EXP. 8. The comparative cost and value of a rotation with and without the use of legumes.

Experiments in Seed Selection.

EXP. 9. We shall be glad to coöperate with several more growers, in originating new varieties, or adapting old varieties of corn for special soil and climatic conditions. These varieties will be selected for high yielding powers, both in stalk and in grain. In some sections of the state varieties are wanted that will produce early maturing seed; in other sections silage corn is in great demand. Farmers who take up this work, should go into it with the idea of producing the highest possible grade of seed corn, to supply to New England growers. *There is not sufficient high grade seed corn adapted to Connecticut conditions to supply the present market.*

EXP. 10. Plans for isolating better strains of different important agricultural plants will be supplied to anyone who will make a specialty of growing a high grade product for the seed market.

EXP. 11. An experiment in curing and storing seed corn in order to produce seed of high vitality.

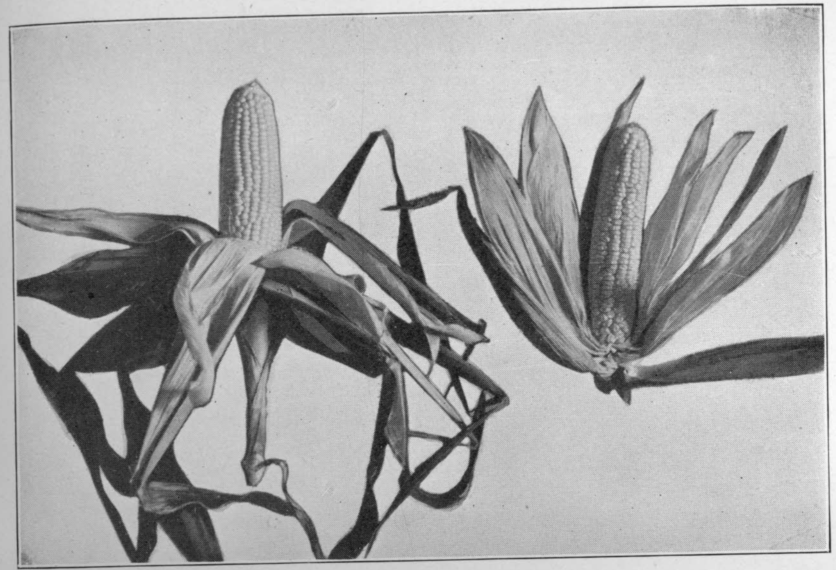
Experiments with Varieties.

EXP. 12. The station always has on hand small amounts of seed of new varieties of different agricultural crops. Some of these varieties are new only in Connecticut; but are worthy of trial in the hope of finding something valuable to the agricultural interests of this state. Other varieties are the latest product of the plant breeders of Europe. All farmers who are interested

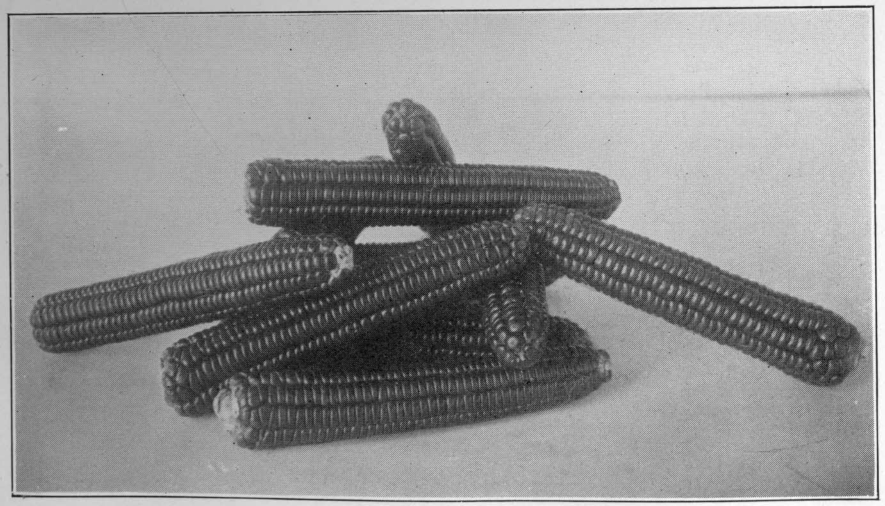
* With soil from an old alfalfa field or from sweet clover field.

in some particular crop, or who are desirous of establishing new crops in Connecticut, are requested to correspond with the station regarding their needs.

EXP. 13. There are often cases in which it would be highly profitable to know what variety of a certain farm crop is best adapted for growing under the conditions that obtain in a specific locality. It is generally believed that the answer to such a question is easily obtained. This is only true when experimental conditions are as carefully controlled as is possible in field work. Directions for such experiments will gladly be furnished upon application.

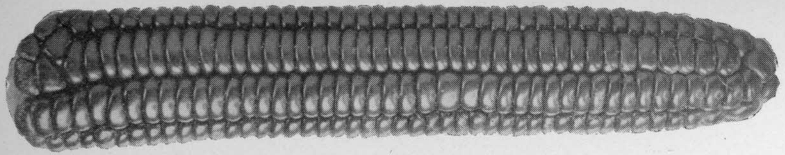


a. Stowell's Evergreen, thick husked and thin husked strains, p. 400.

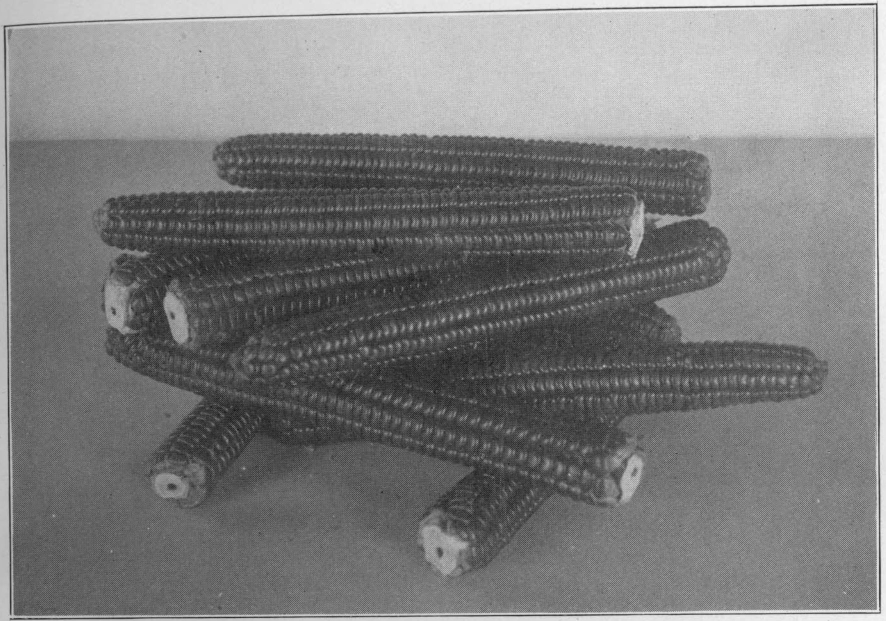


b. Walker's Newgate flint, p. 401.

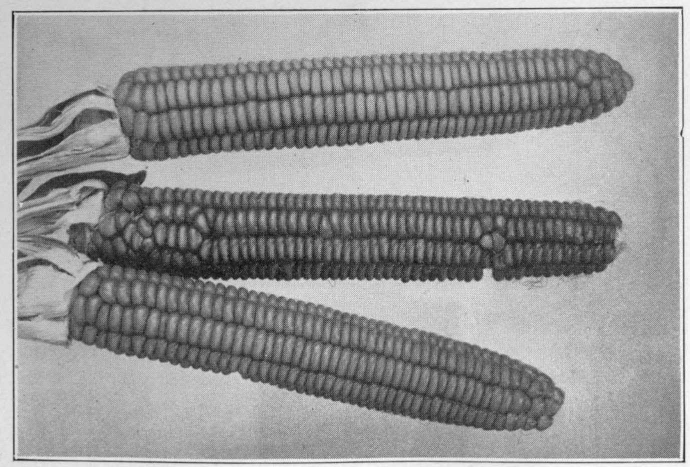
COOPERATIVE CORN BREEDING.



a. Typical ear of Walker's Newgate flint.

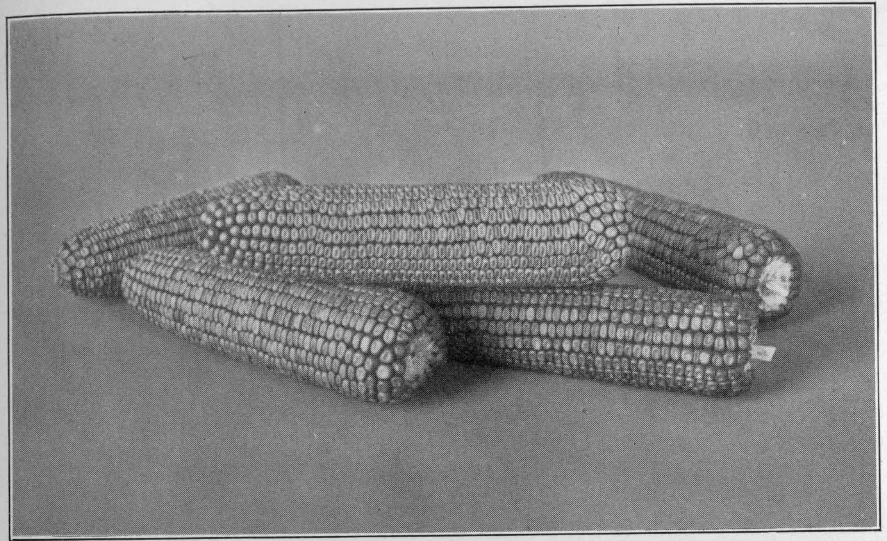


b. Hopson's Longfellow flint, p. 401.

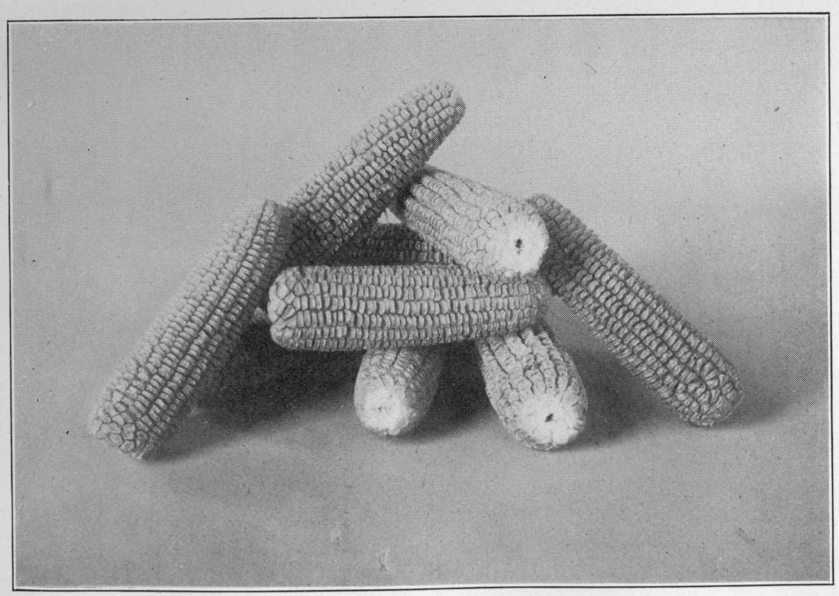


c. Newgate flint: product of one stalk. Upper ear shows dent character, lower ears show flint character.

COOPERATIVE CORN BREEDING.

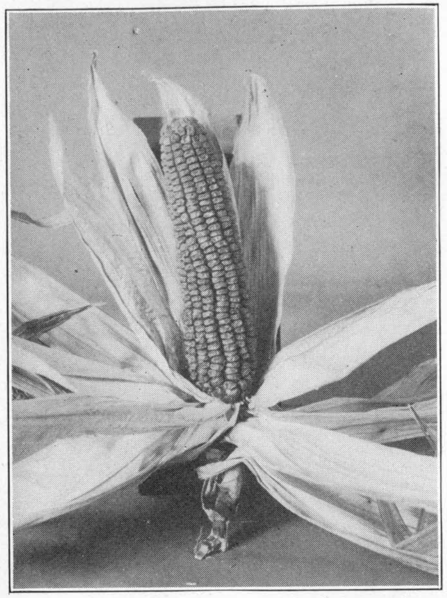


a. Stadtmueller's Leaming, p. 401.

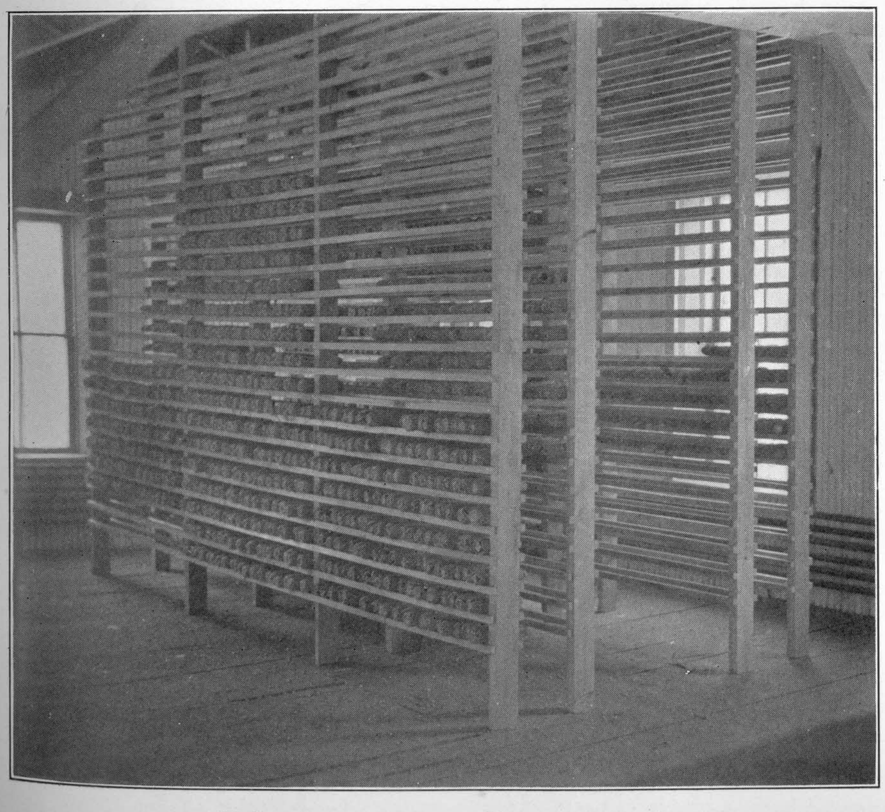


b. Experiment Station Stowell's Evergreen. Selected for yield for three years.

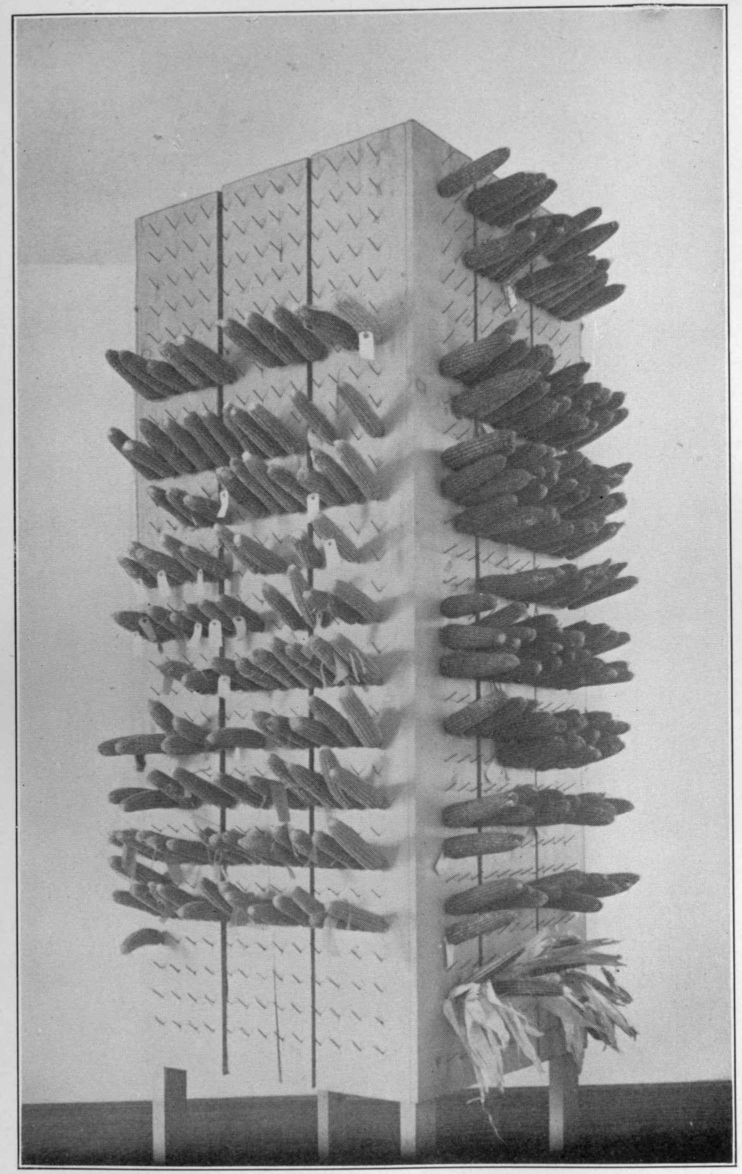
COOPERATIVE CORN BREEDING.



a. Stowell's Evergreen picked in eating condition and properly cured. Germination 95 per cent.

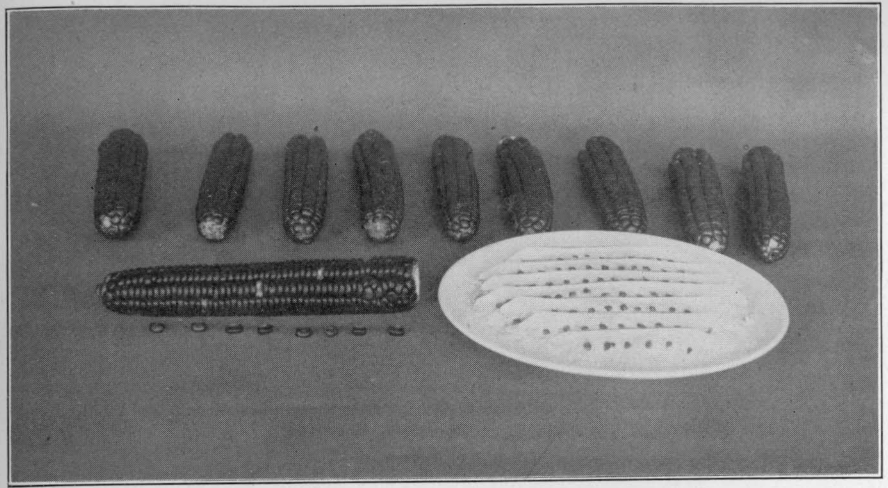


b. Drying rack, p. 402. (Photo. by Jeffrey.)

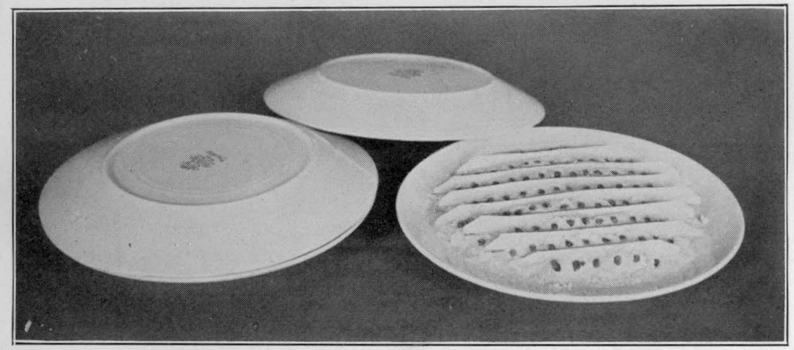


Drying rack, p. 403.

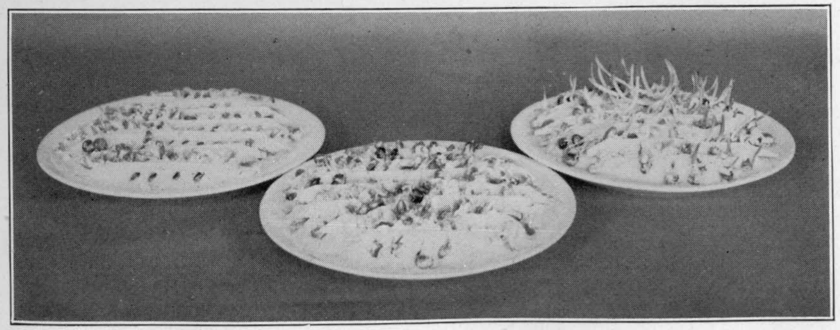
CARING FOR SEED CORN.



a. Sampling the ears, p. 404.



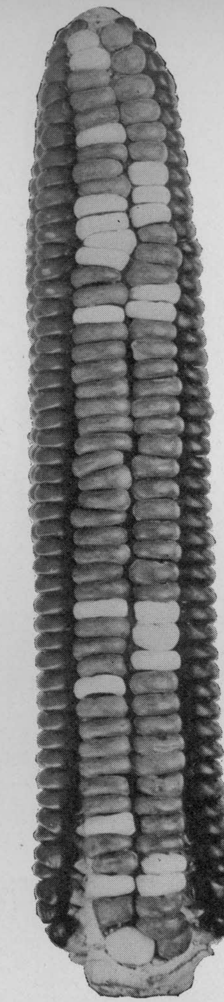
b. Ready to set away. Keep at 80° F., p. 404.



c. One, two and three days after, respectively, p. 405.

THE PRELIMINARY GERMINATION TEST.

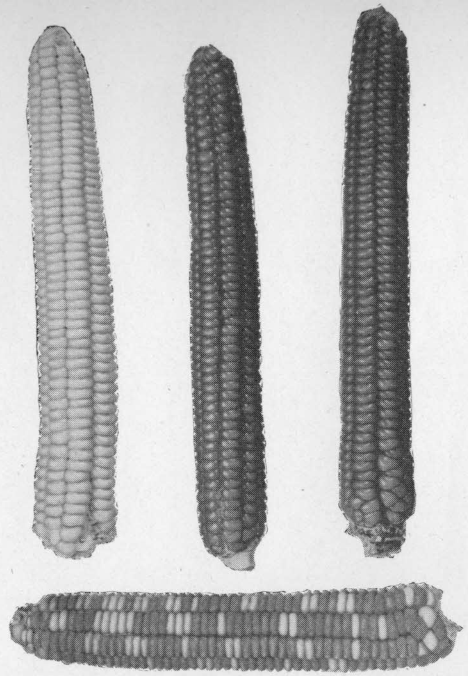
a. (Black Mex. × Crosby) × Crosby.
White kernels are pure.



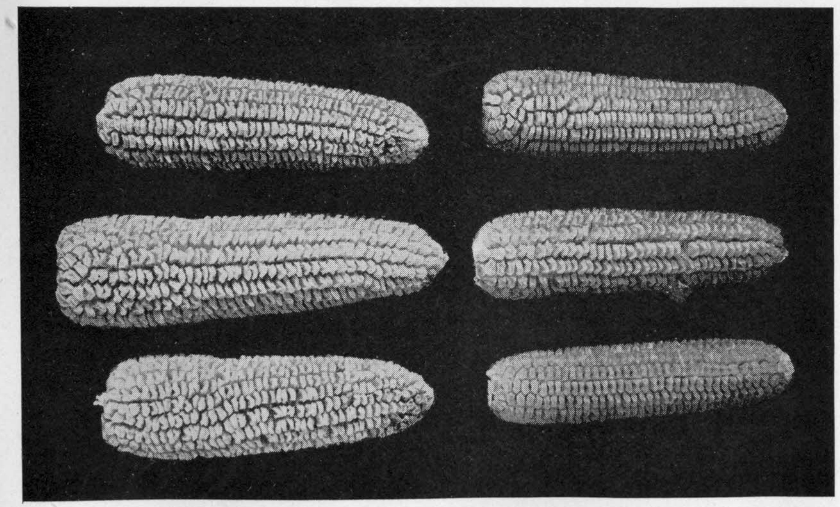
b. Red "Kissing" corn with pericarp removed to show hybrid condition beneath it.

c. Upper three. Pure red, in one the pericarp removed.
Lower three. Hybrid red and purple, in one the pericarp removed showing purple spots.

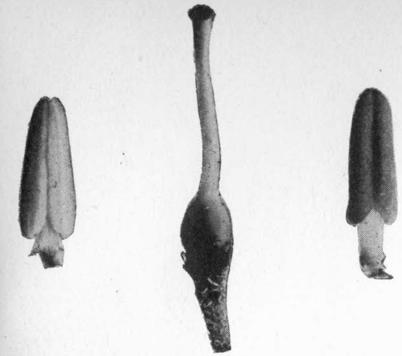
MENDELISM IN CORN BREEDING.



a. White flint × yellow flint. First year hybrid in center. Lower ear is second year hybrid inbred.

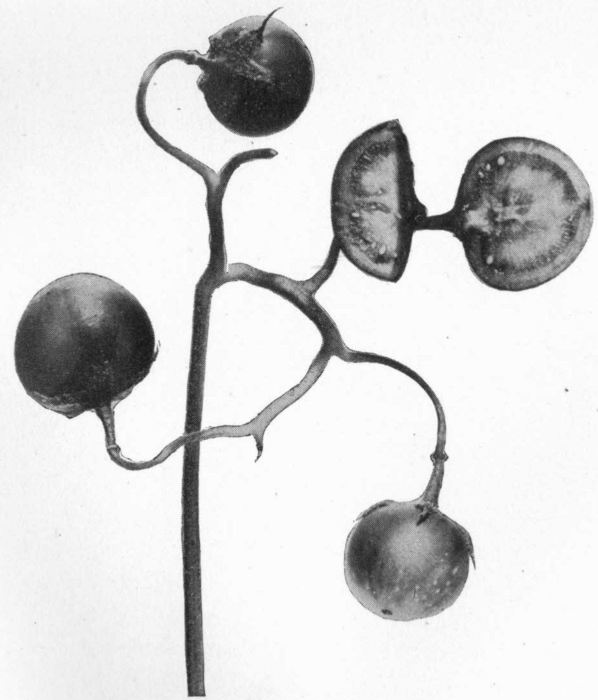


b. At the left strain with peaked kernels. At the right strain with smooth kernels. Crosses are more vigorous than either strain alone.



a. Pistil and front and back view of stamens. Enlarged three diameters.

b. Characteristic double cyme of flower stalk. One emasculated.



c. Potato fruit.

POTATO FLOWER ORGANS AND FRUIT.