

SUMMARY.

1. Dusting experiments in comparison with spraying were conducted in Connecticut in 1921 in four apple orchards containing 757 trees, and in two peach orchards containing 263 trees. This involved the scoring of 150,296 apples, equivalent to about 334 barrels, and 120,063 peaches, or about 1,715 baskets.
2. The dusts were all applied with Niagara dusting machines, and the sprays with Friend and Arlington X. L. power sprayers. In each case two treatments were given after blossoming on apples, and three treatments on peaches.
3. The dusts used in the apple orchards were the sulphur-lead dust, sulphur-lead-nicotine dust, and Sanders' dust. The liquid spray used for comparison in all apple orchards contained liquid lime-sulphur, lead arsenate and nicotine sulphate. In one orchard comparative tests were made between liquid lime-sulphur, dry lime-sulphur, B. T. S., and Bordeaux mixture, with lead arsenate added to each.
4. In nearly all cases the best apples were obtained from the sprayed plots. Both spray and dust gave fairly good control as regards codling moth, and other chewing insects; neither controlled curculio; the spray was more effective in controlling the fungous diseases. In the sprayed orchard dry lime-sulphur gave a larger percentage of good fruit than liquid lime-sulphur, B. T. S., or Bordeaux mixture.
5. The chief pests attacking the fruit in these apple orchards in 1921 were codling moth, plum curculio, apple maggot, various chewing insects, aphids, red bug, scab, black rot, fruit speck and sooty blotch.
6. On peaches the only spray was atomic sulphur, and the dusts were sulphur, and sulphur-lime-lead arsenate dust.
7. In all the peach orchards the dusted plots gave slightly better fruit than the sprayed plots. Peach scab and brown rot were controlled by both dust and spray.
8. The chief pests attacking the fruit in these peach orchards in 1921 were curculio, brown rot and peach scab.
9. At present dusting is more costly than spraying in both peach and apple orchards.

Connecticut Agricultural Experiment Station

NEW HAVEN, CONN.

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JANUARY, 1922

BEING THE

Twenty-Sixth Report

ON

Food Products

AND

Fourteenth Report on Drug Products.

By E. M. BAILEY.

The Bulletins of this Station are mailed free to citizens of Connecticut who apply for them, and to other applicants as far as the editions permit.

CONNECTICUT AGRICULTURAL EXPERIMENT STATION

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January, 1922

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The Twenty-sixth Report on Food Products and the Fourteenth Report on Drug Products, 1921.

By E. M. BAILEY.

This report summarizes examinations of foods, drugs and miscellaneous materials which have been made in this laboratory during the past year. Much of the time of the department is necessarily occupied with control work required by statutes relating to fertilizers and feeding stuffs and with other analytical work in connection with field experiments as well as with human foods and drugs. However, as much time as can be spared is devoted to the study of methods and the investigation of special subjects.

Practically all of the food and drug control work done in the past year has been upon samples submitted by the Dairy and Food Commissioner. Soft drinks, market milk, ice cream and drugs listed in the Pharmacopoeia or National Formulary have been the items of chief importance. A new law regulating the manufacture and sale of beverages of the soda water type prohibits the use of saccharin in these products and it has resulted in greatly diminishing the occurrence of this artificial sweetener which heretofore has been rather widely used in this state.

An investigation of the cryoscopy of milk has been made, involving analyses and freezing point determinations of authentic milk from individual cows and herds for the purpose of establishing the freezing point range of normal milk to serve as a basis for the detection of added water in market milk. This has been done in collaboration with Dr. Hortvet of the Minnesota State Dairy and Food Department, who is the author of the freezing point method we have used, and with Dr. Menge of the Milk Products Department of the Libby, McNeill and Libby Company. The data secured have been included in a report of the writer as associate referee on this subject to the Association of Official Agricultural Chemists and an abstract of the same is published here. The writer has also collaborated with the Council on Pharmacy and Chemistry of the American Medical Association upon questions pertaining to diabetic and other special foods and has prepared and submitted to the Council tentative standards for dietetic casein and calcium caseinate.

Mr. Andrew has served during the year as referee on tea for the Association of Official Agricultural Chemists and has submitted a report to the Association an abstract of which is given in this bulletin. He has also collaborated in the study of methods for the assay of certain drugs.

Three educational exhibits have been arranged. One of these was a part of the general exhibit of this Station at the Farmers' Week Fair at Hartford in January and the others were made jointly with the Biochemical laboratory at the meeting of the American Medical Association at Boston in June and at the meeting of the American Child Hygiene Association at New Haven in November.

During the last few years the volume of work required by the department of the Dairy and Food Commissioner has greatly increased. Charged as we are with analytical work required by other branches of control and investigation, our time and facilities often would be seriously overtaxed were it not for the generous efforts of the Commissioner and his staff to correlate the work of his department with that of ours, so far as it is possible to do so, and we appreciate this coöperation. Under this plan the work of both departments proceeds with an efficiency that otherwise would not be possible.

Acknowledgment is made to the chemists of this laboratory, Messrs. Andrew, Shepard, Edmond, Nolan, Fisher and Merwin, to whom credit for the analytical work herein reported is due, for their efficient coöperation; and to Miss Moss for her valuable assistance in the compilation of data and the preparation of reports and bulletins.

I. FOODS.

CARBONATED BEVERAGES, ETC.

One hundred and fifty-three samples of beverages of the soda water type have been examined for saccharin and of that number twenty-one, representing products of fourteen manufacturers, were found to be adulterated for the reason that they contained that substance. A recent act of the Legislature¹ expressly prohibits the use of saccharin in non-alcoholic beverages and a previous act² likewise prohibits its use in ice cream. These are the only instances of specific legislation against this artificial sweetener, which, however, has heretofore been regarded as an adulterant under the provisions of the general food and drug law and by rules and regulations³ pertaining thereto, made jointly by the Director of this station and the Dairy and Food Commissioner.

In the inspection made in 1920, 40.5 per cent. of the samples examined contained saccharin, as compared with 13.7 per cent. found in the inspection of 1921. There is reason to believe that an even smaller percentage would be found at the present time.

Saccharin was found in the following samples:

¹ Public Acts 1921, Chap. 159, Sec. 3.

² Public Acts 1919, Chap. 260.

³ Regulation 7.

D. C. No.	Brand.	City or Town	Manufacturer or Dealer.
20662	Cherry Soda.	Ansonia:	L. Yolin.
18172	Cherry Soda.	East Norwalk:	Morris Sopshin.
20033	Strawberry Soda.		Morris Sopshin.
20030	Birch Soda.		Morris Sopshin.
20045	Cherry Soda.	Greenwich:	Barney Tunick.
20772	Strawberry Soda.	Jewett City:	Jewett City Bottling Works
20674	Strawberry Soda.	New Britain:	Peerless Bottling Works.
18178	Lemon Soda.	New Canaan:	Gray Bros.
20027	Lenton Soda.		Gray Bros.
18179	Peach Soda.		Gray Bros.
20028	Peach Soda.		Gray Bros.
20679	Cherry Soda.	New Haven:	New Haven Bottling Works.
20682	Cherry Soda.		D. Chiaramonte.
19871	Strawberry Soda.	New London:	Benj. Manoff.
20666	Cream Soda.	Shelton:	Derby Bottling Works.
18529	Cream Soda.	Stamford:	Isaac Silver.
18530	Strawberry Soda.		Isaac Silver.
18531	Strawberry Soda.		Morris Alterwitz.
18532	Creame Soda.		Morris Alterwitz.
19878	Strawberry Soda.	Thompsonville:	Thompsonville Bottling Works.
20651	Cherry Soda.	Waterbury:	C. Mascola Bottling Works.

CASEIN AND CALCIUM CASEINATE.

A number of preparations of casein and calcium caseinate, designed for clinical purposes, have been examined for the Council on Pharmacy and Chemistry of the American Medical Association and tentative standards for these products suggested.

Dietetic casein is the purified protein separated from milk by the action of acids or of enzymes. It finds limited use in the feeding of infants, in the nutrition of convalescents and undernourished individuals and in the dietotherapy of diabetes. It should contain not less than 15 per cent. of nitrogen, on the moisture-free basis, with other specifications as will appear in New and Non-Official Remedies.¹ The proximate composition of casein prepared by various commercial and laboratory methods is shown by data published from the Forest Products laboratory² and by analyses of a number of pure preparations made in the Biochemical laboratory of this station and used by Doctors Osborne, Mendel and Wakeman in studies on nutrition. Analyses of these last named preparations are given in Table I.

Calcium caseinate is also used in medicine for such disorders as can be treated by dietetic measures.

Five preparations of calcium caseinate including three commercial products and one natural preparation made in the Biochemical laboratory of this station have been analyzed and the results are given in Table II.

¹ Published by the Am. Med. Assoc., 1922.

² Jour. Ind. Eng. Chem., 11, 11, 1029, 1919.

TABLE I. PROXIMATE ANALYSES OF CASEIN.

Sample No.....	1 %	2 %	3 %	5 %	6 %	7 %
Moisture.....	7.89	7.75	8.86	6.40	9.68	6.23
Ash.....	0.55	0.61	0.52	0.38	0.60	1.30
Fat.....	0.80	0.40	0.23	1.00	0.50	0.75
Nitrogen.....	14.08	14.08	13.84	14.36	13.82	14.34
Casein (N x 6.38).....	89.83	89.84	88.30	91.60	88.16	91.48
M. F. A.—free material ¹	90.76	91.24	90.39	92.22	89.22	91.72
Diff. between Casein and M. F. A.—free material...	0.93	1.40	2.09	0.62	1.06	0.24
Lactose.....	none	none	none	none	none	none
Undetermined.....	0.93	1.40	2.09	0.62	1.06	0.24
Acidity, cc. N/10 alk. per gm. original material.....	10.0	10.5	11.4	10.4	10.0	6.7
Acidity, cc. N/10 alk. per gm. M. F. A.-free material.....	11.0	11.5	12.6	11.2	11.2	7.3

¹ Moisture, fat and ash-free material.

TABLE II. ANALYSES OF CALCIUM CASEINATE.

	Mois- ture %	Nitro- gen %	Protein (Nx6.38) %	CaO. %	P ₂ O ₅ %	Fat %	Moisture-free Nitro- gen %	Pro- tein %
17029 No. 4 T. B. O.	9.75	13.68	87.28	1.65	1.95	0.43	15.16	96.71
17030 Larosan.....	10.38	13.06	83.31	2.37	1.69	2.36	14.58	93.02
17031 Larosan.....	9.87	13.12	83.71	2.16	1.65	2.57	14.56	92.89
17024 Protolac.....	8.90	12.72	81.15	2.66	1.80	0.75	13.96	89.07
17025 Casac.....	7.60	12.48	79.62	1.50	1.54	2.40	13.50	86.13

CIDER.

Four samples of cider were submitted by the Dairy and Food Commissioner. Three of these, **20358**, **20359** and **20920**, were so-called sweet cider. They contained 5.75 per cent., 5.93 per cent. and 4.16 per cent. of alcohol respectively showing in all cases an advanced stage of fermentation which marked them as hard ciders. One sample, **19414**, Veribest, made by Armour & Co., contained only a trace of alcohol and was free from saccharin, and salicylic, benzoic and sulphurous acids.

COCOA.

Three samples have been submitted by the Dairy and Food Commissioner and two by the New Haven County Farm Bureau. The samples were D. C. Nos. **19874**, Hershey's, **19875**, Van Houten's, **19876**, Lowney's and Sta. Nos. **15963** and **15964**, brands unknown, but sold by D. M. Welch and The Mohican Company, New Haven, respectively.

Partial analyses were made as follows:

D. C. or Sta. No.....	19874 %	19875 %	19876 %	15963 %	15964 %
Moisture.....	5.80	5.95	4.80	6.22	5.05
Ash, total.....	7.12	4.60	4.60	5.10	5.10
insol. in water.....	1.78	2.90	2.65	3.15	2.85
Nitrogen.....	3.50	3.50	3.49	3.74	3.74
Crude Fiber.....	.....	.....	.....	5.38	5.35
Fat.....	24.24	24.58	25.08	21.23	21.06

COFFEE.

One sample of coffee substitute and one of modified coffee have been examined. The brands were Delisco, **16373**, prepared by the Delisco Corporation Ltd., Boston, and Kaffee Hag, **15682**, made by the Kaffee Hag Corporation of Cleveland, Ohio.

Our analysis of the coffee substitute is as follows:

Moisture 5.08 per cent; ash 4.25 per cent; ash soluble in water 3.01 per cent; phosphoric acid (P₂O₅) in insoluble ash 0.49 per cent, in soluble ash 0.43 per cent; alkalinity of ash 3.15 cc N/10 acid per gram; nitrogen 2.25 per cent; soluble solids 27.95 per cent; fat (ether extract) 9.13 per cent; fiber 12.43 per cent; caffeine by weight 0.76 per cent, from nitrogen 0.72 per cent.

This product is declared by the manufacturers to be a combination of cereals and other vegetable substances with a percentage of the finest coffee. Assuming 1.25 per cent. caffeine as an average for pure coffee this product contains about 60 per cent. of coffee.

Kaffee Hag was examined for caffeine only and was found to contain 0.09 per cent. of caffeine by weight and 0.05 per cent. calculated from nitrogen. This product has been examined by us on two previous occasions when 0.03 per cent. and 0.10 per cent. of caffeine were found. Data submitted by the manufacturers show a range over a considerable control period of from 0.03 per cent. to 0.08 per cent; our range for the three market samples examined is from 0.03 per cent to 0.10 per cent.

DIABETIC, SPECIAL AND MISCELLANEOUS FOODS.

Sixty-four samples of diabetic, special and miscellaneous foods have been examined. Some of these were submitted by manufacturers or distributors at our request and some have been referred to us by physicians or others interested.

Three samples of gluten bread made by the American System of Bakeries, Hartford, Conn., were submitted by Dr. W. R. Miller and by Mr. W. J. Hardie.

Two samples, Cassava Breakfast Food and Cassava Cakes, both said to be starchless, were submitted by Arnaud, Inc., New York.

One sample of gluten bread made by Brusson Jeune, Villimur, France and distributed in this country by Gustave Müller, 18 South William St., New York, was sent by John Gilbert and Son, New Haven.

To determine the efficiency of the washing method of preparing washed bran two samples of bran, one unwashed and one washed, were submitted by J. G. Dilworth, Nurse-in-charge, Clifton Springs Sanitarium, Clifton Springs, New York.

For experimental purposes three samples of bread were made in this laboratory using cottonseed, almond and soybean flours respectively.

A sample of gluten bread, **17687**, made by the Howland Co., Bridgeport, was submitted by Mrs. F. A. Doolittle, Bridgeport.

Three samples of Croustils, **16491**, **16492** and **16493** made by Laporte and Gauthier, Somerset, Manitoba, distributed by Charles Horstmann, Clifton, N. J., were referred to us by the American Medical Association.

One sample of Allison flour, **17910**, made by the Schulenburg Oil Mill, Schulenburg, Texas, was also submitted by the American Medical Association.

Eleven samples of Ch. Heudebert products made by La Societé L'Aliment "Essentiel," Nanterre, France, distributed by Park and Tilford, New York, were sent by the distributors with the exception of **16277** which was submitted by the American Medical Association.

Dr. B. H. Ragle, Boston, submitted products of the Woman's Baking Co., Boston. A number of similar products were examined in this laboratory last year.

A sample of Passover Bread, **16255**, said to be made from Dugan gluten flour, was submitted by Mr. Samuel Lapidès, New Haven. Further information regarding the manufacturer of the gluten flour could not be furnished us.

The Diaprotein Company, Columbus, Ohio, submitted fourteen samples "Dieta Brand" specially prepared canned fruits and vegetables.

Seven samples of Ch. Heudebert products recommended for infants, invalids and convalescents were submitted by the distributors, Park and Tilford, New York.

A sample of India Peas, **16485**, was referred to us by Dr. E. P. Joslin, Boston, for analysis.

A sample of dahlia bulbs, **18640**, grown and submitted by Mr. F. C. Sheldon of this laboratory, was examined.

Analyses of these products are given in Table III.

The three samples of gluten bread made by the American System of Bakeries show reasonable uniformity in composition and a substantial reduction in carbohydrates as compared with ordinary wheat bread. It requires 124 parts of sample **15449**, for

example, to equal 100 parts of ordinary bread according to Janney's method of comparison and 173 parts are required according to von Noorden's method. The success of this, or any other diabetic bread, will depend entirely upon the patient's carbohydrate tolerance.

Cassava Breakfast Food and Cassava Cakes, made by Arnaud, Inc., are not labeled as diabetic foods but are labeled "starchless" which is certain to attract the interest of the diabetic patient. Each product contains about 70 per cent. of available carbohydrate a large portion (over 90 per cent.), of which is starch and shows the microscopic characteristics of cassava starch. The labeling of this product is utterly deceptive.

The composition of Brusson Jeune gluten bread is substantially the same as shown by previous analyses made in this laboratory¹ indicating a very uniform product.

Sample **16078** represents a commercial hygienic bran and sample **16336** the same bran after thoroughly washing with water to remove starch. Comparison shows that the readily available carbohydrates i. e., starch and soluble reducing materials, have been reduced from 12 per cent. to 2 per cent., approximately, by this method of treatment.

Breads made from cottonseed-wheat, almond-gluten and soybean flours for our own experimental purposes were made according to recipes suggested by others and do not represent in any way specific suggestions on our part for diabetic dietaries. The soybean bread was, however, particularly palatable and the analysis shows a low content of available carbohydrate. The glucose yield of soybean protein in metabolism has not been determined so far as we know, but assuming it to be equal to that of wheat protein it would require about 2 parts of this bread to yield the same amount of glucose in metabolism as 1 part of ordinary wheat bread according to Janney's method of comparison.

Of the three samples of Croustils made by Laporte and Gauthier it appears from the advertising literature that only the "glutenized" form is recommended or prescribed for diabetic patients. Our analyses show that glutenized croustils, **16493**, contain more protein and less starch than other forms yet this product contains about 50 per cent. of starch and soluble reducing sugars as dextrose combined.

Allison cottonseed flour conforms to the substance and quality shown by our earlier analyses.²

The three samples of Heudebert "Essentiel" gluten bread, submitted from different sources and at different times, show a satisfactory degree of uniformity in composition. Our analysis of

¹ Conn. Exp. Sta. Bull. 220, p. 318.

² Conn. Exp. Sta. Bull. 220, p. 311.

TABLE III. ANALYSES OF DIABETIC,

No.	Manufacturer and Product
FLOUR, BRAN, BAKED PRODUCTS, ETC. American System of Bakeries, Hartford	
15449	Gluten Bread.....
15933	Gluten Bread A.....
15934	Gluten Bread B.....
Arnaud Inc., New York	
17908	Starchless Breakfast Food.....
17909	Cassava Cakes.....
Brusson Jeune, Villimur, France	
17609	Gluten Bread.....
Experimental	
16078	Bran, unwashed.....
16336	Bran, washed.....
16112	Cottonseed-Wheat Bread.....
16114	Almond-Gluten Bread.....
16113	Soybean Bread.....
Howland Co., Bridgeport	
17687	Gluten Bread.....
Laporte and Gauthier, Somerset, Manitoba	
16491	Croustils, Dechloridized.....
16492	Croustils, Simple.....
16493	Croustils, Glutenized.....
Schulenburg Oil Mill, Schulenburg, Texas	
17910	Allison Flour (Cotton Seed).....
La Societe L'Aliment "Essentiel," Nanterre, France	
17612	Heudebert, Bread of Gluten.....
16250	Heudebert, Bread of Gluten.....
16277	Heudebert, Bread of Gluten.....
16252	Heudebert, Aleurone Bread.....
17610	Heudebert, Aleurone Bread.....
.....	Guaranty.....
16251	Heudebert, Special Diabetic Bread.....
17611	Heudebert, Special Diabetic Bread.....
.....	Guaranty.....
16253	Heudebert, Rolls with Gluten.....
16254	Heudebert, Rusks of Gluten.....
16266	Heudebert, Surazotized Gluten Flour.....
16267	Heudebert, Gluten Flour with Cacao.....

SPECIAL AND MISCELLANEOUS FOODS.

No.	Moisture	Ash	Nitrogen	Protein		Fiber	Nitrogen-free Extract			Ether Ex-tract
				N x 6.25	N x 5.70		Starch	Sugar as Dextrose	Other N-free Extract	
	%	%	%	%	%	%	%	%	%	%
15449	35.29	1.65	6.52	.....	26.16	0.30	22.78	1.01	6.84	5.97
15933	30.43	1.79	6.60	.....	27.75	0.41	25.25	2.33	6.12	5.92
15934	30.85	1.60	6.81	.....	28.54	0.43	25.56	1.93	5.65	5.44
17908	10.39	2.06	0.32	2.00	.....	4.16	64.13	6.72	10.33	0.21
17909	10.42	2.16	0.28	1.75	.....	4.83	66.77	2.76	11.08	0.23
17609	10.31	0.71	5.93	.....	33.80	0.15	35.63	9.32	0.38	3.77
16078	6.05	6.31	2.62	16.38	.....	6.05	9.02	3.19	46.86	6.14
16336	.....	.....	.....	.....	.....	.....	1.43	0.86	.....	.....
16112	42.22	2.23	3.10	11.63	.....	0.95	31.52	1.74	8.08	1.63
16114	25.58	6.70	5.81	27.98	.....	0.92	11.43	1.74	8.26	17.39
16113	37.70	5.88	5.38	21.75	.....	0.88	3.70	2.52	9.53	18.04
17687	31.74	2.25	5.80	.....	23.51	0.41	32.28	1.88	7.01	0.92
16491	7.55	1.25	2.66	16.63	.....	0.44	54.45	10.30	3.32	6.06
16492	7.62	1.67	2.74	17.13	.....	0.38	60.36	5.68	3.75	3.41
16493	7.88	1.50	4.84	30.25	.....	0.46	44.55	5.36	3.29	6.71
17910	6.65	6.20	8.07	50.44	.....	4.83	0.56	8.25	15.18	7.89
17612	10.11	2.71	10.78	.....	61.45	0.51	9.96	1.24	8.04	5.98
16250	6.83	2.62	10.82	.....	61.67	0.31	13.59	1.10	7.03	6.85
16277	6.33	2.66	10.94	.....	62.36	0.32	14.32	0.93	7.40	5.68
16252	7.00	2.81	12.07	.....	68.80	0.21	6.51	0.15	8.23	6.19
17610	9.82	3.19	10.39	.....	59.22	0.76	13.56	2.72	6.73	4.00
.....	.....	.....	.....	.....	61.73	.....	10.50		.....	1.62
16251	7.01	2.91	10.48	.....	59.74	0.57	16.12	1.52	5.38	6.75
17611	11.19	3.04	9.01	.....	51.36	0.41	18.76	2.36	7.79	5.09
.....	.....	.....	.....	.....	62.00	.....	30.00		.....	0.50
16253	7.51	2.32	1.70	.....	9.69	0.43	59.12	6.98	5.20	8.75
16254	6.56	1.62	1.90	.....	10.84	0.44	58.05	9.30	5.56	7.63
16266	7.79	3.36	10.75	.....	61.28	0.30	12.71	1.32	10.94	2.30
16267	7.46	3.63	9.40	.....	53.58	1.00	12.30	1.46	14.73	5.84

TABLE III. ANALYSES OF DIABETIC,

No.	Manufacturer and Product
FLOUR, BRAN, BAKED PRODUCTS, ETC.—(Continued).	
Woman's Baking Co., Boston, Mass.	
17555	Washed Bran.....
17552	Bran Cookies, Anice.....
17550	Bran Cookies, Caraway.....
15320 ¹	Bran Cookies, Caraway.....
17551	Bran Cookies, Cocoa Nib.....
15315 ¹	Bran Cookies, Cocoa Nib.....
17553	Bran Cookies, Spice.....
15316 ¹	Bran Cookies, Spice.....
17556	Bran Muffins.....
15257 ¹	Bran Muffins.....
17554	Cellu Biscuit.....
15319 ¹	Cellu Biscuit.....
15258 ¹	Cellu Cookies, Caraway.....
17548	Cellu Cookies, Lemon.....
15259 ¹	Cellu Cookies, Lemon.....
17544	Cellu Cookies, Vanilla.....
15317 ¹	Cellu Cookies, Vanilla.....
15260 ¹	Cellu Kisses.....
17557	Cellu Muffins.....
15256 ¹	Cellu Muffins.....
15314 ¹	Cellu Nuts.....
17549	Cellu Soup Wafers.....
15318 ¹	Cellu Soup Wafers.....
Unknown	
16676	Passover Bread.....
FRUITS AND VEGETABLES, CANNED.	
The Diaprotein Co., Columbus, Ohio	
16385	Apple Sauce.....
16394	Blackberries.....
16388	Cherries, Red, Pitted.....
16387	Cherries, White ²
16395	Peaches, Yellow.....
16397	Pears, Bartlett.....
16392	Raspberries, Red.....
16389	Strawberries.....
16393	Beans, Cut, Wax.....
16391	Beans, Refugee, Green.....

Analysis of 1920.
Analysis of edible portion.

SPECIAL AND MISCELLANEOUS FOODS—(Continued).

No.	Moisture	Ash	Nitrogen	Protein		Fiber	Nitrogen-free Extract			Ether Extract
				N x 6.25	N x 5.70		Starch	Sugar as Dextrose	Other N-free Extract	
	%	%	%	%	%	%	%	%	%	%
17555	9.13	.....	1.79	11.19	.....	.....	4.59	.....	.....	7.39
17552	16.12	.....	1.18	7.39	.....	.....	1.72	3.47	.....	25.87
17550	15.29	.....	1.30	8.13	.....	.....	3.48	.....	.....	23.36
15320 ¹	12.24	6.90	1.30	8.13	.....	2.62	3.15	3.34	38.61	25.01
17551	13.41	.....	1.30	8.13	.....	.....	2.41	3.73	.....	27.80
15315 ¹	14.87	6.30	1.33	8.33	.....	6.05	6.19	5.05	29.17	24.04
17553	15.04	.....	0.98	6.11	.....	.....	2.21	4.11	.....	26.75
15316 ¹	16.31	6.43	1.12	6.99	.....	6.90	4.44	7.77	32.48	18.68
17556	28.41	.....	1.33	8.33	.....	.....	4.76	.....	.....	6.11
15257 ¹	41.51	6.50	1.00	6.26	.....	6.72	1.54	4.83	27.03	5.61
17554	29.31	.....	0.48	3.00	.....	.....	4.76	.....	.....	11.81
15319 ¹	32.81	6.33	0.53	3.34	.....	14.26	1.60	1.41	25.65	14.60
15258 ¹	14.16	5.48	0.89	5.58	.....	16.53	1.51	2.33	31.95	22.46
17548	12.28	.....	0.65	4.10	.....	.....	3.12	.....	.....	27.35
15259 ¹	12.94	5.22	0.69	4.32	.....	17.43	trace	4.62	34.10	21.37
17544	14.13	.....	0.66	4.11	.....	.....	4.39	.....	.....	23.35
15317 ¹	17.16	5.69	0.71	4.45	.....	16.98	1.58	2.22	32.61	19.31
15260 ¹	17.85	4.09	3.68	23.00	.....	27.12	1.29	1.20	25.22	0.23
17557	23.62	.....	0.61	3.84	.....	.....	3.38	.....	.....	14.33
15256 ¹	29.08	5.37	0.59	3.66	.....	18.23	1.61	2.10	27.02	12.93
15314 ¹	15.91	5.71	0.86	5.38	.....	16.80	1.07	2.57	23.82	28.74
17549	15.96	.....	0.53	3.32	.....	.....	4.25	.....	.....	27.66
15318 ¹	14.22	6.66	0.64	4.01	.....	14.97	1.69	2.43	31.39	24.63
16676	7.04	0.60	2.38	14.88	.....	0.38	70.46	.....	6.64	0.37
16385	88.69	0.58	0.03	0.18	.....	0.47	5.75	.....	3.72	0.61
16394	91.80	0.29	0.11	0.67	.....	1.76	2.57	.....	2.41	0.50
16388	90.39	0.34	0.08	0.50	.....	0.13	5.14	.....	3.36	0.14
16387	91.26	0.45	0.11	0.71	.....	0.18	3.79	.....	3.47	0.14
16395	93.38	0.31	0.08	0.47	.....	0.38	2.88	.....	2.52	0.06
16397	93.57	0.17	0.05	0.28	.....	0.62	2.54	.....	2.72	0.10
16392	88.34	0.47	0.14	0.88	.....	2.67	3.00	.....	3.96	0.68
16389	93.58	0.32	0.09	0.57	.....	0.82	1.95	.....	2.40	0.36
16393	96.20	0.27	0.13	0.83	.....	0.99	1.15	.....	0.51	0.05
16391	94.43	1.36 ³	0.11	1.04	.....	0.88	1.43	.....	0.80	0.06

³ 1.04 per cent salt (NaCl calc. from chlorine).

TABLE III. ANALYSES OF DIABETIC,

No.	Manufacturer and Product
FRUITS AND VEGETABLES, CANNED—<i>Concluded</i>	
16390	Peas, Green.....
16386	Rhubarb.....
16396	Spinach.....
16384	Tomatoes.....
SPECIAL PREPARATIONS.	
La Societe L'Aliment "Essentiel," Nanterre, France	
16255	Lacteous Flour.....
16265	"Essential" Flour.....
16268	"Roburol" with Cacao.....
16269	"Essential" Food, Cacao Flavor.....
16279	Cacao and Oat Cakes.....
16270	"Regimette" Dessert Cake.....
16278	Vegetable Broth.....
MISCELLANEOUS.	
16485	India Peas, dried.....
18640	Dahlia Tubers, dried.....
17545	Whiskey.....
17546	Vermouth.....

sample 17612 however does not agree with the one which is given on the package which states protein 72 per cent., fat 0.8 per cent. and carbohydrate plus starch 20 per cent. We find considerably less protein and more fat. Two samples of Aleurone bread, 16252 and 17610, are not in so close agreement between themselves and the guaranty of the last named, protein 61.7, fat 1.6 and carbohydrate 10.5, is not in accord with our findings as regards carbohydrate and fat. It is not entirely clear to us what is referred to as carbohydrate in the guaranty but we interpret it to be comparable with total nitrogen-free extract. Special Diabetic breads, samples 16251 and 17611 are stated to contain protein 62 per cent., fat 0.5 per cent. and carbohydrate plus starch 30 per cent. Our analyses confirm the protein guaranty in one case, the carbohydrate guaranty in the other and the fat guaranty in neither case. As regards fat, however, it should be said that when determined by the usual continuous extraction methods figures reasonably approximating the guaranties in each case were obtained, but by

SPECIAL AND MISCELLANEOUS FOODS—(*Concluded*).

No.	Moisture	Ash	Nitrogen	Protein		Fiber	Nitrogen-free Extract			Ether Extract
				N x 6.25	N x 5.70		Starch	Sugar as Dextrose	Other N-free Extract	
	%	%	%	%	%	%	%	%	%	%
16390	88.74	0.37	0.51	3.19	.....	1.27	3.92		2.15	0.36
16386	96.35	0.51	0.07	0.41	.....	0.54	0.27		1.88	0.04
16396	91.46	2.39 ⁴	0.49	3.08	.....	0.93	0.56		0.98	0.60
16384	95.07	0.53	0.17	1.04	.....	0.32	1.48		1.34	0.22
16255	4.80	2.02	1.38	8.63	.....	0.32	31.22	40.96	8.48	3.57
16265	7.89	1.58	3.14	19.63	.....	0.27	49.13	9.30	9.24	2.96
16268	4.70	3.16	3.26	20.38	.....	0.75	19.76	26.80	20.34	4.11
16269	4.62	1.48	1.47	9.19	.....	0.78	27.83	35.47	16.21	4.42
16279	6.90	2.81	2.25	14.06	.....	1.98	37.03	7.23	17.72	12.27
16270	3.68	1.27	1.10	6.88	.....	0.37	47.00	20.90	8.35	11.55
16278	8.40	3.17	2.10	13.13	.....	3.41	37.52	14.68	18.51	1.18
16485	9.00	3.18	4.00	25.00	.....	4.15	37.91	6.76	12.93	1.07
18640	2.13	7.97	3.12	19.50	.....	8.55	60.50 ⁵			1.35
17545	.....	.....	.....	.....	.....	.....	.....	trace	.....	.....
17546	.....	.....	.....	.....	.....	.....	.....	4.02 ⁶	.....	.....

⁴ 1.00 per cent salt (NaCl calc. from chlorine).

⁵ For distribution of this group of constituents see page 245.

⁶ Grams per 100cc.

the more approved method¹ for baked products much higher results were secured. It would appear from the guaranties of Aleurone, "Essentiel" gluten and Special Diabetic breads that they are designed to represent three classes of carbohydrate tolerance viz. 10, 20 and 30 per cent. in the order named. Our results in the main justify such classification except that Aleurone bread contained 15 to 20 per cent carbohydrate instead of 10 per cent. Samples 16253, Rolls with gluten and 16254, Rusks of gluten, both contain over 65 per cent. of available carbohydrate and are no more suitable for the diabetic than ordinary wheat bread. Surazotized Gluten flour, 16266 and Gluten flour with cacao, 16267, contain from 20 to 25 per cent. total carbohydrate with about one half of that amount probably available.

The products of the Woman's Baking Company are prepared from washed bran or cellu-flour as the basic constituent. These

¹ Conn. Exp. Sta. Bull. 220, p. 273.

products were examined in this laboratory last year¹ and the further examination of them this year has been chiefly to determine the nature of the fat or oil present. The Cellu Products Company has suggested a number of recipes for making non-nutritive "foods" in which the fatty constituent is mineral oil and the Woman's Baking Company, adopting this idea or conceiving a similar one, has used a non-nutritive oil in its products. The nature of the ether extract was not determined in our previous analyses but the low or negligible saponification values of the ether extracts obtained in our recent examinations indicate that only a small amount of saponifiable oil is present, derived probably from the bran, spices, etc. The saponification numbers of the cellu products examined ranged from 3.2 to 10.5 and the bran products from 8.0 to 12.8. The ether extracts from bran muffins gave a value of 90.1 while that of washed bran itself had a value of 152.7. Mineral oil is not saponifiable, or, in other words, it has a saponification value of zero.

In our previous discussion² of these products attention was called to the difficulties of estimating their caloric values due chiefly to the uncertainty regarding the availability of the carbohydrates present. The conventional method of calculating caloric yield was finally followed with the reservation noted. It is now evident that the ether extract should be practically disregarded as a source of available energy in most of these products. Probably as close an approximation of energy yield as can be made will be obtained by including in the formula for calculating calories the nitrogen expressed as protein, carbohydrates represented by starch and soluble reducing sugars and not over 10 per cent. of the fat, except in case of bran muffins where 60 per cent. might be included. Calculated in this way the energy values range approximately from 50 to 100 calories per 100 grams. Including all the nitrogen-free extract in the calculation in the conventional way these values are increased by 100 to 150 calories.

Passover bread, **16676**, was said to be made from Duggan gluten flour but no further information regarding the flour could be obtained. The bread, which was in the form of a hard bread or cracker, contained as much starch as ordinary wheat bread.

Products of the Diaprotein Company, canned fruit and vegetables, were submitted by them at our request. These goods are specially selected by the packers and prepared without added sugar or salt, for clinical purposes. Partial analyses of the various products were submitted by the company which our analytical results substantially confirm. The claims as regards added sugar appear to be substantiated and mineral matter is less than 1 per cent. except in Refugee beans and spinach where the

normal ash appears to be enhanced by 1.04 per cent. and 1.00 per cent, respectively, of salt calculated from the chlorine content of the ash. Variations in composition of fruits and vegetables due to seasonal conditions, degree of ripeness, etc., are, of course, recognized.

The special Heudebert products are indicated for the feeding of infants, invalids or convalescents and recommended, in some instances, as of particular value in specific disorders. None of them are suggested for the use of diabetics and they do not belong in the category of diabetic foods. The claims made, however, are very extravagant. Thus, for example, Ruborol "is especially recommended for troubles of the stomach and the intestines, anaemia, convalescence of infectious sickness, tuberculosis, neurasthenia, and intellectual overwork." "Essential" Food, "is much more digestive than chocolate and kindred products; . . . It is also good for Bright's disease owing to the theobromine it contains and for persons in good health." The physician and the critical dietitian will require convincing evidence on these points before accepting these conclusions.

The sample of India peas closely resembles our common garden peas in composition. They contain about 58 per cent. of nitrogen-free extract about 3/5 of which is in the form of starch and soluble carbohydrate.

An analysis of dahlia tuber **18640** was made after the tuber had been washed free from adhering dirt, sliced thin, and air dried. The proximate analysis is given in Table III. A further distribution of the nitrogen-free extract was made as follows:

Soluble in hot water, before hydrolysis, as levulose .	1.68 per cent.
after hydrolysis, as inulin ¹	49.18
Direct acid hydrolysis of water-insoluble residue, as	
dextrose	4.92
Total nitrogen-free extract (Table III.)	60.50
Undetermined nitrogen-free extract	4.72

¹ Calculated from levulose assuming the factor 0.9.

Thus inulin constitutes about 80 per cent. of the total nitrogen-free extract. The reducing power of the water solution before hydrolysis may be due to performed reducing substances or to levulose derived from partial hydrolysis of inulin by hot water.

Inulin occurs as a reserve carbohydrate in the underground parts of plants, particularly dahlia, artichoke, elecampane, burdock and similar plants. Unlike starch, it is somewhat soluble in water, readily soluble in hot water, gives no blue color with iodine, is not attacked by animal or vegetable amylases and hydrolyzes with dilute acid to levulose instead of dextrose. Plants which store up reserve material in the form of inulin have the mechanism (inulase), for its conversion to utilizable form, as do also certain

¹ Conn. Exp. Sta. Bull. 227, p. 231.

² Conn. Exp. Sta., Bull. 227, p. 232.

fungi, but there are no enzymes in the several digestive juices of the body capable of converting inulin into sugar. Human fecal extracts have been shown to contain an enzyme which attacks inulin with the formation of reducing sugars.¹ The acidity of the gastric juice is sufficient to hydrolyze inulin but the extent to which this proceeds will depend upon the conditions in the stomach. In the length of time which food ordinarily remains in the stomach, i.e., 2 to 3 hours, extensive hydrolysis does not take place.

Early observations that inulin fed to diabetics resulted in no conspicuous elimination of inulin, as such, in the feces and no glucose output in the urine led to the conclusion that it was utilized in the organism. The studies of Neubauer,² Lewis,³ Frankel⁴ and others indicate, however, that the failure of sugar to appear in the urine is due to the fact that no sugar is formed to be excreted; and the failure to recover inulin, as such, in conspicuous amounts in the feces is due to the decomposition of inulin by intestinal bacteria. The mechanism of inulin transformation in the intestine is obscure, but it does not result in recoverable sugar. The presence of inulase in the intestinal contents and excessive gas production which is observed after inulin feeding suggest that sugar may be an intermediate product in the transformation and that the sugar thus formed is immediately destroyed by fermentation. Whether or not inulin is excreted in the feces will therefore depend upon the length of time it remains in the intestine and the opportunity bacteria have had to act upon it; under some conditions a considerable amount may be eliminated unchanged.

The apparent utilization and tolerance of inulin in the body has led to its use to some extent in the diet of diabetics. Thus Teyxera⁵ suggested adding inulin to gluten of wheat. White⁶ recommended that dahlia tubers be cooked and eaten as a vegetable by diabetics. Persia⁷ reported favorable results from the use of inulin in diabetic treatment and remarks that the inulin was "well digested and assimilated." Strauss⁸ likewise reports favorably on its use.

The assumption that levulose is better tolerated than other sugars has, perhaps, been based upon these earlier experiences with inulin when it was supposed that levulose resulted from it in metabolism. The facts appear to be, however, that inulin has little, if any, nutritive value and that from it no significant amounts of levulose are derived. Whatever levulose may arise from the action of the

¹ Okey, J. Biol. 39, 149, (1919)

² München. med. Wchnschr., p. 1525, 1905.

³ Jour. Am. Med. Assoc., 58, 1176, 1912.

⁴ Jour. Biol. Chem., 17, 365, 1914.

⁵ Boll. Chim. Farm., 43, 605-6; Jahresb. Tierchem., 35, 822, 1905.

⁶ Allbutt and Rolleston; System of Medicine, III, 204.

⁷ Jahresb. Tierchem., 25, 822, 1905.

⁸ Therapie der Gegenwart, 52, 337, 1911.

acid gastric juice upon inulin will behave in diabetic metabolism just as does levulose from any other source.

FATS AND OILS.

OLIVE OIL.

An unofficial sample of pure Spanish olive oil, **17918**, was submitted by the Dairy and Food Commissioner. The sample had been referred to his department by the H. J. Heinz Co. who remarked that the oil responded to the tests for sesame oil as generally applied. Our examination showed that the oil responded positively to the Baudouin and Villavecchia tests, the red color darkening in a short time, finally becoming almost black. These tests when applied to the liquid fatty acids, however, gave only very faint pink colors which should be regarded as negative. This experience indicates the necessity of checking positive tests for sesame obtained in the regular way by tests made upon the liquid fatty acids.

COOKING FATS.

Seven samples of shortening materials were examined for the Dairy and Food Commissioner. They were **18112**, Flake White; **18113**, Peerless Puff Paste; **18121**, Selex; **18122** Cottolene; **18123** Snowdrift; **18124**, Puff Paste.

The samples were examined chiefly with reference to the presence of beef stearin by Belfield's test, samples of hardened cottonseed oil and known mixtures of cottonseed oil and beef stearin being examined as controls. Evidence of beef stearin seemed positive in cases of **18113** and **18124** but negative or inconclusive in the other samples. Positive tests were obtained for cottonseed oil in all cases except in **18121**, but it is recognized that heated or hydrogenated cottonseed oil does not respond to the Halphen test.

BUTTER.

Ten samples sold for butter were submitted by the Dairy and Food Commissioner and five were examined for purchasers. One sample, D. C. No. **19184**, sold by Morris Gold, New Haven, was found to be renovated butter.

Of five samples submitted by purchasers one, **16468**, was so-called "wavy" or "mottled" butter, the effect being due probably to unequal distribution of water and brine or to incomplete removal of buttermilk or both.¹

¹ Jour. Dairy Science, 3, 2, p. 27.

TABLE IV. INSPECTION OF ICE CREAM.

Town	No. of Samples	Fat Content		
		Range		Average
		%	%	%
Ansonia.....	6	9.2	11.2	9.7
Beacon Falls.....	1	....	....	9.6
Branford.....	2	9.4	13.0	11.2
Bridgeport.....	20	6.4	15.0	10.4
Bristol.....	7	7.2	15.2	12.8
Brookfield.....	2	7.6	8.2	7.9
Centerbrook.....	1	....	....	7.6
Compounce.....	1	....	....	11.8
Danbury.....	12	8.4	15.6	10.2
Danielson.....	5	5.6	11.0	8.1
Dayville.....	1	....	....	10.6
Deep River.....	1	....	....	13.3
Derby.....	1	....	....	4.8
Devon.....	1	....	....	7.1
East Haven.....	1	....	....	9.2
Forestville.....	7	8.0	14.0	10.8
Greenwich.....	9	5.6	17.2	10.1
Guilford.....	1	....	....	13.2
Hartford.....	12	7.6	17.6	11.6
Hazardville.....	1	....	....	10.1
Jewett City.....	4	4.5	14.0	9.6
Meriden.....	6	12.2	15.6	14.3
Mianus.....	2	8.2	9.6	8.9
Middletown.....	8	11.4	23.2	15.5
Milldale.....	1	....	....	8.0
Moosup.....	2	10.0	11.2	10.6
Naugatuck.....	8	8.0	13.2	10.8
New Britain.....	9	8.2	15.0	12.3
New Haven.....	31	6.0	17.0	10.7
New London.....	18	8.8	19.8	13.8
New Milford.....	10	7.1	20.0	12.2
North Haven.....	1	....	....	10.0
Norwalk.....	6	9.0	14.4	11.5
Norwich.....	10	8.4	18.6	11.8
Old Lyme.....	1	....	....	9.4
Plainfield.....	4	9.2	18.2	13.5
Plantsville.....	3	8.8	9.8	9.3
Pomfret.....	1	....	....	23.0
Portland.....	1	....	....	15.2
Putnam.....	6	8.4	19.2	12.4
Ridgefield.....	2	7.2	9.4	8.3
Rockville.....	4	3.6	15.4	8.7
Saybrook.....	3	8.0	15.8	11.1
Somerville.....	1	....	....	11.2
South Manchester.....	7	7.6	16.0	10.2
South Norwalk.....	3	13.2	16.0	14.4
Southington.....	4	8.0	13.0	10.8
Stafford Springs.....	4	9.0	15.6	12.4
Stamford.....	10	9.0	13.0	11.0
Stratford.....	4	7.8	9.6	8.7
Suffield.....	2	8.0	10.6	9.3
Terryville.....	1	....	....	9.2

TABLE IV. INSPECTION OF ICE CREAM—(Concluded.)

Town	No. of Samples	Fat Content		
		Range		Average
		%	%	%
Thomaston.....	3	14.0	14.8	14.5
Thompsonville.....	3	8.6	12.2	10.1
Torrington.....	8	8.0	15.6	11.7
Unionville.....	4	7.6	10.4	8.3
Wallingford.....	6	8.8	15.4	11.6
Wauregan.....	2	6.4	7.6	7.0
Waterbury.....	14	8.0	20.0	11.4
Westbrook.....	1	....	....	9.4
West Haven.....	1	....	....	6.8
Willimantic.....	4	13.6	17.0	15.8
Windsor Locks.....	5	2.3	10.8	6.5
Winsted.....	7	5.8	10.2	8.3
Not Given.....	1	....	....	13.2
Not Given.....	1	....	....	13.6

OLEOMARGARINE.

Five samples were examined, one being submitted by the Dairy and Food Commissioner and four by the Connecticut School for Boys. Analyses of the four last named are as follows:

No.....	16125	16126	16127	16128
	%	%	%	%
Moisture.....	9.66	7.86	9.33	10.94
Fat.....	85.01	89.30	84.25	83.54
Salt, curd, etc.....	5.33	2.84	6.42	5.52
Refraction of fat, butyro-refract. at 25° C....	59.2	58.2	56.48	56.25
Reichert-Meissel No.....	2.02	4.21	4.90	7.37

On the basis of the Reichert Meissel number sample 16128 contains the greatest amount of butter or milk fat. From the standpoint of caloric value there is no great difference among the several products but milk fat enhances the food value by reason of the peculiar diet factors which it contains.

ICE CREAM.

During the past summer an extensive inspection of ice cream has been conducted by the Dairy and Food Commissioner. The samples submitted to us do not adequately represent the scope of the work since some of the samples collected were tested by inspectors of his department who are licensed milk testers and who have followed methods approved by this laboratory. All doubtful cases have been resampled and referred to us for final judgment.

Three hundred and twenty-nine samples have been tested here. The distribution of these by towns, the range in fat content and the average are given in Table IV.

TABLE V. ICE CREAM BELOW STANDARD.

No.	Dealer	Manufacturer	Flavor	Fat.
	BRIDGEPORT			%
20268	Frank Cuneo.....	Own make.....	Vanilla.....	7.3
20266	G. Monaco.....	Own make.....	Vanilla.....	7.7
	BROOKFIELD			
18189	Mrs. E. Calkins.....	Int'l Ice Cream Co.	Vanilla.....	7.6
	DANIELSON			
20293	Mary E. Salotti.....	Own make.....	Chocolate.....	5.6
	DERBY			
20596	Debarbiere & Musante.....	Own make.....	Vanilla.....	4.8
	DEVON			
20276	Ideal Confectionery Co.....	R. Kostopoulos.....	Vanilla.....	7.1
	GREENWICH			
20072	A. B. Libano & Co.....	Own make.....	Strawberry....	5.6
	HARTFORD			
20006	Soda Shop.....	New Haven Dairy..	Coffee.....	7.6
	JEWETT CITY			
20793	Dennis Sullivan.....	Own make.....	Chocolate.....	6.8
20792	Dennis Sullivan.....	Own make.....	Maple Walnut	4.5
	NEW HAVEN			
20025	Sweetland Bros.....	Own make.....	Chocolate.....	7.6
20563	Union Confectionery Co.....	Own make.....	Lemon.....	7.6
20783	J. Basil.....	Own make.....	Chocolate.....	7.6
	NEW MILFORD			
18200	Noble, Lynch & Noble.....	Int'l Ice Cream Co.	Vanilla.....	7.2
18193	Hipp's Ice Cream Co.....	Own make.....	Chocolate.....	7.1
	ROCKVILLE			
19958	John E. Gawtreys.....	Own make.....	Vanilla.....	3.6
19959	John E. Gawtreys.....	Own make.....	Coffee.....	3.7
	SOUTH MANCHESTER			
19956	Manchester Dairy Ice Cream Co.	Own make.....	Chocolate.....	7.8
19954	Joseph Sardella.....	Own make.....	Vanilla.....	7.6
	UNIONVILLE			
20000	Chas. Hackney.....	.....	Vanilla.....	7.6
	WAUREGAN			
20295	H. J. Fournin.....	Own make.....	Vanilla.....	7.6
	WINDSOR LOCKS			
19192	Vito Colapietro.....	Own make.....	Vanilla.....	2.3
19195	Leon Colapietro.....	Own make.....	Vanilla.....	2.6
19183	Louis Molinari.....	Peter Fossa.....	Chocolate.....	7.0
	WINSTED			
20634	John Nubarek.....	Int'l Ice Cream Co.	Vanilla.....	7.8
20639	Manchester Dairy Co.....	Own make.....	Vanilla.....	7.6
20640	T. Lentin.....	Manchester Dairy Co	Strawberry....	5.8

Samples found below standard, viz., 8 per cent. for plain cream and 6 per cent. for fruit and nut creams, are reported in more detail in Table V.

It is of interest to classify the samples on the basis of milk fat as we have done in other years. Such a comparison is given in Table VI.

TABLE VI. CLASSIFICATION OF ICE CREAM ON THE BASIS OF FAT CONTENT.

Range of Fat, per cent.	1919		1920		1921	
	Samples	Per cent.	Samples	Per cent.	Samples	Per cent.
8.0 to 9.9.....	25	30.5	134	33.5	94	28.5
10.0 to 11.9.....	26	31.7	83	20.8	71	21.6
12.0 and above.....	28	34.1	125	31.2	123	37.4
Below 8.....	3	3.7	58 ¹	14.5	41 ²	12.5
Total.....	82	100.0	400	100.0	329	100.0

¹ Includes 11 fruit ice creams of legal standard viz., 6 per cent.

² Includes 14 fruit ice creams of legal standard viz., 6 per cent.

As noted in our report last year¹ the true average quality of the market product of the state is not shown by these figures since we have no knowledge of the gross production of the several grades. It is quite probable that the production of ice cream testing between 8 and 10 per cent. exceeds that of grades testing higher. It is evident however that our statute legalizing 8 per cent. ice cream has not caused grades richer in fat to disappear.

Fifteen samples were examined for individuals. Of these only three, 17668, 17669 and 17670, require notice. These were the top, middle and bottom portions of a gallon can of vanilla cream submitted by the Semon Ice Cream Company of New Haven for study of uniformity of fat distribution. The can was heated gently to permit removal of the contents as a whole and cross sections were taken at the top, middle and bottom. Each of the three sections tested 10 per cent. fat showing a very even fat distribution.

Three similar experiments made in this laboratory on another occasion² showed satisfactory uniformity in two of the trials but in the third case the product had evidently stratified either by reason of imperfect mixing originally or, more probably, because of partial melting or "weakening" subsequently.

MILK AND MILK PRODUCTS.

CRYSCOPY OF MILK.³

Methods for the detection of adulteration in milk have been greatly improved in recent years. Twenty-years ago the analyst was obliged to base his judgment of milk samples submitted for

¹ Conn. Exp. Sta. Bull. 227, p. 249.

² Conn. Exp. Sta. Bull. 219, pp. 215-216.

³ The data and much of the discussion on this subject is taken from the report of the writer as associate referee to the Association of Official Agricultural Chemists at the meeting at Washington in October, 1921.

examination entirely upon the analysis of the sample. If the specific gravity, fat and non-fatty solids were low, added water was suspected; if the specific gravity and non-fatty solids were high and the fat low, skimming was indicated. In either case it was obviously difficult to pass certain judgment unless the samples were well outside the limits of reasonable composition, and a combination of both of the forms of sophistication mentioned further complicated the task of diagnosis. As a result of careful study of analyses of whole milk certain relationships between its several proximate constituents have been postulated and it is largely upon such ratios that the identification of skimmed milk still depends. The introduction of the immersion refractometer facilitated the solution of a number of analytical problems, not the least of which was that of the more certain detection of watered milk. Exhaustive observations upon the sera of authentic milks from cows in various periods of lactation, upon varied rations and in different seasons of the year, etc., showed that the refraction of the serum is a factor which varies within comparatively narrow limits and that it is possible to choose, from the large amount of data collected, a figure below which milk will not refract provided it is undiluted with water. Thus, for the copper method of preparing the serum, a refraction of 36 is the lowest recorded value for milk of known purity and a reading of less than this figure is regarded as indicative of added water. It is recognized that this method has its limitations and that 10 per cent. dilution, or even in some cases considerably more, may escape detection, but taken in conjunction with deductions drawn from the chemical analysis it is still an invaluable aid in deciding the presence of added water.

More recently a method has been devised whereby milk containing extraneous water can be detected and the amount thereof estimated with a degree of delicacy not heretofore possible. The method is based upon the freezing point of milk which is a physiological constant varying within very narrow limits, viz., -0.530°C . to -0.566°C . according to the studies herein reported which is the best information available at this time. Obviously as milk is diluted with water its freezing point approaches that of water and depressions less than -0.530° will be observed. By comparing the freezing point depression of milk which has been diluted with water with the minimum or the accepted average depression observed for whole milk of known purity the percentage of water added can be very closely approximated.

The theory and practice of freezing point determinations as applied to milk together with a critical review of the literature dealing with cryoscopic investigations of blood serum, bile, gastric juice, etc. have been very adequately set forth in a paper by Hortvet¹

who has outlined a carefully standardized method of procedure for the determination of freezing points. The practical application of this method to the detection and estimation of added water in milk is necessarily based upon a knowledge of the range in freezing point depressions which may be shown by normal milk and this further necessitates a study of milk obtained in different localities from normal individual cows and herds and from animals under varying conditions of daily routine and general health. Dr. Hortvet, as referee on dairy products for the Association of Official Agricultural Chemists, has continued the study of this subject during the past year and the writer, as associate referee for the same Association, has collaborated with him with special reference to the definition of the freezing point range for normal milk and the depressions which may be observed in milk from cows under abnormal conditions. We discuss here only that part of the work which comes within the scope of the writer's part in the program.

COLLABORATION.

Generous coöperation was received from the Libby, McNeill and Libby Laboratories, Morrison, Ill. through Dr. G. A. Menge who has reported results credit for which is due to Messrs. R. T. Beardsley and W. H. Tucker. Further data were supplied from the State Dairy and Food Department, St. Paul, Minn., through the collaboration of Messrs. Henry Hoffman, Otto Kneffner and C. S. Carl. Credit for data submitted from this Station is due to Mr. R. E. Andrew, collaborator, assisted by Mr. R. T. Merwin. Samples examined here were taken under the supervision of Mr. G. T. Fowler of the Dairy and Food Commissioner's Department and Mr. C. E. Shepard of this laboratory.

CLASSIFICATION OF RESULTS.

Two hundred and sixteen samples are represented in the combined reports of collaborators. Partial or complete analyses with freezing point determinations, the latter largely in duplicate, have been made and these data have been classified in appropriate groups and are discussed under titles as follows:

- I. Freezing Point Depressions of Authentic Milk From Normal Individual Cows.
- II. Freezing Point Depressions of Authentic Milk From Normal Herds.
- III. Freezing Point Depressions of Authentic Milk From Healthy Cows but Under Abnormal Conditions of Daily Routine or Environment.
- IV. Freezing Point Depressions of Authentic Milk From Cows which are Diseased or Otherwise Abnormal Physically.

¹ Jour. Ind. Eng. Chem., 13, 3, p. 198, 1921.

TABLE VII. ANALYSES AND FREEZING POINT DEPRESSIONS OF AUTHENTIC MILK, NORMAL INDIVIDUAL COWS.

Herd	Indiv. Cow No. Sample No.	Breed	Date 1921	Sp. Gr. 15.6° C.	Fat	S-N-F.	Lactose	Ash	Acidity	Freezing Point —0° C.	
(Collaborator, Libby, McNeill and Libby)											
H. T.	5 B	Holstein	9/14 P.M.	1.0306	3.3	8.30	4.64	0.639	0.145	0.532	0.531
H. A.	4 B	Holstein	9/14 P.M.	1.0310	3.6	8.47	3.71	0.799	0.147	0.551	0.551
H. A.	7 B	Holstein	9/14 P.M.	1.0380	3.8	10.26	3.65	0.805	0.155	0.566	0.566
B. J. F.	6 B	Holstein	9/14 P.M.	1.0300	3.3	8.15	4.39	0.660	0.140	0.533	0.533
	1	Holstein, Gr'd	9/18 P.M.	1.0260	6.3	7.76	3.41	0.664	0.120	0.548	0.549
	7	Holstein, Gr'd	9/18 P.M.	1.0303	4.9	8.55	4.45	0.697	0.170	0.548	0.546
	8	Holstein, Gr'd	9/18 P.M.	1.0264	3.0	7.20	4.29	0.770	0.103	0.548	0.548
	9	Holstein, Gr'd	9/18 P.M.	1.0303	3.8	8.34	4.37	0.678	0.165	0.538	0.537
	11	Holstein, Gr'd	9/18 P.M.	1.0288	4.7	8.14	4.16	0.728	0.153	0.549	0.548
B. J. F.	....	Holstein, Pure	9/14 P.M.	1.0300	2.2	7.90	4.38	0.693	0.140	0.535	0.535
B. V.	....	Holstein, Gr'd	9/16 P.M.	1.0287	0.9 ¹	7.36	4.15	0.719	0.100	0.538	0.537
A. H.	....	Holstein, Gr'd	9/21 P.M.	1.0357	3.3	10.01	4.17	0.784	0.190	0.548	0.548
J. N.	....	Holstein, Gr'd	9/21 P.M.	1.0316	3.7	8.63	4.34	0.707	0.153	0.551	0.550
B. F. H.	....	Holstein, Gr'd	9/21 P.M.	1.0338	4.1	9.26	4.15	0.770	0.165	0.549	0.548
E. K.	....	Jersey, Gr'd	9/21 P.M.	1.0328	4.3	9.05	4.68	0.730	0.165	0.542	0.540
J. H.	....	Jersey, Gr'd	9/26 A.M.	1.0326	3.1	8.77	5.03	0.628	0.115	0.560	0.560
			9.26 P.M.	1.0320	2.8	8.57	4.78	0.622	0.118	0.546	0.545
.....	5	Br. Swiss	9/18 P.M.	1.0256	5.3	7.46	3.65	0.647	0.145	0.549	0.548
A. M.	....	Durham	9/16 P.M.	1.0310	3.5	8.44	4.55	0.661	0.145	0.533	0.533
A. S.	....	Durham, Gr'd	9/16 P.M.	1.0328	4.0	8.99	4.61	0.676	0.160	0.545	0.547
G. T.	....	Durham, Gr'd	9/26 A.M.	1.0318	4.0	8.74	3.75	0.782	0.110	0.548	0.549
			9/26 P.M.	1.0310	4.3	8.60	3.56	0.797	0.120	0.541	0.540
A. D.	....	Dur.-S. Horn	9/26 A.M.	1.0340	4.9	9.48	4.63	0.829	0.135	0.550	0.550
			9/26 P.M.	1.0340	4.4	9.37	4.52	0.832	0.123	0.548	0.547
O. R....	....	S. Horn-Hol.	9/26 A.M.	1.0325	4.6	9.05	3.63	0.636	0.083	0.540	0.539
			9/26 P.M.	1.0326	4.2	8.96	3.43	0.661	0.080	0.540	0.540
F. F.	....	Red Pole	9/23 A.M.	1.0304	5.5	8.94	4.53	0.695	0.138	0.551	0.551

¹ A.M. sample following day tested 1.6% fat.

TABLE VII. ANALYSES AND FREEZING POINT DEPRESSIONS OF AUTHENTIC MILK, NORMAL INDIVIDUAL COWS—(Continued).

Herd	Indiv. Cow No. Sample No.	Breed	Date 1921	Sp. Gr. 15.6° C.	Fat %	S-N-F. %	Lactose %	Ash %	Acidity %	Freezing Point —0° C.	
(Collaborator, State Dairy & Food Dept., St. Paul, Minn.)											
.....	1 H.	Holstein, Reg.	5/9	1.0295	4.7	8.47	....	.....	.....	0.560	.....
.....	2 H.	Holstein, Reg.	5/9	1.0281	4.2	8.02	....	.....	.....	0.554	.....
.....	3 H.	Holstein, Reg.	5/9	1.0312	3.4	8.63	....	.....	.....	0.550	.....
.....	4 H.	Holstein, Reg.	5/9	1.0313	2.9	8.54	....	.....	.....	0.542	.....
.....	5 H.	Holstein, Reg.	5/9	1.0310	2.3	8.34	....	.....	.....	0.540	.....
.....	6230	Holstein	5/14	1.0305	3.3	8.57	....	.....	.....	0.544	.....
.....	6231	Holstein	5/14	1.0310	2.6	8.24	....	.....	.....	0.541	.....
.....	6232	Holstein	5/14	1.0310	2.8	8.48	....	.....	.....	0.543	.....
.....	6233	Holstein	5/14	1.0320	2.4	8.60	....	.....	.....	0.540	.....
.....	6234	Holstein	5/14	1.0330	2.8	8.95	....	.....	.....	0.554	.....
.....	6235	Holstein	5/14	1.0310	2.6	8.43	....	.....	.....	0.556	.....
.....	6236	Holstein	5/14	1.0315	4.9	9.07	....	.....	.....	0.552	.....
.....	6237	Holstein	5/14	1.0330	3.3	9.05	....	.....	.....	0.540	.....
.....	6238	Holstein	5/14	1.0310	4.4	8.78	....	.....	.....	0.545	.....
.....	6250	Holstein	5/17	1.0290	3.7	9.25	....	.....	.....	0.546	.....
.....	7022	Durham	9/7	1.0323	4.4	9.10	....	.....	.....	0.554	.....
St. L. P.	.....	.....	8/25	1.0315	3.8	8.80	....	.....	.....	0.551	.....
(Collaborator, Agricultural Experiment Station, New Haven, Conn.)											
Y	1	Holstein	4/5 A.M.	1.0323	3.6	8.80	....	.....	0.17	0.573	0.574 ²
			4/13 A.M.	1.0317	3.2	8.58	....	.....	0.15	0.558	0.559
			4/15 A.M.	1.0330	3.3	8.92	....	.....	0.16	0.565	0.566
			4/15 A.M.	1.0330	3.3	8.92	....	.....	0.15	0.565	0.565
			4/16 A.M.	1.0322	3.4	8.74	....	.....	0.16	0.565	0.565
			4/20 A.M.	1.0315	3.3	8.55	....	.....	0.15	0.562	0.562
			4/20 P.M.	1.0305	3.3	8.30	....	.....	0.14	0.542	0.542
			5/20 P.M.	1.0299	3.4	8.17	....	.....	0.14	0.536	0.537
	2	Holstein	4/6 A.M.	1.0320	4.3	8.88	....	.....	0.14	0.572	0.572 ²

² See discussion.

TABLE VII. ANALYSES AND FREEZING POINT DEPRESSIONS OF AUTHENTIC MILK, NORMAL INDIVIDUAL COWS—(Continued).

Herd	Indiv. Cow No. Sample No.	Breed	Date 1921	Sp. Gr. 15.6° C.	Fat %	S-N-F. %	Lactose %	Ash %	Acidity %	Freezing Point —0° C.
(Collaborator, Agricultural Experiment Station, New Haven, Conn.—Continued)										
Y	2	Holstein	4/13 A.M.	1.0311	3.4	8.46	....	....	0.15	0.544
			4/16 A.M.	1.0317	4.1	8.76	....	....	0.14	0.562
			4/20 A.M.	1.0317	3.6	8.67	....	....	0.13	0.553
			4/26 P.M.	1.0307	3.8	8.46	....	....	0.15	0.547
	3	Holstein	5/18 P.M.	1.0309	4.3	8.60	....	....	0.13	0.551
			4/7 A.M.	1.0337	5.4	9.54	....	....	0.15	0.572
			4/13 A.M.	1.0321	4.7	8.98	....	....	0.15	0.557
			4/20 A.M.	1.0330	5.1	9.29	....	....	0.15	0.562
	4	Holstein	4/26 P.M.	1.0325	5.0	9.14	....	....	0.14	0.547
			5/20 P.M.	1.0332	5.0	9.31	....	....	0.15	0.549
			4/9 A.M.	1.0308	4.4	8.60	....	....	0.12	0.560
			4/20 A.M.	1.0320	3.6	8.73	....	....	0.14	0.562
	5	Holstein	4/9 P.M.	1.0299	4.4	8.37	....	....	0.12	0.552
			4/26 P.M.	1.0308	3.1	8.34	....	....	0.15	0.543
			5/26 P.M.	1.0315	3.3	8.85	....	....	0.13	0.543
			4/8 A.M.	1.0333	3.7	9.07	....	....	0.15	0.552
	6	Holstein	4/16 A.M.	1.0326	3.3	8.82	....	....	0.12	0.571
			4/22 A.M.	1.0313	3.5	8.52	....	....	0.11	0.571
			4/26 P.M.	1.0309	3.7	8.48	....	....	0.10	0.544
			4/25 P.M.	1.0301	3.1	8.15	....	....	0.11	0.533
	7	Holstein	4/22 A.M.	1.0322	4.0	8.85	....	....	0.12	0.571
			4/25 P.M.	1.0312	4.0	8.60	....	....	0.11	0.545
			5/26 P.M.	1.0326	4.3	9.03	....	....	0.12	0.553
			4/22 A.M.	1.0342	4.6	9.48	....	....	0.13	0.580
	8	Holstein	4/25 P.M.	1.0333	4.0	9.13	....	....	0.12	0.542
			5/18 P.M.	1.0343	5.0	9.58	....	....	0.11	0.552
			4/22 A.M.	1.0340	3.8	9.28	....	....	0.15	0.571
			4/25 P.M.	1.0317	4.7	8.90	....	....	0.12	0.543
	9	Holstein	5/18 P.M.	1.0318	4.6	8.94	....	....	0.12	0.551

TABLE VII. ANALYSES AND FREEZING POINT DEPRESSIONS OF AUTHENTIC MILK, NORMAL INDIVIDUAL COWS—(Continued).

Herd	Indiv. Cow No. Sample No.	Breed	Date 1921	Sp. Gr. 15.6° C.	Fat %	S-N-F. %	Lactose %	Ash %	Acidity %	Freezing Point —0° C.
(Collaborator, Agricultural Experiment Station, New Haven, Conn.—Continued)										
Y	10	Holstein	4/22 A.M.	1.0320	4.1	8.83	....	....	0.15	0.572
			5/18 P.M.	1.0301	4.0	8.33	....	....	0.12	0.542
	11	Holstein	4/22 A.M.	1.0320	3.7	8.75	....	....	0.15	0.562
			5/18 P.M.	1.0303	3.9	8.35	....	....	0.15	0.543
	12	Holstein	4/23 A.M.	1.0301	6.8	8.88	....	....	0.16	0.572
			5/18 P.M.	1.0327	6.5	9.47	....	....	0.15	0.551
	13	Holstein	4/23 A.M.	1.0304	3.8	8.37	....	....	0.12	0.540
			5/26 P.M.	1.0316	4.6	8.84	....	....	0.12	0.542
	14	Holstein	4/23 A.M.	1.0319	3.8	8.75	....	....	0.16	0.549
			5/20 P.M.	1.0320	4.0	8.81	....	....	0.16	0.539
	15	Holstein	4/27 A.M.	1.0317	3.5	8.65	....	....	0.11	0.561
			4/25 P.M.	1.0298	3.0	8.76	....	....	0.13	0.523
			4/26 P.M.	1.0305	3.3	8.30	....	....	0.14	0.532
			4/27 P.M.	1.0301	3.2	8.17	....	....	0.13	0.536
	16	Holstein	5/20 P.M.	1.0312	3.4	8.48	....	....	0.13	0.544
			4/26 P.M.	1.0302	4.5	8.45	....	....	0.16	0.540
			5/20 P.M.	1.0317	4.6	8.87	....	....	0.16	0.542
			4/26 P.M.	1.0294	3.5	8.06	....	....	0.13	0.541
F	1	Holstein	5/20 P.M.	1.0291	3.5	7.98	....	....	0.12	0.542
			4/16 A.M.	1.0310	3.2	8.40	....	....	0.14	0.542
	2	Holstein	5/6 P.M.	1.0304	3.1	8.23	....	....	0.14	0.541
			4/18 A.M.	1.0313	2.8	8.38	....	....	0.15	0.542
	3	Holstein	5/5 P.M.	1.0295	...	...	....	....	0.14	0.543
			4/18 A.M.	1.0329	...	...	....	....	0.14	0.550
	4	Holstein	5/5 P.M.	1.0296	3.2	8.05	....	....	0.14	0.532
			4/18 A.M.	1.0308	3.1	8.34	....	....	0.15	0.542
	5	Holstein	5/5 P.M.	1.0301	3.2	8.17	....	....	0.15	0.529
			4/18 A.M.	1.0318	3.4	8.64	....	....	0.16	0.543
			5/5 P.M.	1.0317	3.5	8.64	....	....	0.16	0.542

TABLE VII. ANALYSES AND FREEZING POINT DEPRESSIONS OF AUTHENTIC MILK, NORMAL INDIVIDUAL COWS—(Concluded).

Herd	Indiv. Cow Sample No.	Breed	Date 1921	Sp. Gr. 15.6° C.	Fat %	S.N.F. %	Lactose %	Ash %	Acidity %	Freezing Point —0° C.
(Collaborator, Agricultural Experiment Station, New Haven, Conn.—Concluded)										
F	6	Holstein	4/19 A.M.	1.0280	4.0	7.81	....	....	0.11	0.545
			5/5 P.M.	1.0307	4.0	8.50	....	....	0.13	0.541
	7	Holstein	4/19 A.M.	1.0325	4.1	8.90	....	....	0.14	0.552
	8	Holstein	5/6 P.M.	.....	3.5	....	....	....	0.11	0.542
	9	Holstein	4/19 A.M.	1.0335	4.8	9.35	....	....	0.14	0.549
			5/6 P.M.	1.0310	2.9	8.33	....	....	0.16	0.536
	10	Holstein	4/19 A.M.	1.0298	3.8	8.23	....	....	0.15	0.542
			5/6 P.M.	1.0305	3.8	8.40	....	....	0.14	0.534
	11	Holstein	4/19 A.M.	1.0309	3.8	8.50	....	....	0.13	0.547
			5/6 P.M.	1.0310	5.1	8.79	....	....	0.12	0.543
			5/6 P.M.	1.0303	2.7	8.10	....	....	0.16	0.542
S	1	Jersey	4/29 A.M.	1.0336	6.0	9.63	....	....	0.17	0.535
	2	Ayrshire	4/29 A.M.	1.0309	4.1	8.56	....	....	0.17	0.543
	3	Guernsey	4/29 A.M.	1.0309	5.1	8.77	....	....	0.18	0.532
	5	.....	5/11 P.M.	1.0320	3.7	8.75	....	....	0.16	0.549
P			7/6 P.M.	1.0303	4.7	8.53	....	....	0.14	0.533
			5/11 P.M.	1.0309	....	....	....	....	0.09	0.536
	6	.....	7/6 P.M.	1.0271	3.8	7.55	....	....	0.09	0.542
										0.535

FREEZING POINT DEPRESSIONS OF AUTHENTIC MILK FROM I, NORMAL INDIVIDUAL COWS AND II, NORMAL HERDS.

The data obtained upon normal individual cows and normal herds are given in Tables VII and VIII respectively.

The term "normal" as applied to an individual cow or herd is used in this report to refer to animals which in the judgment of the ordinary observer or dairyman would be classed as healthy and which are fed and kept with ordinary care. It does not refer to animals which have been subjected to clinical tests and pronounced sound by expert authority. The milk from animals which conform to this interpretation of the term is presumed to be normal milk. While from a purely scientific standpoint it would be of interest to define the limits of freezing point depression for the milk of only such individuals as had been judged healthy by expert examination and clinical tests, yet that would be beside the immediate purpose of this study which is to define such limits as will serve for safely judging the substance and quality of market milk.

UNCORROBORATED RESULTS.

Before taking up the discussion of freezing point range as shown by the combined data, attention is called to certain extreme results which lie outside the experience of the collaborators as a whole. This refers to results below -0.570° C. found for a number of morning samples and to one extremely high figure, -0.523° C. observed in one case of evening milk.

These results are summarized from Table VII as follows:

TABLE VII, A. RESULTS REQUIRING FURTHER CORROBORATION.

Herd	Cow No.	Breed.	Date.	Freezing Point—0° C.	
Y	1	Holstein	4/5 A. M.	0.573	0.574
	2	Holstein	4/6 A. M.	0.572	0.572
	3	Holstein	4/7 A. M.	0.572	0.572
	6	Holstein	4/16 A. M.	0.571	0.571
			4/22 A. M.	0.571	0.571
	7	Holstein	4/22 A. M.	0.571	0.571
	8	Holstein	4/22 A. M.	0.580	0.580
	9	Holstein	4/22 A. M.	0.571	0.571
	10	Holstein	4/22 A. M.	0.572	0.572
	12	Holstein	4/23 A. M.	0.572	0.572
	15	Holstein	4/25 P. M.	0.523	0.523

All these results were obtained in the laboratory of the writer who can vouch for the care with which the freezing point observations were made and who can obtain no information of any abnormal conditions prevailing in this herd at the time the samples were taken. So far as this herd is concerned the low figures seem

TABLE VIII. ANALYSES AND FREEZING POINT DEPRESSIONS OF AUTHENTIC MILK, NORMAL HERDS.

Herd	No. of Cows	Breed	Date 1921	Sp. Gr. 15.6° C.	Fat	S-N-F.	Lactose	Ash	Acidity	Freezing Point —0° C.	
(Collaborator, Libby, McNeill & Libby.)											
E. M.	4	Holstein, Gr'd	4/1 P.M.	1.0314	3.6	8.56	....	.....	0.145	0.535	0.534
W. T.	12	Holstein, Gr'd	4/1 P.M.	1.0305	2.8	8.17	....	.....	0.145	0.530	0.531
	13	Holstein, Gr'd	6/22 P.M.	1.0300	3.1	8.13	4.46	.....	0.140	0.541	0.541
	15	Holstein, Gr'd	7/14 P.M.	1.0304	3.3	8.26	....	.....	0.135	0.538	0.538
G. H.	13	Holstein, Gr'd	3/29 P.M.	1.0290	3.6	7.98	....	.....	0.135	0.532	0.532
			7/14 P.M.	1.0295	3.3	8.03	4.58	.....	0.135	0.541	0.541
W. B.	6	Holstein, Gr'd	4/1 P.M.	1.0324	2.7	8.63	....	.....	0.150	0.529	0.530
	13	Holstein, Gr'd and Pure	6/22 P.M.	1.0310	3.0	8.36	4.72	.....	0.135	0.539	0.537
			7/14 P.M.	1.0295	3.2	8.01	....	.....	0.130	0.533	0.532
			8/2 P.M.	1.0294	3.4	8.02	....	.....	0.135	0.538	0.537
A. G.	15	Holstein, Pure	9/16 P.M.	1.0313	3.5	8.53	4.44	0.722	0.150	0.547	0.548
M. B.	16	Holstein, Gr'd	9/21 P.M.	1.0323	3.2	8.72	4.18	0.734	0.143	0.552	0.552
H. W.	11	Holstein, Gr'd	9/26 A.M.	1.0292	4.3	8.16	4.29	0.678	0.123	0.534	0.532
O. R.	10	Holstein, Gr'd	9/26 P.M.	1.0285	4.3	7.98	3.69	0.710	0.110	0.532	0.533
			9/21 P.M.	1.0313	3.5	8.53	4.23	0.696	0.133	0.551	0.551
G. P.	6	Holstein, Gr'd	9/14 P.M.	1.0336	3.4	9.08	4.53	0.693	0.145	0.550	0.550
D. F. M.	3	Holstein, Pure	9/14 P.M.	1.0300	2.7	8.05	4.39	0.676	0.145	0.535	0.535
I B.	2	Hol.-Jersey	9/16 P.M.	1.0313	3.7	8.57	4.61	0.684	0.155	0.549	0.548
B. J. F.	2	Hol. 10, Jersey 1	9/16 P.M.	1.0301	3.1	8.15	4.47	0.686	0.145	0.550	0.549
3 B.	11	Hol. 4, Jersey 1, Bk. Pole 1, Dur. 2, Hereford 1, Guernsey 1	9/21 P.M.	1.0319	3.5	8.68	4.42	0.710	0.140	0.546	0.545
A. P. T.	10	Holstein 2, Jer. 10	9/21 P.M.	1.0320	3.8	8.76	4.52	0.704	0.148	0.543	0.542
E. K.	12										

TABLE VIII. ANALYSES AND FREEZING POINT DEPRESSIONS OF AUTHENTIC MILK, NORMAL HERDS—(Concluded).

Herd	No. of Cows	Breed	Date 1921	Sp. Gr. 15.6° C.	Fat %	S-N-F. %	Lactose %	Ash %	Acidity %	Freezing Point -0° C.	
(Collaborator, Libby, McNeill & Libby.—Concluded.)											
F. F.	9	Holstein 7, Red Pole 1, Jersey 1	9/23 A.M.	1.0309	4.2	8.56	4.59	0.666	0.148	0.547	0.545
D. L.	2	Jersey, Gr'd	6/22 P.M.	1.0329	5.4	9.30	4.92	.....	0.142	0.550	0.549
J. J. R.	2	Jersey, Gr'd	8/1 P.M.	1.0316	3.3	8.56	4.82	.....	0.130	0.551	0.551
R. N.	6	Jersey 1, S. Horn 5	9/21 P.M.	1.0316	3.8	8.66	4.67	0.672	0.150	0.550	0.550
B	10	Durham, Gr'd	3/29 P.M.	1.0321	3.8	8.77	....	.....	0.143	0.542	0.541
A. D.	6	Dur.-S. Horn	9/26 A.M.	1.0325	4.6	9.05	4.52	0.687	0.105	0.540	0.539
			9/26 P.M.	1.0325	4.2	8.96	4.50	0.700	0.123	0.540	0.540
P. W.	7	Reds, Gr'd	6/20 P.M.	1.0322	3.9	8.83	4.68	.....	0.157	0.531	0.531
			7/14 P.M.	1.0324	3.7	8.84	....	.....	0.130	0.534	0.533
B. L.	4	S. Horn, Gr'd	9/23 A.M.	1.0314	3.6	8.57	4.48	0.706	0.150	0.557	0.556
B. W.	16	Mixed, Gr'd	6/20 P.M.	1.0326	3.7	8.98	4.45	.....	0.152	0.536	0.537
J. H.	11	Mixed, Gr'd	9/26 A.M.	1.0318	4.0	8.74	4.68	0.696	0.118	0.548	0.549
			9/26 P.M.	1.0310	4.3	8.60	4.55	0.698	0.120	0.541	0.540
G. T.	5	Mixed, Gr'd	9/26 A.M.	1.0313	4.5	8.73	4.29	0.719	0.128	0.552	0.553
			9/26 P.M.	1.0313	4.1	8.65	4.14	0.750	0.125	0.552	0.553
Factory Sample	2300	Mixed	9/23 A.M. & P.M.	1.0310	3.7	8.49	4.45	0.704	0.145	0.541	0.540
(Collaborator, Agricultural Experiment Station, New Haven, Conn.)											
Y	17	Holstein	4/27 A.M.	1.0317	4.1	8.77	....	.....	0.13	0.553	0.553
			4/27 P.M.	1.0309	3.5	8.44	....	.....	0.14	0.539	0.540
F	11	Holstein	5/2 A.M.	1.0312	3.3	8.46	....	.....	0.16	0.559	0.560
			4/13 P.M.	1.0313	3.7	8.56	....	.....	0.15	0.535	0.535
			4/18 P.M.	1.0309	3.7	8.48	....	.....	0.16	0.539	0.540
			4/19 P.M.	1.0310	3.4	8.44	....	.....	0.15	0.540	0.540
			5/2 P.M.	1.0305	3.7	8.38	....	.....	0.14	0.540	0.540
S	7	Holstein	4/18	.....	3.4	....	....	.....	0.13	0.542	0.542
B	7	Holstein	4/18	.....	3.5	....	....	.....	0.13	0.550	0.550

to be substantiated by their occurrence in so many different individuals, at intervals of from one to eighteen days, and in one case recurrence in the same individual after an interval of six days, nevertheless, except in the instance just mentioned, they were not duplicated or very closely approximated in any other samples from the same cows. Similarly, the very high figure obtained in sample from No. 15 was not again observed although three other samples were examined. There is no information upon which these samples can be declared abnormal in the sense of the term herein defined yet for the reason that the figures have all been obtained from one herd, and because they have not been duplicated by the experience of any other collaborator nor satisfactorily substantiated in the laboratory where they were obtained they are recorded here with the provision that they require further corroboration and are classed accordingly.

VARIATIONS BETWEEN MORNING AND EVENING MILK WITH REFERENCE TO THE FREEZING POINT DEPRESSION.

A considerable amount of data have been obtained to show the relation between morning and evening milk both of individual cows and of herds as regards freezing point depressions. The data have been submitted chiefly by one collaborator so that no adequate comparison upon this point can be made of the experiences of collaborators as a whole. The results reported from this station show quite consistently greater depressions in the case of morning samples, whether from individuals or herds.

The results reported from the laboratory of Libby, McNeill and Libby do not confirm this experience but the data are not complete enough to successfully contradict it.

The comparisons are shown in the following summary based upon Tables VII and VIII.

The extreme figures which were discussed and disposed of in the preceding table are included in this tabulation merely to show that the differences, without reference to their magnitude, are in the same general direction as the majority of other differences.

The last four observations in each group are from the Libby, McNeill and Libby laboratories. In the case of individual cows their data harmonize with those reported from this station but in the case of herds they do not. However taking the six observations as they stand the average freezing point depression is 0.007° greater in the morning milk which is a magnitude well beyond the limit of experimental error and may therefore be regarded as a real value.

TABLE VII-VIII, A. VARIATION IN FREEZING POINT DEPRESSIONS OF MORNING AND EVENING MILK.

		INDIVIDUAL COWS.				A. M. Freezing Pt. lower (+) or higher (—) than P. M. —°C.
Herd and Cow No.	No. of Samples	A. M.	P. M.	A. M. Freezing Pt. Average —°C.	P. M. Freezing Pt. Average —°C.	
Y 1	5	2		0.563	0.539	+ 0.024
2	3	2		0.553	0.549	+ 0.004
3	2	2		0.560	0.548	+ 0.012
4	2	3		0.561	0.546	+ 0.015
6	2	2		0.571	0.539	.....
7	1	2		0.571	0.550	.....
8	1	2		0.580	0.547	.....
9	1	2		0.571	0.548	.....
10	1	1		0.572	0.542	.....
11	1	1		0.562	0.543	+ 0.019
12	1	1		0.572	0.551	.....
13	1	1		0.540	0.542	— 0.002
14	1	1		0.549	0.538	+ 0.011
15	1	3		0.561	0.538	+ 0.023
F 1	1	1		0.542	0.541	+ 0.001
2	1	1		0.542	0.544	— 0.002
3	1	1		0.551	0.533	+ 0.018
4	1	1		0.543	0.530	+ 0.013
5	1	1		0.543	0.541	+ 0.002
6	1	1		0.546	0.542	+ 0.004
7	1	1		0.552	0.542	+ 0.010
8	1	1		0.549	0.536	+ 0.013
9	1	1		0.542	0.534	+ 0.008
10	1	1		0.547	0.543	+ 0.004
11	1	1		0.542	0.535	+ 0.007
J. H.	1	1		0.560	0.546	+ 0.014
G. T.	1	1		0.549	0.541	+ 0.008
A. D.	1	1		0.550	0.548	+ 0.002
O. R.	1	1		0.540	0.540	± 0.000
HERDS.						
Y	1	1		0.553	0.540	+ 0.013
F	1	4		0.560	0.539	+ 0.021
J. H.	1	1		0.549	0.541	+ 0.008
G. T.	1	1		0.553	0.553	± 0.000
A. D.	1	1		0.540	0.540	± 0.000
O. R.	1	1		0.533	0.533	± 0.000

VARIATION IN FREEZING POINT DEPRESSIONS OBSERVED IN MILK FROM THE SAME INDIVIDUAL COW OR THE SAME HERD AT DIFFERENT INTERVALS.

In a few instances a sufficient number of samples have been taken from the same cow or herd to indicate what the variation in freezing point depression may be from day to day. While the data are not extensive enough to be conclusive they indicate that the

variation between the morning and evening milk is greater than the variation between morning samples or evening samples from day to day.

The following summary illustrates this point:

TABLE VII-VIII, B. VARIATION IN FREEZING POINT DEPRESSIONS OF MILK FROM THE SAME COW OR HERD.

Herd and Cow No.	No. of Samples.		Freezing Point Variation		Extreme Range A. M. and P. M. —°C.
	A. M.	P. M.	A. M. —°C.	P. M. —°C.	
INDIVIDUAL COWS.					
Y 1	5	2	0.007	0.006	0.029
2	3	2	0.018	0.005	0.018
3	2	2	0.006	0.003	0.016
4	2	3	0.002	0.008	0.019
6	2	2	0.000	0.011	.....
7	1	2	.....	0.007	.....
8	1	2	.....	0.011	.....
9	1	2	.....	0.008	.....
15	1	3	.....	0.013	0.029
HERDS.					
F	1	4	.....	0.005	0.025

THE RANGE IN FREEZING POINT DEPRESSIONS OBSERVED IN MILK FROM NORMAL COWS.

Hortvet has reported¹ summaries covering his experience with reference to the range in freezing point depressions for milk from 60 normal individual cows and from 15 normal herds. It is of interest and, indeed the chief purpose of this study, to compare his data with that obtained from the wider observations of the several collaborators this year, and our combined experience is shown in condensed form in the following summary, Table VII-VIII, C.

From this condensed summary it appears that the tentative limits suggested by Hortvet are not substantially changed by the further observations made in collaborative study. For individual cows the minimum depression of -0.530° and maximum depression -0.566° are recorded as compared with -0.534° and -0.562° reported a year ago. For herd milk the new high figure of -0.530° has been found but no new low figure established. The average for individual cows as reported last year (-0.547°), remains practically unchanged, -0.545° , while the average for herd milk is raised from -0.551° to -0.544° . The minimum depression observed for normal individual cows is -0.530° and the same figure obtains also for herd milk.

¹ Report of Minnesota State Dairy and Food Commissioner, 1920, p. III.

TABLE VII-VIII, C. RANGE IN FREEZING POINT DEPRESSIONS IN NORMAL MILK.

	Sp. Gr.	Fat. %	S-N-F. %	Freezing Point —°C.
INDIVIDUAL COWS.				
<i>State Dairy and Food Dept., St. Paul, Minn.—1919-1920 (60 samples).</i>				
Maximum	1.0350	7.30	10.15	0.562
Minimum	1.0262	2.20	7.37	0.534
Average	1.0319	3.94	8.90	0.547
<i>—1921 (17 samples).</i>				
Maximum	1.0330	4.9	9.25	0.560
Minimum	1.0281	2.4	8.02	0.540
Average	1.0311	3.4	8.67	0.547
<i>Libby, McNeill and Libby.—1921 (27 samples).</i>				
Maximum	1.0380	6.3	10.26	0.563
Minimum	1.0256	0.9	7.20	0.532
Average	1.0313	3.9	6.2	0.546
<i>Agricultural Experiment Station, New Haven, Conn.—1921 (75 samples).</i>				
Maximum	1.0343	6.8	9.63	0.566
Minimum	1.0271	2.7	8.17	0.530
Average	1.0313	4.0	8.64	0.543
HERDS.				
<i>State Dairy and Food Dept., St. Paul, Minn.—1919-1920 (15 samples).</i>				
Maximum	1.0330	5.50	9.27	0.562
Minimum	1.0305	3.10	8.48	0.545
Average	1.0319	4.15	8.95	0.551
<i>Libby, McNeill and Libby.—1921 (37 samples).</i>				
Maximum	1.0336	5.4	9.30	0.553
Minimum	1.0285	2.7	7.98	0.530
Average	1.0312	3.7	8.45	0.542
<i>Agricultural Experiment Station, New Haven, Conn.—1921 (9 samples).</i>				
Maximum	1.0317	4.1	8.77	0.560
Minimum	1.0305	3.3	8.38	0.535
Average	1.0311	3.6	8.50	0.544
<i>Combined results of all collaborators.</i>				
INDIVIDUAL COWS (179 SAMPLES)				
Maximum	1.0380	7.3	10.26	0.566
Minimum	1.0256	0.9	7.20	0.530
Average	1.0315	3.8	8.71	0.545
HERDS (61 SAMPLES).				
Maximum	1.0336	5.5	9.30	0.562
Minimum	1.0285	2.7	7.98	0.530
Average	1.0313	3.8	8.58	0.544

TABLE IX. ANALYSES AND FREEZING POINT DEPRESSIONS OF AUTHENTIC MILK. Healthy Cows Under Abnormal Conditions of Daily Routine or Environment.

Herd	Date of milking, 1921	Description	Sp. Gr. 15.6° C.	Fat %	S.-N.-F. %	Lactose %	Ash %	Acidity %	Freezing Point —0° C.
(Collaborator, Libbey, McNeill & Libbey)									
INDIVIDUAL COWS.									
A. M. 2A.	8/30 P.M.	Pure Jersey, driven 4 blocks to Fair, milking delayed 1 hour.	1.0327	7.6	9.69	4.29	0.817	(1)	0.563
2B.	9/14 P.M.	Same cow, normal conditions.	1.0398	7.0	11.34	1.80	0.874	0.160	0.562
H. T. 4A.	8/30 P.M.	Pure Holstein, driven 6 miles to Fair, milking delayed 3½ hours.	1.0294	4.1	8.18	4.52	0.666	(1)	0.547
4B.	9/14 P.M.	Same cow, normal conditions.	1.0306	3.3	8.30	4.64	0.639	0.145	0.531
H. A. 5A.	8/31 P.M.	Pure Holstein, milking delayed 10½ hours.	1.0322	3.9	8.84	4.00	0.815	(1)	0.578
5B.	9/14 P.M.	Same cow, normal conditions.	1.0310	3.6	8.47	3.71	0.799	0.147	0.551
H. A. 6A.	8/31 P.M.	Pure Holstein, milking delayed 10½ hours.	1.0358	5.5	10.05	4.25	0.808	(1)	0.563
6B.	9/14 P.M.	Same cow, normal conditions.	1.0380	3.8	10.26	3.65	0.805	0.155	0.566
J. F. 7A.	8/31 P.M.	Pure Holstein, milking delayed 9½ hours.	1.0270	3.8	7.51	3.67	0.732	(1)	0.537
7B.	9/14 P.M.	Same cow, normal conditions.	1.0300	3.3	8.15	4.39	0.660	0.140	0.533
HERDS.									
F. M. 1A.	8/30 P.M.	Three pure Holsteins, driven 6 miles to Fair arriving 7:30 A.M. Sample taken from evening milk.	1.0318	5.48	9.95	4.59	0.762	(1)	0.571
1B.	9/14 P.M.	Same herd, normal conditions.	1.0336	3.40	9.08	4.53	0.693	0.145	0.550
J. F. 3A.	8/30 P.M.	Two pure Holsteins, driven 5 miles to Fair arriving 7:30 A.M. Sample taken from evening milk.	1.0316	3.3	8.55	4.59	0.700	(1)	0.560
3B.	9/14 P.M.	Same herd, normal conditions.	1.0300	2.7	8.05	4.39	0.676	0.145	0.535

¹ Freezing point observed same evening that samples were taken.

III. FREEZING POINT DEPRESSIONS OF AUTHENTIC MILK FROM HEALTHY COWS UNDER ABNORMAL CONDITIONS OF DAILY ROUTINE OR ENVIRONMENT.

An interesting group of data was submitted by one of the collaborators showing the effect upon the freezing point of milk when the animals had been subjected to slight exercise, severe exercise or strain, or to delayed milkings.

The data appear in Table IX.

Apparently long delayed milking may or may not influence the freezing point depression. Of three cases where milkings were delayed from 9½ to 10½ hours, in one there was a conspicuous increase in depression but in the other two the changes were very slight, one of them being a decreased depression. There appears to be no evidence that moderately delayed milking e.g., 1 to 3 hours, produces any effect upon the freezing point.

Moderate exercise, such as a walk of four blocks, was without effect. In cases of severe exercise, strain or fatigue, such as walks of 5 or 6 miles, the freezing point was very materially lowered both for individuals and herds, the variations from normal being from 0.015° to 0.026°. The comparisons between the normal and abnormal are true since the observations were made on the evening milk in both cases. In point of magnitude certain of these abnormal figures e.g., -0.571 and -0.578, are at first glance suggestively coincident with the extremely low depressions observed in a number of morning samples discussed elsewhere in this report, but they offer no valid explanation of them first, because a delay of 10½ hours in milking does not occur in ordinary practice and second, morning milk is drawn after a period of rest.

IV. FREEZING POINT DEPRESSIONS OF AUTHENTIC MILK FROM COWS WHICH ARE DISEASED OR OTHERWISE ABNORMAL PHYSICALLY.

The observation that cows which to all outward appearances are sound and healthy may yet prove to be tubercular as judged by the tuberculin test is not uncommon. This suggested the desirability of studying the freezing point depressions of milk obtained from tubercular reactors and animals otherwise physically abnormal, and the data obtained in this investigation are given in Table X. Over 80% of the results reported by collaborators were within the limits observed for normal individuals and herds, but in 5 cases out of 33 unusually high freezing points were obtained which ranged from -0.520° to -0.523°. The evidence in 3 of these 5 cases is, however, somewhat contradictory for the reason that samples drawn from the same cows after an interval of 2 months gave

TABLE X. ANALYSES AND FREEZING POINT DEPRESSIONS OF AUTHENTIC MILK.
Cows Diseased or Otherwise Abnormal Physically.

Herd or No.	Date of milking, 1921	Description	Sp. Gr. 15.6° C.	Fat %	S-N-F. %	Lactose %	Ash %	Acidity %	Freezing Point —0° C.
(Collaborator, Libby, McNeill & Libby)									
INDIVIDUAL COWS.									
2	9/18 P.M.	Pure Holstein, tubercular reactor.....	1.0263	4.0	7.38	3.10	0.763	0.137	0.550 0.549
3	9/19 A.M.	Grade Holstein, tubercular reactor, not milked evening of previous day.....	1.0265	3.3	7.28	2.41	0.790	0.100	0.555 0.556
6	9/18 P.M.	Grade Holstein, tubercular reactor.....	1.0298	3.4	8.13	2.41	0.731	0.130	0.560 0.560
12	9/18 P.M.	Grade Holstein, tubercular reactor.....	1.0286	4.5	8.05	4.04	0.698	0.170	0.544 0.543
13	9/18 P.M.	Pure Holstein, tubercular reactor.....	1.0280	4.6	7.92	4.17	0.661	0.155	0.550 0.550
14	9/18 P.M.	Pure Holstein, tubercular reactor.....	1.0240	3.2	6.64	3.12	0.697	0.090	0.536 0.535
15	9/19 A.M.	Pure Holstein, tubercular reactor.....	1.0364	3.7	7.34	2.80	0.782	0.100	0.551 0.549
4	9/18 P.M.	Guernsey-Holstein, tubercular reactor.....	1.0299	4.7	8.42	2.67	0.714	0.145	0.550 0.552
10	9/18 P.M.	Grade Guernsey, tubercular reactor.....	1.0270	4.6	7.67	2.96	0.767	0.136	0.542 0.543
SC	7/13 A.M.	Grade Jersey, poor physical condition.....	1.0286	3.6	7.91	.....	.....	0.123	0.522 0.523
	7/14 A.M.	Symptoms of tuberculosis.....	.....	.....	.....	.....	.....	0.132	0.523 0.523
A. M. 2B.	9/14 P.M.	Jersey, colostrum milk.....	1.0398	7.0	11.34	1.80	0.874	0.160	0.562 0.563
HERDS.									
	9/18 P.M.	14 cows, mixed breeds, 8 tubercular.....	1.0272	4.2	7.64	3.65	0.716	0.133	0.548 0.548
(Collaborator, Agricultural Experiment Station, New Haven, Conn.)									
P 1	5/11 P.M.	Holstein, tubercular.....	1.0300	3.7	8.25	.....	.....	0.14	0.522 0.522
	7/6 P.M.	.....	1.0272	4.4	7.69	.....	.....	0.12	0.537 0.538
P 2	5/11 P.M.	Holstein, tubercular.....	1.0304	2.0	8.00	.....	.....	0.14	0.519 0.520
	7/6 P.M.	.....	1.0215	9.5	7.38	.....	.....	0.13	0.534 0.535
P 3	5/11 P.M.	Holstein, tubercular.....	1.0287	.....	.....	.....	.....	0.12	0.522 0.522
	7/6 P.M.	.....	1.0286	4.0	7.96	.....	.....	0.18	0.550 0.552
P 4	5/11 P.M.	Holstein, tubercular.....	1.0304	4.0	8.41	.....	.....	0.15	0.537 0.538
	7/6 P.M.	.....	1.0277	4.2	7.78	.....	.....	0.13	0.541 0.541

TABLE X. ANALYSES AND FREEZING POINT DEPRESSIONS OF AUTHENTIC MILK.—(Concluded).
Cows Diseased or Otherwise Abnormal Physically.

Herd or No.	Date of milking, 1921	Description	Sp. Gr. 15.6° C.	Fat %	S-N-F. %	Lactose %	Ash %	Acidity %	Freezing Point —0° C.
(Collaborator, State Dairy & Food Department, St. Paul, Minn.)									
517	9/22	Heifer, 2 years old, in heat, tubercular reactor.....	1.0301	3.4	8.35	.....	.....	.....	0.551
518	9/22	Tubercular reactor, 10 years old.....	1.0285	2.9	7.84	.....	.....	.....	0.541
519	9/22	Heifer, 3 years old, tubercular reactor.....	1.0284	3.8	8.00	.....	.....	.....	0.548
520	9/22	Tubercular reactor.....	1.0295	3.6	8.23	.....	.....	.....	0.544
521	9/22	Tubercular reactor, wild cow, one eye blind.....	1.0328	3.6	9.05	.....	.....	.....	0.547
522	9/22	Tubercular reactor, produced 30 lbs. 80% butter in 7 consecutive days.....	1.0293	3.1	8.08	.....	.....	.....	0.543
523	9/22	Tubercular reactor.....	1.0303	4.4	8.60	.....	.....	.....	0.543
524	9/22	Tubercular reactor.....	1.0328	3.3	9.00	.....	.....	.....	0.534
525	9/22	Tubercular cow with infected udder.....	1.0254	0.5	6.59	.....	.....	.....	0.586
526	9/22	Tubercular reactor.....	1.0290	3.7	8.23	.....	.....	.....	0.540
513	9/17	Holstein, calved 7 days previous to sampling, infected, still discharges pus.....	1.0294	4.5	8.40	.....	.....	.....	0.554
514	9/17	Guernsey, abortion 11 days previous to sampling..	1.0341	4.3	9.53	.....	.....	.....	0.538

freezing points within the limits for normal milk. On the basis of these data therefore it would appear that while in many cases tuberculosis and other pathological conditions may not necessarily be reflected in the freezing point depression of the milk, nevertheless, a few exceptionally high freezing points have been observed which should be borne in mind when deciding the significance of depressions less than -0.530° in the case of milk from individual cows.

It has not been possible to include in this report any adequate review of the literature dealing with the effect of pathological conditions upon the freezing points of secretions. Tieken¹ has shown comparisons between the freezing point of the blood and of various body fluids for a number of diseases in man. In the several cases of tuberculosis reported the freezing point of the blood remained normal, (-0.56° C.), with the other fluids under observation closely corresponding. When conspicuous departures from normal were observed in the blood e.g., in uremic coma, they were in the direction of *increased* depressions (-0.58° to -0.68°). Marked increase in depression in freezing point of the blood has been observed by some investigators in carcinoma, excessive amounts of protein decomposition products being regarded as the cause, but this experience has been questioned by others who found no such increase.² Koestler³ has investigated the detection of milk altered by secretion disturbances and finds that pathological disturbances increase the serum nitrogen, chlorine and sodium and decrease the lactose, potassium and phosphorus. It is said that the altered milk showed normal lowering of freezing point; and that this determination is a valuable check in cases where the general analytical results indicate added water. Further examination of this and other literature on the subject must be reserved for future study.

CONCLUSIONS.

The complete data now represent the examination of 291 samples distributed as follows:

Normal individual cows	179
Normal herds	61
Diseased or otherwise abnormal:	
individual cows	37
herds	3
Unclassified, requiring further corroboration	11
Total	291

The results indicate:

¹ Wells, Chem. Pathol. p. 324.

² Wells, Chem. Pathol. p. 461.

³ Chem. Abs. 15, 10, 1581.

(1). That there is an appreciable, and may be a conspicuous, difference in freezing point depression between morning and evening milk. This morning-evening variation is greater than that observed between morning samples or evening samples from day to day.

(2). The minimum freezing point depression of -0.530° and maximum of -0.566° for milk from normal individual cows and the minimum of -0.530° and maximum of -0.562° for milk from normal herds is reasonably substantiated by the experience of all collaborators.

(3). According to the data here reported moderate exercise or moderately delayed milkings are not reflected in the freezing point depressions of the milk. Long delayed milkings, $9\frac{1}{2}$ to $10\frac{1}{2}$ hours, may or may not be followed by depressions varying from normal. Severe exercise, strain or fatigue are followed by materially increased depressions.

(4). The milk from tubercular cows or those otherwise in poor or abnormal physical condition has generally fallen within the limits for normal milk as regards freezing point. The few exceptions noted have been in the direction of decreased depressions.

(5). Extremely low freezing points observed in certain samples of morning milk suggest a fuller investigation of this point. The study also of the effect of pathological conditions upon the freezing point may well be continued. The effect of increased acidity upon the freezing point depression with a view to corroborating or modifying the correction factor suggested by Kiester¹ should be studied.

MARKET MILK.

Nine hundred and sixty-seven samples of market milk have been submitted by the Dairy and Food Commissioner classified as follows:

Not found adulterated	593	61.3%
Adulterated by dilution with water	78	8.0
Adulterated by skimming	30	3.1
Adulterated by skimming and dilution with water	1	0.1
Adulterated by reason of being:		
below standard in solids and solids-not-fat ..	139	14.4
below standard in solids and fat	21	2.2
below standard in solids, fat and solids-not-fat ..	105	10.9
Total	967	100.0

There is reason to believe that the general quality of market milk available in this state is better than the data just given would indicate since, as we have stated in previous reports on this subject, the majority of samples received by us are submitted upon the suspicion of inferiority or adulteration. Many samples are tested

¹ Jour. Ind. Eng. Chem., 9, p. 862.

TABLE XI. ADULTERATED MILK.

No.	Dealer	Solids	Fat	No.	Dealer	Solids	Fat
	<i>Containing Added Water.</i>				<i>Containing Added Water</i>		
	AVON.				—continued		
21102	Wm. Thompson & T. B. Edgerly.....	10.93	3.8	20939	W. J. Humphrey.....	10.97	3.5
21103	Wm. Thompson & T. B. Edgerly.....	7.98	2.8		DANBURY.		
	BARKHAMSTED.			19378	Geo. Waltz.....	9.76	2.3
20719	Ralph Bradley.....	10.81	3.3	19379	Geo. Waltz.....	10.47	3.1
20713	Chas. H. Segeyt.....	11.55	3.7		FORESTVILLE.		
20720	John J. Wright.....	9.88	2.9	21105	Weintz Zwarville.....	10.95	3.4
	BECKLEY.				GUILFORD.		
19156	Thomas Boncek.....	4.19	1.1	19558	Wm. Hinnes.....	10.30	3.0
19157	Thomas Bodcek.....	5.17	0.7	19555	C. Woruncke.....	11.20	3.6
19159	Alex. Kokoski.....	7.56	2.8	19556	C. Woruncke.....	12.19	4.9
	BERLIN.				HAWLEYVILLE.		
19160	James Balfye.....	10.90	3.5	19368	S. Bonderank.....	8.62	2.7
17389	Alexander Bruce.....	11.35	3.7	19369	S. Bonderank.....	9.12	2.5
17390	Alexander Bruce.....	9.99	3.1	18543	John Oshavett.....	10.12	3.1
17391	Alexander Bruce.....	10.41	3.2		KENSINGTON.		
	BETHANY.			20747	Walter Rudnick.....	10.42	3.4
20532	Kasloski & Nero.....	10.64	3.6		MERIDEN.		
	BETHEL.			21006	Belmont Lunch, T. Chamis	9.69	2.7
19388	E. H. Converse.....	10.94	3.7	17382	D. Marcellino.....	10.86	3.2
	BLOOMFIELD.			17395	D. Marcellino.....	10.58	3.3
20916	T. Ballai.....	10.63	3.2		MILFORD.		
20393	Thomas Seathem.....	11.48	4.2	19410	Chris. Anderson.....	9.79	2.6
20394	Thomas Seathem.....	11.16	3.9	19411	Chris. Anderson.....	9.93	2.8
	BRANFORD.				NEW MILFORD.		
21320	Nick. Dubiago.....	10.86	3.7	19331	John Anderson.....	10.46	3.3
19594	Angello Mongello.....	11.15	3.5	19308	J. Prucknik.....	10.73	3.3
	BRIDGEPORT.				NORWALK.		
20442	Beebe Dairy.....	9.51	2.9	18537	Peter O'Haro.....	11.63	4.1
20523	Beebe Dairy.....	10.38	2.9	18353	M. Roberts.....	8.18	2.9
	BRISTOL.			18354	M. Roberts.....	8.15	2.6
20801	A. Alklis.....	10.73	3.3		NORWICH.		
	CANTON.			21190	George Anderson.....	10.92	3.6
20943	M. Basha.....	10.89	3.5		RIDGEFIELD.		
18328	Mike Mishi.....	11.89	4.1	18563	Jacob Baker.....	12.29	4.4

TABLE XI. ADULTERATED MILK—(Continued).

No.	Dealer	Solids	Fat	No.	Dealer	Solids	Fat
	<i>Containing Added Water</i>				<i>Containing Added Water</i>		
	—continued				—concluded		
	ROCKY HILL.				WOODBURY.		
20362	J. Anulewicz.....	10.34	3.1	20353	F. H. Shaw.....	10.78	3.4
20363	J. Anulewicz.....	11.35	3.6	20356	F. H. Shaw.....	10.59	3.2
20364	J. Anulewicz.....	10.90	3.2		Skimmed Milk.		
20365	J. Anulewicz.....	11.04	3.6		BRIDGEPORT.		
20366	J. Anulewicz.....	10.82	3.5	20436	Beebe Dairy.....	10.91	2.0
20367	J. Anulewicz.....	11.14	3.6		BRISTOL.		
20374	Toney Russell.....	10.97	3.5	21104	Presto Lunch, Peter Blanos	11.19	2.4
	SHELTON.				DANIELSON.		
20426	Joseph Carson.....	10.83	3.3	21150	Harry Evergates.....	10.99	2.6
20427	Joseph Carson.....	11.09	3.5	21088	J. W. Gallup.....	11.47	2.8
20428	James Facendo.....	11.07	3.4		EAST GRANBY.		
	STEPNEY DEPOT.			20902	M. C. Griffin.....	11.14	2.6
19415	Mnozinski.....	11.04	3.7	20903	M. C. Griffin.....	11.16	2.6
19416	Mnozinski.....	10.38	3.3		GOSHEN.		
19417	Mnozinski.....	10.07	3.2	21101	Edward Sailing.....	11.20	3.6
	UNIONVILLE.			19080	S. Oviatt.....	11.34	2.7
	WATERBURY.				HARTFORD.		
20805	Exchange Lunch.....	10.91	3.3	20687	Vermont Lunch.....	10.50	2.0
20807	Puritan Ice Cream Parlor..	10.24	2.7		KENSINGTON.		
	WATERFORD.			20743	Louis Prey.....	12.04	2.9
19265	Joe Verito.....	10.46	3.2		MERIDEN.		
	WETHERSFIELD.			21003	Jack Barkowitz.....	11.31	2.5
20378	Gerrent Bros.....	11.11	3.4	21005	Frank E. Packard.....	10.82	2.2
20395	H. W. Wells.....	10.08	3.4		NEW BRITAIN.		
20396	H. W. Wells.....	10.85	3.5	20731	James Chimoridis.....	9.90	1.6
20397	H. W. Wells.....	10.10	3.0	20735	Hudson Lunch.....	12.04	2.9
20398	H. W. Wells.....	9.62	3.0	20739	Welgner Bros., Hotel Beloin	11.01	2.4
	WEST HARTFORD.				NEW LONDON.		
18304	A. J. Back.....	11.71	4.0	18825	Far East Lunch.....	11.07	2.4
18305	A. J. Back.....	10.62	3.0		ROCKY HILL.		
18306	A. J. Back.....	10.32	3.2	20373	Toney Russell.....	10.71	2.3
18307	A. J. Back.....	11.11	3.5	20360	Fred Suppe.....	10.97	2.6
20985	C. F. Crosson.....	6.72	1.6		STAFFORD SPRINGS.		
	WILLIMANTIC.			21275	Rand Bros.....	11.26	2.5
21017	Walo Andryshawki.....	11.32	3.7		SUFFIELD.		
	WOODBURGE.			20961	A. G. Bissell.....	11.34	2.5
20534	I. Setlow.....	10.27	2.5				
20538	I. Setlow.....	10.15	2.5				

TABLE XI. ADULTERATED MILK—(Concluded).

No.	Dealer	Solids	Fat	No.	Dealer	Solids	Fat
<i>Skimmed Milk—continued</i>				<i>Skimmed Milk—concluded</i>			
THOMPSONVILLE.				WINDSOR LOCKS.			
20975	Geo. Thomas.....	10.89	2.3	20956	Gregory Apostol.....	10.99	2.3
20969	Peter Tenerowicz.....	10.59	2.2	21125	Bridgeview Rest., Thos. Zacheo.....	12.10	3.1
WATERFORD.				WOODBURY.			
19277	John W. Worral.....	10.95	1.9	Joe Baltz.....			
WEST HARTFORD.				18585	Unknown.....	12.32	2.7
20989	E. W. Downs.....	10.39	1.3	21010		11.25	2.6
20996	W. E. Johnson.....	11.19	2.4	<i>Watered and Skimmed.</i>			
20990	R. B. White.....	10.90	2.2	SHELTON.			
WINDSOR.				Alex. Emory.....			
20979	I. W. Hemphill.....	11.28	2.1	20544		9.54	2.1

by inspectors attached to the Dairy and Food Commissioner's Department who have qualified for licenses to test milk and cream. In this way we are often saved the necessity of testing milk of good quality.

Samples found adulterated by reason of watering or skimming or both are summarized in Table XI.

Ninety-eight samples have been submitted by purchasers or producers of which number three were found to be watered.

CREAM.

Twenty-two samples of cream have been examined for purchasers or producers and four to check candidates for tester's license.

CONDENSED MILK AND OTHER MILK PRODUCTS.

Eight samples of various milk products have been examined.

Three samples of condensed milk were found to be of average composition and require no comment.

Two samples of condensed skimmed milk D. C. Nos. 20160 and 20204 were mouldy and unfit for food.

A sample of malted milk, 15976, submitted by Crary Brokerage Co., Waukesha, Wis. was examined as follows:

Moisture 1.90 per cent.; ash 3.78 per cent.; nitrogen 1.42 per cent.; fat 7.60 per cent.; acidity as lactic acid 0.86 per cent.

A sample of milk powder, 16272, contained moisture 4.34 per cent. and fat 3.45 per cent.

Protein milk, 17957, and Modified Buttermilk, 17958, both made by the Beebe Laboratories Inc., St. Paul, Minn. were examined as follows:

No.	17957	17958
Water	86.39%	90.02%
Ash	0.99	0.93
Protein (N x 6.38)	6.20	3.40
Fat	2.78	0.43
Carbohydrates (by diff.)	2.92	4.62 ¹
Acidity, calc. as lactic acid.	0.72	0.60

¹ Starch conversion products present.

Protein Milk, 17957, is stated to be prepared by the formula of Finkelstein and Meyer and to be relatively low in carbohydrate and mineral matter and comparatively high in protein. It is directed to make the contents of the can, 20 ozs., up to 1 quart, hence the composition of the diluted material will be approximately, solids 8.5 per cent., protein 3.9 per cent., fat 1.7 per cent., carbohydrate 1.8 per cent., ash 0.6 per cent. and lactic acid 0.5 per cent. This shows rather more protein and less fat than the diluted material is stated to contain but agrees with the statement as regards lactic acid and carbohydrates. As compared with average whole milk the product is higher in protein and much lower in sugar, as claimed. Mineral matter (ash), is higher than in average whole milk.

Modified Buttermilk, 17958, is stated to be freshly prepared buttermilk combined with carbohydrates consisting of starch and resultant dextrins. This preparation as well as Protein Milk are intended for infant and invalid feeding and both the quantity to be fed and the frequency of feeding are left to the discretion of the physician.

HUMAN MILK.

Thirty samples of human milk have been examined for physicians or for the Visiting Nurse Association. Nurses should bear in mind the necessity of obtaining a representative sample for examination because the fractional parts of the secretion vary in composition. The variation is chiefly with respect to fat so that no adequate idea of the "richness" of breast milk will be obtained unless the entire supply is drawn and well mixed.¹

The composition of milk varies with the species, with individuals of the same species and with the same individual under varied conditions. The average composition of cow's milk can be stated with rather more accuracy than that of human milk on account of the difficulties, in many cases, of obtaining adequate and repre-

¹ Conn. Exp. Sta. Bull. 227, p. 255.

sentative samples of the last named. Authorities will differ as to the exact figures which should be chosen to represent the average composition of the milk of these two species but the following comparison may be taken as illustrating their essential differences.

TABLE XII. AVERAGE COMPOSITION OF COW'S MILK AND HUMAN MILK.

	No. of analyses	Water	Solids	Protein	Fat	Sugar	Ash
		%	%	%	%	%	%
Cow's milk ¹	...	87.4	12.6	3.8	3.6	4.5	0.7
Human milk	200 ²	87.4	12.6	2.3	3.8	6.2	0.3
	94 ³	88.2	11.8	1.5	3.3	6.8	0.2

¹ As stated by S. M. Babcock.

² From König's *Chemie der mens. Nahr. u. Genuss.*, Leach 2d Ed., p. 127.

³ From Richmond, *Dairy Chem.*, London, Leach 4th Ed., p. 113.

It is evident that cow's milk contains more tissue building material, protein and mineral matter, than human milk which is in harmony with the peculiar needs of the first named species, the young of which are born in a relatively more advanced stage of development than is the human being.

Analyses of the samples submitted during the past year are given in Table XIII.

OYSTERS.

Three samples were examined for the Dairy and Food Commissioner. Two of these, 18545 and 18546, were taken from the Thomas Oyster Co. and one, 18547, from the J. P. McNeil Estate, both of New Haven. Sample 18545 had been aerated by means of a mechanical blower, evidently in water of less salt content than that of the original oyster liquor. Samples 18546 and 18547 were shucked oysters not so treated. It is illegal in this state to "sell oysters or other shell-fish which have been subjected to 'floating' or 'drinking' in brackish water, or water containing less salt than that in which they are grown."¹

Analyses are given in Table XIV.

Solids, ash and salt in the drained oysters are distinctly less in 18545 than in the others and the salt content of the liquor is only a small fraction of that found in the original liquor.

TEA.

DETERMINATION OF CAFFEINE.

According to the plan indicated in our report² last year a method for the determination of caffeine in tea, which was devised in this

¹ Conn. Regulation 14.

² Conn. Exp. Sta. Bull. 227, p. 256.

TABLE XIII. ANALYSES OF HUMAN MILK.

No.	Solids %	Protein %	Fat %	Sugar %	Ash %
15843	10.50	1.37	1.20	7.69	0.24
15872	12.76	1.28	3.40	7.84	0.24
15937	.....	.....	3.00	.....	.....
16301	.....	1.46	1.50	.....	.....
16304	.....	1.40	3.60	.....	.....
16379	.....	1.50	2.20	.....	.....
16807	.....	.....	2.80	.....	.....
16854	9.48	.....	1.00	.....	0.17
16876	.....	1.21	2.60	.....	.....
16916	14.17	1.60	5.50	6.83	0.24
16917	.....	1.72	4.60	.....	.....
16990	.....	1.28	3.40	.....	.....
17038	14.10	1.28	6.20	6.38	0.24
17039	15.14	1.28	7.40	6.31	0.15
17055	10.43	1.08	2.60	6.61	0.14
17093	.....	1.28	3.40	.....	.....
17124	9.60	1.25	1.20	6.95	0.20
17514	11.36	0.92	2.80	7.64	0.15
17542	12.60	1.31	3.80	7.28	0.21
17607	12.28	1.32	3.20	7.54	0.22
17614	11.91	1.03	3.40	7.26	0.22
17623	15.60	1.33	5.30	.....	.....
17644	13.42	.....	4.20	8.97 ¹	0.25
17627	13.95	.....	4.80	8.82 ¹	0.33
17650	11.71	1.34	2.20	7.95	0.22
17732	12.15	1.46	5.00	5.43	0.26
17758	11.45	1.79	2.20	7.19	0.27
17767	11.95	.....	2.66	9.16 ¹	0.13
17920	.....	1.27	3.80	.....	.....
17922	11.06	1.28	2.20	7.31	0.27

¹ Protein included.

TABLE XIV. ANALYSES OF OYSTERS.

D. C. No.	18545	18546	18547
Net weight of sample, grams	463.8	474.4	478.0
Weight of liquor, grams	34.7	128.7	110.5
Weight of drained oysters, grams	429.1	345.7	367.5
Loss on boiling drained oysters, per cent	49.79	40.93	43.30
Solids in drained oysters, per cent	16.10	22.13	20.65
Ash in drained oysters, per cent	1.06	2.41	2.24
Solids in liquor, per cent	4.15	5.22	5.16
Ash in liquor, per cent	0.60	2.48	2.32
Salt (NaCl) in oysters, per cent	0.05	0.68	0.73
Salt (NaCl) in liquor, per cent	0.24	1.92	1.81

laboratory, has been studied collaboratively and the results have been summarized elsewhere by Mr. Andrew.¹ An abstract of his report is given here.

¹ Report of R. E. Andrew, Referee on Tea, Assoc. Official Agricultural Chemists, Washington, Oct., 1921.

COLLABORATION.

Samples were sent to ten different chemists who expressed their willingness to cooperate. Reports were received from Mr. Henry Lepper, Bureau of Chemistry; Mr. W. S. Hubbard, who reported analyses by Mr. Charles A. Herrmann, Bureau of Chemistry, New York Station; Dr. I. K. Phelps, Food Control Laboratory, Bureau of Chemistry, who reported analyses by Miss Dorothy B. Scott, Miss Lillian Offutt and Mr. J. I. Palmore; Mr. L. E. Walter, Laramie, Wyoming, who reported results obtained by Mr. Harold R. Baker, Asst. State Chemist.

INSTRUCTIONS TO COLLABORATORS.

Three samples were used, viz., I Green Tea, II Black Tea, III Mixture of Green and Black Teas. Each sample was finely ground and well mixed. Sub-samples were sent to each collaborator with the following instructions:

Determine caffeine in each of the samples by the following methods:—

MODIFIED STAHLSCHMIDT METHOD.

Weigh 3.125 grams of the finely powdered sample into a 500 cc. flask, add 225 cc. of water (this volume will be reduced to about 200 cc. by boiling), attach a reflux condenser and boil for 2 hours. Add 2 grams of dry basic lead acetate and boil 10 minutes. Cool, transfer to a 250 cc. graduated flask, fill to the mark, filter through a dry filter, measure 200 cc. of the filtrate into a 250 cc. graduated flask and pass hydrogen sulphid through to remove the excess of lead. Make the solution up to the mark and filter through a dry filter. Measure 200 cc. of this filtrate into an evaporating dish and concentrate to about 40 cc. Wash the concentrated solution with as little water as possible into a small separatory funnel and shake out six times with chloroform, using 25, 20, 15, 10, 10, 10 cc., respectively, combining the several extracts in a second separatory funnel. Treat the combined extracts with 5 cc. of 1 per cent. potassium hydroxide, allow the liquids to separate and draw off the chloroform. Wash the aqueous solution in the separatory with chloroform, in two portions of 10 cc. each adding these washings to the main extract. Distill off most of the solvent, transfer to a small tared flask, evaporate, dry at 100° C. and weigh. Test the purity of the residue by determining nitrogen therein and calculate caffeine by the factor 3.464.

POWER-CHESNUT METHOD.

Extract 10 grams of material for 8 hours in a Soxhlet apparatus with hot 95 per cent. alcohol. Add the alcoholic extract to a suspension of 10 grams of heavy magnesium oxide in 100 cc. of water, rinse the flask with a little hot water and add rinsings to the mixture. Allow the mixture to evaporate slowly on a boiling water bath, with frequent stirring, until the alcohol is removed and a nearly dry, powdery mass is obtained. Transfer the mass to a smooth filter by means of a sufficient amount of hot water, cleaning the container thoroughly. Wash the material on the filter with

successive portions of hot water until the filtrate measures 250 cc. Add 10 cc. of 10 per cent. sulphuric acid to the filtrate contained in a flask of suitable size, place a funnel in the neck of the flask, boil cautiously until danger of frothing is passed and continue active boiling for one half hour. Allow the solution to cool and filter into a separatory funnel through a double moistened filter and wash the flask and filter with small portions of 0.5 per cent. sulphuric acid. Shake the clear acid filtrate with 6 successive 25 cc. portions of chloroform, collecting the several extracts in a second separatory funnel. Treat the combined chloroform extracts with 5 cc. of 1 per cent. solution of potassium hydroxide and allow the chloroform to completely subside. Draw off the chloroform into a suitable flask, filtering through a dry paper or pledget of cotton inserted in the stem of the separatory funnel. Wash the alkaline liquid remaining in the separatory with two portions of chloroform, also washing the filter if used, and unite the washings with the main bulk of chloroform solution. Distill the solvent to small volume, transfer to a tared beaker, evaporate to dryness, further dry for one hour at 100° C., cool and weigh.

To test the purity of the residue determine nitrogen therein and calculate caffeine by the factor 3.464.

PROPOSED METHOD.

To 5 grams of material in a 500 cc. graduated flask add 10 grams of heavy magnesium oxide and 200 cc. of distilled water. Boil gently over a low flame for two hours using a small bore glass tube 30 inches long as a condenser. Cool, dilute to volume and filter through a dry paper. Take an aliquot of 300 cc., equivalent to 3 grams of original material, in an Erlenmeyer flask of 1000 cc. capacity, add 10 cc. of 10 per cent. solution of sulphuric acid and boil until the volume is reduced to about 100 cc. Filter into a separatory funnel, washing the flask with small portions of 1 per cent. sulphuric acid and shake out six times with chloroform using 25, 20, 15, 10, 10, 10 cc. portions. Treat the combined extracts with 5 cc. of a 1 per cent. solution of potassium hydroxide. When the liquids have completely separated draw off the chloroform layer into a suitable flask or beaker. Wash the alkaline solution in the separatory with two portions of chloroform of 10 cc. each and unite the washings with the main bulk, transfer to a tared flask, evaporate to dryness and further dry in a water oven at 100° C. to constant weight.

If desired, transfer the residue thus obtained to a digestion flask with successive small portions of sulphuric acid and determine nitrogen by the Kjeldahl method. Calculate caffeine from nitrogen by the factor 3.464.

NOTES ON METHODS.

Results for caffeine *by weight* and *from nitrogen* are desired.

In the Power-Chesnut method extraction should be continued until the extract is colorless. The heavy magnesium oxide used should meet the United States Pharmacopoeia requirements.

Evaporation of the last portion of solvent from the caffeine should be done carefully to prevent loss by spattering.

If the results by all methods outlined cannot be obtained those by the Modified Stahl Schmidt and proposed methods are particularly desired.

RESULTS OF COLLABORATIVE WORK.

The results obtained by the various collaborators are given in Table XV.

TABLE XV. CAFFEINE IN TEA.

Analyst	Sample I.					
	Modified Stahlshmidt		Power-Chesnut		Proposed	
	Method. Caffeine by weight.	from N.	Method. Caffeine by weight.	from N.	Method. Caffeine by weight.	from N.
Henry A. Lepper, Bureau of Chemistry	1.97	1.97	2.09	1.98	2.10	1.92
	....	....	2.05	1.99	2.11	1.92
Dorothy Scott, Food Control Laboratory, Bureau of Chemistry.	2.30	1.60	2.09	1.93	2.38	2.05
	2.02	1.65	1.85R	1.79	2.14	1.96
Lillian Offutt, Food Control Laboratory, Bureau of Chemistry.	2.10	1.63	2.36	2.09	2.08	1.65
	2.00	1.55	2.34K	2.15	2.00	1.85
J. I. Palmore, Food Control Laboratory, Bureau of Chemistry.	2.33	1.94	2.15	....	2.20	2.02
	2.19	1.81	2.16S	....	2.29	2.02
Harold R. Baker, Asst. State Chemist, Laramie, Wyoming.	2.63	1.73	....	....	1.96	1.63
	2.32	1.73	....	....	2.15	1.68
	2.17	1.82	....	....	2.33	1.73
Charles A. Herrmann, Bureau of Chemistry, New York Station.	2.23	2.25	....	....	2.34	2.25
R. E. Andrew, Agricultural Exp. Station, New Haven, Conn.	2.18	2.08	2.33	2.25	2.20	2.16
	2.19	2.08	2.34	2.26	2.25	2.17
	....	....	....	....	2.20	2.15
	....	....	....	....	2.20	2.15
Analyst	Sample II.					
	Modified Stahlshmidt		Power-Chesnut		Proposed	
	Method. Caffeine by weight.	from N.	Method. Caffeine by weight.	from N.	Method. Caffeine by weight.	from N.
Henry A. Lepper, Bureau of Chemistry.	2.25	2.16	2.15	2.06	2.29	2.10
	....	....	2.24	2.17	2.31	2.16
Dorothy Scott, Food Control Laboratory, Bureau of Chemistry.	2.17	1.65	2.49R	2.32	2.35	2.14
	2.03	1.75	....	....	2.19	2.15
Lillian Offutt, Food Control Laboratory, Bureau of Chemistry.	2.16	1.75	2.55	....	....	....
	2.10	1.58	2.37K	2.21	2.20	2.13
J. I. Palmore, Food Control Laboratory, Bureau of Chemistry.	2.56	1.99	2.32	2.20	2.37	2.22
	2.39	2.02	2.33S	2.21	2.28	2.12
	....	....	2.38	2.21	2.22	2.05
	....	....	2.35R	2.20	2.50	2.23
Harold R. Baker, Asst. State Chemist, Laramie, Wyoming.	2.28	1.78	....	....	2.36	1.97
	2.29	1.68	....	....	2.39	....
	2.28	1.92	....	....	2.40	1.97
R. E. Andrew, Agricultural Exp. Station, New Haven, Conn.	2.28	2.25	2.52	2.42	2.38	....
	2.29	2.22	2.46	2.37	2.40	2.30
	....	....	....	....	2.39	2.33
	....	....	....	....	2.40	2.33

TABLE XV. CAFFEINE IN TEA.--(Concluded).

Analyst	Sample III.					
	Modified Stahlshmidt		Power-Chesnut		Proposed	
	Method. Caffeine by weight.	from N.	Method. Caffeine by weight.	from N.	Method. Caffeine by weight.	from N.
Charles A. Herrmann, Bureau of Chemistry, New York Station.	2.45	2.42	....	....	2.56	2.54
R. E. Andrew, Agricultural Exp. Station, New Haven, Conn.	2.43	2.37	2.49	2.44	2.53	2.51
	2.43	2.39	2.39	2.32	2.53	2.52

K Modified Knorr Extractor used.
R Rask Extractor used.
S Soxhlet Extractor used.

DISCUSSION OF RESULTS.

The experience with these three methods was summarized by the referee¹ last year as follows:

"The results obtained by the proposed method are in close agreement with those obtained by the other two methods and the caffeine residues are of an equal degree of purity. The time required is very much less than in either of the other procedures." The average difference between results for caffeine by weight and from nitrogen was considerably under 0.1 per cent. and practically the same in all methods.

The results this year show satisfactory agreement as regards results for caffeine by weight but too wide discrepancies between these figures and the corresponding results estimated from nitrogen. The trouble quite evidently lies in the determination of caffeine nitrogen, but why this should be at all troublesome, or why it should be more so in case of the Stahlshmidt method than in the other methods, is difficult to understand. An allowance of 0.1 per cent. for experimental error in determining nitrogen (equivalent to 0.35 per cent. caffeine), is a very liberal tolerance and about twice as great as is generally necessary; nevertheless, excluding only those figures for caffeine from nitrogen which vary from caffeine by weight by more than 0.35 per cent. the averages for the three samples become as follows:

¹ Report of the Referee on Tea to the A. O. A. C., 1920.

TABLE XVI. SUMMARY OF CAFFEINE DETERMINATIONS IN TEA.

Sample No.	Modified Stahlshmidt Method.		Power-Chesnut Method.		Proposed Method.	
	by weight.	from N.	by weight.	from N.	by weight.	from N.
I	2.20	2.04	2.18	2.06	2.18	2.02
II	2.26	2.10	2.38	2.24	2.34	2.19
III	2.44	2.39	2.44	2.38	2.54	2.53

In computing this summary no figures reported by the Power-Chesnut method have been excluded. Of results reported by the proposed procedure only five have been excluded. It was necessary to exclude sixteen of the 28 results reported by collaborators by the Stahlshmidt method, as it is manifestly unfair in this case to recognize results which vary from the results by weight to the extent of from 0.5 to nearly 1 per cent. since it is evident that the results by weight are in satisfactory accord with the other two methods and there are ample data to show that the method will yield a caffeine residue of equal purity. The summary given is reasonably fair to all methods although it will be noted that the Power-Chesnut method gains by the fact that reports are less complete by that method than by the other two. If all figures reported had been included in the averages reported in the summary the only conspicuous change would occur in the results for caffeine from nitrogen in samples I and II by the Stahlshmidt method.

The accumulated data of the past two years show that the proposed method compares satisfactorily with the other two methods both as regards the gross amount of caffeine obtained and the degree of purity of the caffeine residues. In the opinion of all collaborators it is simpler to manipulate, requires less time than the Stahlshmidt method, and in the opinion of some it is superior to the Power-Chesnut method. The referee, however, made the second recommendation that the Power-Chesnut method as herein described, except that in line 10 the wording be changed to read 20 cc. of 10 per cent. sulphuric acid instead of 10 cc. of 10 per cent. sulphuric acid, be made official for the determination of caffeine in tea; and made a first recommendation that the proposed method for the same determination also be made official. Both recommendations were adopted.

VINEGAR.

Thirteen samples were submitted by the Dairy and Food Commissioner, four of which failed to meet the legal requirements. Three samples, 20777, 20778 and 20778A, were sent for examina-

tion in connection with a peculiar growth which formed on the top of pickles in which this vinegar had been used. The growth was referred to the Department of Botany of this station and found to be a dense growth of bacteria zoogloea. The infection is thought to have come from the pickles but experimental inoculations of this and other vinegars indicated that this particular vinegar offered especially favorable conditions for growth, the exact cause of which has not been determined.

Of eight samples sent by individuals three were found to be below the standard required in this state.

MISCELLANEOUS MATERIALS.

FOODS, ETC.

Twenty samples of this class have been examined for individuals and for the Dairy and Food Commissioner. They require no particular comment.

D. C. No. 20161. *Baked Beans, Diamond Brand*, were found wholesome and fit for food as far as organoleptic tests could discover.

17473. *Blackberry Preserves*, showed gas formation, had a sour taste and were judged unwholesome.

16313. *Cherries, Maraschino*, were analyzed as follows:

Solids 52.63 per cent.; invert sugar 11.48 per cent.; sucrose 38.22 per cent.; ash 0.17 per cent.; undetermined 2.67 per cent.

The liquor and drained cherries were analyzed separately and the above composite analysis calculated. The cherries were colored with a permitted dye, erythrosin, and no alcohol, saccharin, salicylic or benzoic acids or sulphites were found.

16294. *Crullers*, sugared, were analyzed as follows:

Moisture 21.80 per cent.; ash 1.42 per cent.; protein (N x 6.25) 5.88 per cent.; fat 21.23 per cent.; carbohydrates, by difference, 49.67 per cent.

16757. *Les Fruits*. This is a fruit paste to be used as a laxative food. It contained:

Moisture 31.41 per cent.; ash 3.11 per cent.; protein (N x 6.25) 3.12 per cent.; ether extract (crude fat) 2.26 per cent.; total sugars, as invert sugar 48.40 per cent.; undetermined nitrogen-free extract 6.99 per cent. Emodin-bearing drugs present.

D. C. No. 20205. *Peaches*, canned, were found to be wholesome and fit for food. Another sample 17470, V-W Brand, was fermented and the can sprung by gas pressure.

16302. *Purslain*, canned, prepared by Mrs. John Haberle, New Haven was examined as follows:

Moisture 91.68 per cent.; ash 1.76 per cent.; protein (N x 6.25) 1.12 per cent.; fiber 1.19 per cent.; ether extract 0.35 per cent.; nitrogen-free extract, by difference 3.90 per cent.

Chemical analysis alone is not very illuminating. The product is said to possess antiscorbutic properties, which, of course, no chemical analysis can demonstrate.

Other samples include sugar, flour, canned spinach, canned peas, wine, beer, whiskey and water and require no particular comment.

MATERIALS EXAMINED FOR POISONS, ETC.

Thirty-one samples were examined for poisonous, injurious or illegal substances as follows:

No. of samples.	Kind of Material.	Remarks.
1	Bread.	Moulds present.
8	Candy.	No poisons detected.
		Alcohol 0.4 per cent. in one sample.
1	Canning compound.	Borax present.
4	Chicks, viscera of	No poison detected.
1	Corn.	No poison detected.
1	Coffee.	No poison detected.
1	Deposit in engine.	Aluminum powder.
1	Ginger extract.	Capsicum present.
1	Goose, viscera of	Pins, nails, staple, bits of brass in gizzard.
1	Lumps in flour.	Not identified.
2	Soils.	No poison detected.
5	Stomach contents.	No poison detected.
3	Urine, for lead.	No lead detected.
1	Wine.	Traces of tin and zinc.

II. DRUGS.

PROPRIETARY REMEDIES, ETC.

Five preparations of this class have been examined.

15668. *Dr. True's Elixir*, a family laxative and worm expeller, made by Dr. J. F. True & Co., Auburn, Me. and Knowlton, Que. Examination and analysis showed the following composition:

Alcohol 7.90 per cent. by volume; solids 45.0 grams per 100 cc.; flavor wintergreen; santonin none; spigelia indicated; emodin-bearing drugs present, aloes identified.

This is a syrup containing vegetable laxatives. A previous examination¹ of this remedy showed the presence of santonin which has apparently been replaced by spigelia.

15670. *Russell Emulsion*, made by the Standard Emulsion Co., New York. This preparation is said to be made of equal parts of

¹ Conn. Exp. Sta. Report 1914, p. 254.

beef suet, cocoanut, peanut and cottonseed oils with clove oil to flavor and less than $\frac{3}{4}$ of 1 per cent. of sodium borate as a preservative.

Examination and analysis showed the following composition:

Solids 47.45 per cent.; ash 1.74 per cent.; fats 39.11 per cent.; constants of fat, refractive index 1.4613, Riechert-Meissel No. 9.4; cottonseed oil present; boric acid 0.32 per cent.; oil of cloves present.

The declared composition is practically substantiated by the analysis. No test was made for peanut oil but cottonseed and cocoanut oils are indicated. Sodium borate is illegal when used as a preservative in foods¹ but its use in drugs is probably within the law.

15669. *Milks Emulsion*, made by the Milks Emulsion Co., Terre Haute, Ind.

Examination and analysis showed the following composition:

Solids 95.43 per cent.; fat, unsaponifiable, 94.00 per cent.; glycerin, small amount indicated; wild cherry not identified; oil of wintergreen present.

This analysis essentially confirms advertising literature which states that the product is composed of about 95 per cent. of petroleum oil with vegetable oils, glycerin and wild cherry syrup.

D. C. No. 18396. *Medicine* submitted by the Dairy and Food Commissioner. It is not sold as a proprietary remedy and there is no advertising literature available. The medicine was purchased as a cure for tuberculosis and the purchaser claims that a cure was effected. The preparation was a syrup containing alcohol, chloroform and unidentified vegetable extractives. Opium alkaloids and emodin-bearing drugs were not detected. The label bore no claim of curative properties.

D. C. No. 16330. Phosphorated Iron, distributed by the Iron Remedy Co., Fort Wayne, Ind. These were sugar-coated pills in which iron and phosphates were the only medicaments detected.

UNITED STATES PHARMACOPOEIA OR NATIONAL FORMULARY PREPARATIONS.

All samples discussed in this section were submitted by the Dairy and Food Commissioner unless otherwise stated.

BAY RUM.

Bay Rum, or Spirit of Myrcia, was formerly an official preparation of the United States Pharmacopoeia. These names are used synonymously in the 3d edition of the National Formulary but in the 4th edition the title Compound Spirit of Myrcia appears and the name Bay Rum has been dropped. The formula, however,

¹ Regulation 7.

remains substantially the same, the finished product containing about 58 per cent. of alcohol by volume. The preparation is held to be fit for beverage purposes under Federal Prohibition Regulations¹ and for this reason we find many samples marked to indicate that they have been medicated with tarter emetic or otherwise to make them non-drinkable.

Twenty-four samples were examined. The inspection was made primarily with reference to the possible presence of wood alcohol but that substance was not found in any case. A large proportion of the samples were deficient in grain alcohol, nineteen falling short of the standard or declared alcohol content by more than 10 per cent.

TINCTURE OF BELLADONNA LEAVES.

This preparation should contain in 100 mls not less than 0.027 gram nor more than 0.033 gram of the total alkaloids of belladonna leaves.²

Nine samples were examined. All were found to be of standard strength or within reasonable limits thereof.

TABLE XVII. ASSAYS OF TINCTURE OF BELLADONNA.

D. C. No.	City or Town	Dealer	Alkaloids of belladonna, gm. per 100 cc.
19428	Derby	Prudy Drug Co.	0.025
20134	Hartford	Sisson Drug Co.	0.027
20126	Middletown	Hartman Drug Co.	0.029
19700	New Britain	L. K. Liggett Co.	0.027
20210	New Haven	Est. of J. A. Hodgson	0.025
19715	Thompsonville	Geo. R. Steele, Est.	0.026
20185	Unionville	Paul Flynn	0.025
20170	Waterbury	Apothecaries Hall Co.	0.035
20111	Willimantic	Cartier, The Druggist	0.032

BELLADONNA LEAVES (POWDER).

Belladonna leaves should yield not less than 0.3 per cent. of total alkaloids and not over 20 per cent. of ash.³

One sample, 19641, was examined which was not excessive in ash but was deficient in alkaloids, containing only 0.17 per cent. or 56.6 per cent. of the required amount.

MILK OF BISMUTH.

The official preparation of Bismuth Magma contains not less

¹ Bureau of Int. Rev., Regulations 60, p. 36.

² U.S.P. IX, p. 448.

³ U.S.P. IX, p. 72.

than 5.6 per cent. nor more than 6.2 per cent. of bismuth trioxide, Bi_2O_3 .¹

Ten samples were submitted which assayed as shown in Table XVIII.

TABLE XVIII. ASSAYS OF MILK OF BISMUTH.

D. C. No.	City or Town	Dealer or Manufacturer	Per cent. Bi_2O_3 , min. required or declared	found
20179	Meriden	Louis Liggett (Park Davis)	5.6	6.6
19421	Naugatuck	Carl G. Olson (Park Davis)	5.6	6.8
19702	New Britain	L. K. Liggett Co. (Park Davis)	5.6	6.8
20494	New London	James' Drug Store	5.6	6.4
19432	Shelton	E. J. Barden (Lilly)	5.6	3.7
19621	So. Manchester	J. H. Quinn & Co. (Lilly)	3.35	3.8
19631	Stafford Springs	D. H. McCormick (Park Davis)	5.6	6.9
19717	Thompsonville	Geo. R. Steele, Est. (Lilly)	3.35	3.8
20188	Unionville	Albert C. Roby (Lilly)	5.6	3.7
20106	Willimantic	Bay State Drug Co. (Park Davis)	5.6	6.0

The products examined are not of the druggists' own manufacture except possibly in one case, and the amount of bismuth present is somewhat in excess of the maximum amount named in the official specifications in most cases. Two of the Lilly products are stated to contain 3.35 per cent. bismuth trioxide and it is probable that the other samples of this make are intended to be of the same strength, but the samples as sold have no declaration of the fact and were therefore presumed to be of standard quality, hence arises what is probably only an apparent deficiency.

SOLUTION OF CALCIUM HYDROXIDE (LIME WATER).

This preparation is a solution containing not less than 0.14 per cent. of calcium hydroxide, $\text{Ca}(\text{OH})_2$, at 25° C.²

Sixty-nine samples were examined and twelve were found to be deficient by substantial amounts. Assays are given in Table XIX.

TINCTURE OF COLCHICUM SEED.

One hundred mls of this tincture are required to contain not less than 0.036 gram nor more than 0.044 gram of colchicine.³

Two samples, 19438, from Goulden's Pharmacy, Stamford, and 19430, from F. G. Stanford, Shelton, contained 0.03 gram and 0.04 gram of colchicine respectively.

¹ U.S.P. IX, p. 260.

² U.S.P. IX, p. 239.

³ U.S.P. IX, p. 453.

TABLE XIX. ASSAYS OF LIME WATER.

D.C.No.	City or Town	Dealer	Calcium Hydroxide per cent.
20479	Bethel	English's Drug Store	0.06
20218	Branford	Branford Pharmacy	0.13
20215		Spalding Co.	0.03
20412	Bridgeport	Kaesmann Drug Store	0.16
19743	Bristol	Madden Drug Store	0.15
19745		Rickman's Economy Drug Store	0.15
19740		Leroy P. Tucker	0.17
20323	Central Village	H. Elmer Lewis	0.16
20128	Cromwell	Geo. F. Chapin Est.	0.16
20464	Danbury	Burns' Drug Store	0.16
20474		Doran's Drug Store	0.16
20468		Kenner & Benjamin	0.12
20319	Danielson	Burrough's Drug Store	0.17
20316	Dayville	Wm. E. LaBelle	0.14
19734	East Hartford	O'Connell Drug Co.	0.17
20483	Fairfield	The Boyle Pharmacy	0.10
20486		Randall's Pharmacy	0.17
20158	Hartford	Frank L. Palmer	0.17
20140		Sisson Drug Co.	0.15
20184	Meriden	M. P. Forcier	0.15
20176		Louis Liggett	0.16
20182		Pinks Pharmacy	0.13
20122	Middletown	Lincoln's Drug Store	0.16
20239	Milford	J. H. Barnes	0.05
20240		John Howes	0.14
20305	Mystic	Mystic Pharmacy	0.17
20487	New Haven	Coburn's Drug Store	0.16
20195		T. P. Gillespie & Co.	0.05
20203		Horowich & Son	0.21
20222		Deegan-Hope Drug Co.	0.17
20199		Spalding Drug Co.	0.14
20207		Taft Pharmacy	0.16
20225		Visel & Kennedy	0.16
20219		Wood's Drug Store	0.04
20496	New London	L. P. Desmarais	0.16
20491		Starr Bros.	0.01
20235	New Milford	Albert Evitts	0.03
20232		W. N. Noble	0.17
20300	Noank	Wm. M. Hill, M.D.	0.05
20480	Norwalk	Devine & Hardwick Co., Inc.	0.16
20482		H. Glendening & Co.	0.16
20332	Norwich	Smith Pharmacy	0.15
20325	Plainfield	Edmond Mercier	0.16
20102	Plainville	Geo. R. Byington	0.15
20119	Portland	C. E. Blodgett	0.16
20310	Putnam	Edward H. Burt	0.17
20313		James F. Donahue	0.12
20311		Geo. E. Dresser	0.13
19644	Rockville	Thomas' Pharmacy	0.14
19747	Southington	Chafee's Drug Store	0.16
20462	South Norwalk	L. K. Liggett Co.	0.13
20458		H. A. Mead	0.16
20301	Stonington	Burch's Drug Store	0.15
20247	Stratford	F. B. Brill	0.16
20243		Wm. H. St. John & Co.	0.14
20155	Thomaston	Pickett Drug Co.	0.16
20148	Torrington	Claxton's Pharmacy	0.16
20150		Collins & Collins	0.15
20187	Unionville	Paul Flynn	0.09

TABLE XIX. ASSAYS OF LIME WATER—(Concluded).

D.C.No.	City or Town	Dealer	Calcium Hydroxide, per cent.
19726	Wallingford	Wallingford Drug Co., Inc.	0.16
20169	Waterbury	Apothecaries Hall Co.	0.04
20162		H. W. Lake Drug Co.	0.15
20191	West Hartford	Allen B. Judd Co.	0.13
20418	West Haven	Home Drug Store	0.16
19441	Westport	Westport Drug Co.	0.19
20131	Wethersfield	W. T. Eagan	0.16
20117	Willimantic	Wilson Drug Co.	0.01
20115		Chas. de Villers	0.17
20142	Winsted	John A. Williams	0.16

TINCTURE OF FERRIC CHLORIDE.

This preparation is required to contain not less than 4.48 per cent. of iron (Fe).¹

Eighteen samples were submitted and all were found to be of standard quality or within reasonable limits thereof.

TABLE XX. ASSAYS OF TINCTURE OF FERRIC CHLORIDE.

D. C. No.	City or Town	Dealer	Iron (Fe), per cent.
20216	Branford	Spalding Co.	4.65
19444	Bridgeport	Hindle's Drug Store	4.38
20402	Clinton	Chas. B. Hull	4.78
20467	Danbury	Kenner & Benjamin	4.75
20308	Groton	C. S. Woodhull Davis	5.11
20489	New Haven	Coburn's Drug Store	4.76
20211		Est. J. A. Hodgson	6.52
20209		Taft Pharmacy	4.42
20221		Visel & Kennedy	4.35
20498	New London	Nichols & Harris Co.	4.76
20230	New Milford	Park Pharmacy	4.54
20236		Albert Evitts	4.76
20334	Norwich	James C. Mara	4.26
20461	South Norwalk	L. K. Liggett	4.32
20450		Plaisted Drug Store	5.45
20248	Stratford	F. B. Brill	4.53
20244		H. H. St. John & Co.	4.32
20302	Stonington	C. T. Brayton & Co.	4.90

SYRUP OF FERROUS IODIDE.

The official preparation is a syrupy liquid containing not less than 4.75 per cent. nor more than 5.25 per cent. of ferrous iodide (FeI₂).²

Six samples were examined two of which were somewhat less than the minimum strength required but the deficiency was less than 10 per cent.

¹ U.S.P. IX, p. 454.² U.S.P. IX, p. 429.

TABLE XXI. ASSAYS OF FERROUS IODIDE.

D. C. No.	City or Town	Dealer	FeI ₂ , per cent.
19443	Bridgeport.....	John Clampet Drug Store.....	5.30
20409		Laity Bros.....	4.41
20208	New Haven.....	Taft Pharmacy.....	4.38
20220	New Milford.....	Park Pharmacy.....	4.79
20338	Norwich.....	Lee & Osgood.....	5.19
20452	South Norwalk..	Plaisted Drug Store.....	4.84

SYRUP OF HYDRIODIC ACID.

One hundred mls of this preparation are required to contain not less than 1.3 grams nor more than 1.45 grams hydriodic acid (HI).¹ The solution when fresh is colorless or straw-colored; solutions which are orange colored or darker have deteriorated.

Sixteen samples have been examined. Three were deficient, one conspicuously so being only 59.2 per cent. of the minimum requirement, while the other two were 91 per cent. and 86 per cent. of minimum standard strength.

TABLE XXII. ASSAYS OF SYRUP OF HYDRIODIC ACID.

D. C. No.	City or Town	Dealer	HI, gram per 100 cc.
19426	Ansonia.....	E. B. Schoonmaker.....	1.43
20473	Danbury.....	Doran's Drug Store.....	1.52
20157	Hartford.....	Frank L. Palmer.....	1.18
20124	Middletown.....	Hartmann Drug Co.....	1.28
19649	New Britain.....	L. K. Liggett Co.....	1.50
20223	New Haven.....	Deegan-Hope Drug Co.....	1.12
20206		Taft Pharmacy.....	1.43
20495	New London.....	James' Drug Store.....	1.50
20226	New Milford.....	Park Pharmacy.....	1.52
19642	Rockville.....	Thomas' Pharmacy.....	1.47
19622	So. Manchester..	J. H. Quinn & Co.....	1.49
19630	Stafford Springs..	D. H. McCormick.....	1.47
19635		Ethel H. Wikes.....	1.41
19435	Stamford.....	Sherwood Drug Store.....	1.47
19716	Thompsonville..	Geo. R. Steele Est.....	1.48
19721	Wallingford.....	Wallingford Drug Co., Inc.....	0.77

TINCTURE OF IODINE.

The official tincture contains in 100 mls not less than 6.5 grams nor more than 7.5 grams of iodine and not less than 4.5 grams nor more than 5.5 grams of potassium iodide.²

Thirty-five samples were examined and all were satisfactory except one sample, 20407, which was about 14 per cent. too low in iodine and contained 18 per cent. too much potassium iodide indicating careless preparation.

¹ U.S.P. IX, p. 427.² U.S.P. IX, p. 457.

TABLE XXIII. ASSAYS OF TINCTURE OF IODINE.

D. C. No.	City or Town	Dealer	Grams per 100 cc.	
			I	KI
20213	Branford.....	T. D. Williams.....	7.0	5.0
20413	Bridgeport.....	European Pharmacy.....	6.7	5.1
20407		H. A. Scanton.....	5.6	6.5
20410		Wolf-Heiman.....	6.8	4.9
19746	Bristol.....	Rickman's Economy Drug Store..	6.9	5.3
19739		Leroy P. Tucker.....	6.6	4.8
20471	Danbury.....	Northrop's Drug Store.....	7.1	5.1
20322	Danielson.....	Woodward's Drug Store.....	7.5	5.3
19736	East Hartford..	W. B. Noble.....	6.8	4.5
19733		O'Connell Drug Co.....	7.2	5.1
19729	Glastonbury.....	People's Pharmacy.....	6.9	4.8
20159	Hartford.....	Frank L. Palmer.....	6.5	4.6
20138		Sisson Drug Co.....	6.9	5.4
20327	Jewett City.....	Chas. R. Carey.....	7.3	5.3
20328		J. P. Gorman.....	7.3	5.3
20121	Middletown.....	Lincoln's Drug Store.....	6.8	5.4
20488	New Haven.....	Coburn's Drug Store.....	7.4	5.1
20201		Spalding Drug Co.....	6.9	5.0
20492	New London....	United Chemists.....	7.2	5.3
20237	New Milford....	Albert Evitts.....	6.9	5.0
20233		W. N. Noble.....	6.8	5.1
20329	Norwich.....	G. G. Engler.....	7.5	5.6
20455	South Norwalk..	Harold A. Mead.....	6.6	4.7
20245	Stratford.....	Wm. H. St. John & Co.....	7.4	5.2
20154	Thomaston.....	Pickett Drug Store.....	7.8	4.6
20189	Unionville.....	Albert Roby, Druggist.....	7.1	5.1
19725	Wallingford.....	Wallingford Drug Co.....	7.3	5.5
20164	Waterbury.....	H. W. Lake Drug Co.....	7.4	4.2
20401	Westbrook.....	J. W. Neidlinger.....	7.1	5.2
20417	West Haven.....	Silver Drug Corp.....	6.6	4.5
19440	Westport.....	Bridge Pharmacy.....	7.0	5.1
20109	Willimantic.....	Bay State Drug Co.....	6.9	6.6
20113		Cartier, The Druggist.....	7.2	5.5
20144	Winsted.....	Bannon's Drug Store.....	6.8	4.0
20143		John A. Williams.....	6.8	5.1

IPECAC.

The official dried root contains not less than 1.75 per cent. of the ether-soluble alkaloids of ipecac.¹

Four samples were examined and found to conform substantially to the required standard.

TABLE XXIV. ASSAYS OF IPECAC.

D. C. No.	City or Town	Dealer	Ether-soluble alkaloids, per cent.
19429	Derby.....	Alfonso Indocci.....	1.63
19640	Rockville.....	Thomas' Pharmacy.....	1.92
19623	So. Manchester..	J. H. Quinn & Co.....	2.07
19632	Stafford Springs..	D. H. McCormick.....	1.73

¹ U. S. P. IX, p. 229.

CHLORINATED LIME. (CHLORIDE OF LIME).

This product is made by treating calcium hydroxide with chlorine and should contain not less than 30 per cent. of available chlorine.¹ It is directed to be preserved in air-tight containers and kept in a cool, dry place.

Eight samples were examined representing, however, but three brands. None were found to be of standard strength. Four were approximately one-half strength, two were about two-thirds strength and two were three-fourths strength. It is probable that, as first packed, the products contained the full amount of available chlorine but it is well known that they will deteriorate with access of air. The samples were obtained in original containers none of which could be said to be air-tight, but sealed by means of circular covers fitted into the cans by pressure. The general use of this material as a disinfectant makes it the more important that it should be used as fresh as possible and the purchaser should understand that, once opened, the contents does not remain efficient indefinitely.

The samples were assayed by the method as described in the Pharmacopoeia. To gain some idea of the rate of deterioration duplicate assays were made about 7 weeks subsequent to the first examination with the results shown in Table XXV.

TABLE XXV. ASSAYS OF CHLORINATED LIME.

D. C. No.	City or Town	Dealer	Brand	Available Chlorine per cent.	
				First assay	Second assay (7 weeks later)
19425	Ansonia.....	Bristol Drug Co.....	Acme.....	13.9	11.0
20190	Farmington.....	S. J. Adgate.....	Acme.....	23.2	21.8
19645	New Britain....	L. K. Liggett Co.....	Hudson..	14.5	14.1
19616	So. Manchester..	J. H. Quinn & Co.....	Acme.....	15.8	13.4
19627	Stafford Spgs...	D. H. McCormick.....	Acme.....	15.1	13.8
19711	Thompsonville..	Geo. R. Steele Est.....	Acme.....	21.0	19.5
19707		Thompsonville Drug Co.	Wander's.	19.2	17.6
20104	Willimantic....	Bay State Drug Co.....	Wander's.	23.1	20.8

LINSEED OIL.

The official oil of the Pharmacopoeia is raw oil, i.e., not boiled.² Among other specifications, the specific gravity should be between 0.925 and 0.935 at 25° C. and the oil should be free from mineral and rosin oils. The refractive index³ at 25° C. is between 1.4790 and 1.4805.

¹ U. S. P. IX, p. 96.

² U. S. P. IX, p. 295.

³ Canada Inland Rev. Bull. 430, 1919.

Fifteen samples were examined and all found to conform essentially to the requirements of the Pharmacopoeia for raw oil and no adulterants were detected.

One sample, 17628, submitted by the Department of Entomology of this station, conformed also to the usual requirements.

MILK OF MAGNESIA.

Magnesia Magma yields not less than 6.5 per cent nor more than 7.5 per cent. of magnesium hydroxide, $Mg(OH)_2$.¹

One sample, 20100, contained 7.4 per cent. of magnesium hydroxide and was of standard quality.

MERCURIAL OINTMENT.

The official ointment will contain about 50.5 per cent. mercury on the basis of the formula given in the Pharmacopoeia. It should assay not less than 49 per cent. nor more than 51 per cent. of mercury.²

Diluted mercurial ointment, otherwise known as blue ointment, contains 60 per cent. of mercurial ointment of official strength and should assay from 29 per cent. to 31 per cent. of mercury.³

Only one sample, 20133, of the full strength preparation was examined. It was said to be made by Powers and Weightman and was sold by the Sisson Drug Co., Hartford. It contained 45.9 per cent. of mercury which is about 94 per cent. of official strength.

Fifteen samples of diluted ointment were examined. Three of these, 19434, 19442, and 19713, were not so marked and would therefore be presumed to be of full strength while 20153, marked dilute, contained an excess of mercury for the dilute article. The assays are given in Table XXVI.

TINCTURE OF NUX VOMICA.

One hundred mls of this preparation yields not less than 0.237 gram nor more than 0.263 gram of the alkaloids of nux vomica.⁴

The single sample, 19643, assayed was purchased at Thomas' Pharmacy, Rockville and contained 0.291 gram of the alkaloid which is about 10 per cent. in excess of the maximum limit.

¹ U. S. P. IX, p. 261.

² U. S. P. IX, p. 479.

³ U. S. P. IX, p. 480.

⁴ U. S. P. IX, p. 461.

TABLE XXVI. ASSAYS OF DILUTED MERCURIAL OINTMENT.

D. C. No.	City or Town	Dealer and Manfr. (if known)	Mercury, per cent.
19447	Essex.....	W. H. Pond (Powers & Weightman)	28.4
19434	Greenwich.....	Greenwich Drug Store.....	28.4
20405	Guilford.....	J. H. Monroe.....	27.3
20174	Meriden.....	W. Mosher (Powers & Weightman).	26.4
19419	Naugatuck.....	Vrehoe & Leary.....	31.1
19701	New Britain.....	L. K. Liggett Co (United Drug Co.)	30.6
19639	Rockville.....	Thomas' Pharmacy.....	30.2
19442	Southport.....	L. R. Switzer Drug Store (Eimer & Amend).....	26.9
20249	Stratford.....	F. B. Brill (Park, Davis & Co.)....	26.6
19713	Thompsonville....	Geo. R. Steele Est. (United Drug Co.).....	30.3
19708		Thompsonville Drug Co. (Norwich Phar. Co.).....	29.4
20149	Torrington.....	Claxton's Pharmacy (Mallinkrodt)..	30.7
20153		Donahue's Pharmacy.....	36.6
19722	Wallingford.....	Wallingford Drug Co., Inc. (Merck & Co.).....	29.6
20114	Willimantic.....	Chas. de Villers (Park, Davis & Co.).	26.4

SPIRIT OF PEPPERMINT.

(ESSENCE OF PEPPERMINT.)

The official preparation should contain 10 per cent. by volume of peppermint oil¹ but no method is described in the Pharmacopoeia for the determination of oil. Mitchell's precipitation method,² in our experience, gives low results until the solution contains about 8 per cent. of oil when they are substantially correct. Howard's modification³ is more satisfactory but is subject to some inaccuracies due to difficulties of technique. The tentative method³ gives results which accord with Mitchell's method, at least on solutions containing 8 to 10 per cent. of oil. In preparations containing only small amounts (less than 5 per cent.), of oil we have used an abbreviated form of the tentative method centrifuging directly after the addition of saturated salt solution.

Fifty-eight samples have been examined. Six were very low in oil and five others were deficient by amounts ranging from 12 per cent. to 20 per cent. of the standard. The results are given in Table XXVII.

OIL OF TURPENTINE.

("SPIRITS OF TURPENTINE.")

Among other specifications official oil of turpentine should have a specific gravity of from 0.860 to 0.870 at 25 °C.; 5 mls should leave not more than 0.1 gram of residue on evaporation;

¹ U. S. P. IX, p. 409.² Leach, 4th. Ed., p. 431.³ Methods of Analysis, A. O. A. C., p. 206.

TABLE XXVII. ASSAYS OF ESSENCE OF PEPPERMINT.

D. C. No.	City or Town	Dealer	Peppermint oil, per cent.
19418	Ansonia.....	Everett McQuade.....	10.0
20478	Bethel.....	English's Drug Store.....	10.8
20214	Branford.....	Spalding Drug Co.....	9.6
20217		Branford Pharmacy.....	10.2
20408	Bridgeport.....	A. Parsdine.....	9.6
20414		Frank E. Fickett.....	9.2
19737	Bristol.....	Leroy Tucker.....	9.4
19742		Madden Drug Store.....	5.0
19744		Rickman's Economy Drug Store....	10.0
20466	Danbury.....	Simons Pharmacy.....	4.6
20469		Kenner & Benjamin.....	6.1
20472		Northrop's Drug Store.....	14.8
20475		Doran's Drug Store.....	1.9
20476		Ideal Pharmacy.....	9.6
20321	Danielson.....	Woodward's Drug Store.....	11.2
19427	Derby.....	Clarence Hotchkiss.....	10.0
20484	Fairfield.....	The Boyle Pharmacy.....	1.7
20485		Randall's Pharmacy.....	9.2
20307	Groton.....	C. S. Woodhull Davis.....	9.2
20404	Guilford.....	F. F. Donden.....	10.0
20137	Hartford.....	The Sisson Drug Co.....	2.5
20156		F. L. Palmer, Park Drug Store....	10.4
20181	Meriden.....	Pinks Pharmacy.....	9.2
20120	Middletown.....	Lincoln's Drug Store.....	8.8
20238	Milford.....	J. H. Barnes.....	8.6
20324	Moosup.....	Frank La Rose & Co.....	9.6
20303	Mystic.....	Mystic Pharmacy.....	8.6
19422	Naugatuck.....	C. G. Olson.....	9.8
19703	New Britain.....	L. K. Liggett Co.....	10.2
20194	New Haven.....	T. P. Gillespie & Co.....	9.9
20202		Horowich & Son.....	13.6
20220		Wood's Drug Store.....	9.6
20224		Visel & Kennedy.....	10.0
20490	New London....	Starr Bros.....	10.0
20499		Nichols & Harris Co.....	9.2
20231	New Milford....	W. N. Noble.....	9.0
20234		Albert Evitts.....	9.8
20481	Norwalk.....	H. Glendening & Co.....	9.8
20330	Norwich.....	G. G. Engler.....	11.0
20333		James C. Mara.....	9.8
20337		Lee & Osgood.....	10.2
20309	Putnam.....	Edward H. Burt.....	9.0
20312		James F. Donahue.....	9.6
19748	Southington....	Chafee's Drug Store.....	8.6
19626	So. Manchester.	J. H. Quinn & Co.....	9.6
20451	South Norwalk..	Plaisted Drug Store.....	9.0
20454		Harold A. Mead.....	16.8
19437	Stamford.....	Borg Bros.....	9.8
19719	Thompsonville..	Geo. R. Steele Est.....	9.0
20147	Torrington.....	Claxton's Pharmacy.....	9.6
19724	Wallingford.....	Wallingford Drug Co., Inc.....	10.8
20163	Waterbury.....	H. W. Lake Drug Co.....	9.2
20420	West Haven.....	W. J. Coughlan.....	8.0
20130	Weiherfield....	W. T. Eagan.....	10.0
20107	Willimantic....	Bay State Drug Co.....	9.2
20116		Chas. de Villers.....	11.6
20241		John T. Howes.....	10.0
20141	Winsted.....	John A. Williams.....	8.0

unpolymerized oil should not exceed 1 per cent. and the refractive index of the unpolymerized portion should not be less than 1.5 at 20° C.¹

Twenty samples were examined. One sample, 20186, contained 5.6 per cent. of mineral oil. It was examined as follows:

Sp. Gr. 25° C. 0.858; unpolymerized oil 5.6 per cent.; refractive index at 20° C. of unpolymerized residue 1.4613; residue on evaporation 0.144 gram per 5 cc.

The sample was purchased of Paul Flynn, Unionville, and said to have been supplied by the Hoffman Wall Paper Co., New York.

The other samples were not found to be adulterated. In a few instances unpolymerized residues exceeded 1 per cent. but the constants thereof did not indicate mineral oil.

WITCH HAZEL WATER

Hamamelis water or witch hazel water should contain not less than 14 per cent. of alcohol by volume and certain other specifications should obtain.²

Four samples were submitted and since the object of the examination was the detection of wood alcohol, only alcohol was determined. No wood alcohol was indicated in any case and there were no significant deficiencies of grain alcohol the percentages of which ranged from 13.20 per cent. to 14 per cent. Only two manufacturers were represented by the four samples, viz., the E. E. Dickenson Co., Essex, and Brewer & Co., Worcester, Mass.

OINTMENT OF ZINC OXIDE.

(ZINC OINTMENT.)

The official preparation contains 20 per cent. of zinc oxide (ZnO).³ No method of assay is given but direct ignition of the ointment has been shown⁴ to give reliable results and this method was followed.

Thirty-four samples were examined, nearly all of which were of standard or satisfactory quality. No deficiencies greater than 10 per cent. were found except sample 20200 which contained 88 per cent. of the required amount of zinc oxide. Assays are given in Table XXVIII.

¹ U. S. P. IX, p. 302; also Bureau of Chemistry, Bull. 135, p. 31 et seq.

² U. S. P. IX, p. 58.

³ U.S.P. IX, p. 483.

⁴ Mass. State Board of Health, Food and Drug Report 1909, p. 53.

TABLE XXVIII. ASSAYS OF ZINC OINTMENT.

D. C. No.	City or Town	Dealer and Manufacturer	Zinc Oxide, per cent.
19738	Bristol.....	Leroy Tucker, (Meyers & Co.).....	18.0
20129	Cromwell.....	Geo. F. Chapin Est., (Lilly)	20.0
20463	Danbury.....	Burn's Drug Store, (Lilly).....	19.8
20318	Danielson.....	Burroughs' Drug Store.....	18.5
19735	East Hartford...	W. B. Noble, (Norwich Pharmacal Co.).....	20.9
19731		O'Connell Drug Co., (Sisson Drug Co.).....	20.2
20132	Hartford.....	Sisson Drug Co.....	20.5
20183	Meriden.....	N. P. Forcier.....	19.5
20180		Louis Liggett, (United Drug Co.)...	20.2
20175		W. Mosher, (Sharpe & Dohme).....	21.3
20123	Middletown.....	The Hartman Drug Co., (Bristol & Myers).....	21.0
20304	Mystic.....	Mystic Pharmacy.....	19.4
19420	Naugatuck.....	Pickett Drug Co.....	18.9
19647	New Britain....	L. K. Liggett, (United Drug Co.)...	20.0
20200	New Haven.....	Spalding Drug Co., (Apothecaries Hall Co.).....	17.6
20227	New Milford....	Park Pharmacy, (Park, Davis & Co.)	19.0
20339	Norwich.....	Lee & Osgood.....	19.3
20331		Smith's Pharmacy, Inc.....	18.1
20118	Portland.....	C. E. Blodgett, (E. L. Patch).....	20.4
19638	Rockville.....	Thomas' Pharmacy, (Crystal Chem. Co.).....	21.2
20400	Saybrook.....	Saybrook Pharmacy.....	20.2
19618	So. Manchester.	J. H. Quinn & Co., (The Upjohn Co.).....	19.5
20460	South Norwalk..	L. K. Liggett Co., (United Drug Co.)	19.7
20456		Harold A. Mead, (Norwich Pharmacal Co.).....	20.0
19629	Stafford Springs.	D. H. McCormick, (United Drug Co.).....	19.8
19634		Ethel Wikes, (McKesson & Robbins).....	20.3
19436	Stamford.....	Jones Drug Store, (Sharpe & Dohme)	20.6
19712	Thompsonville...	Geo. R. Steele Est., (United Drug Co.).....	19.7
19706		Thompsonville Drug Co., (Norwich Pharmacal Co.).....	19.8
20152	Torrington.....	Donahue's Pharmacy, (Upjohn & Co.).....	20.6
19720	Wallingford....	Wallingford Drug Co., Inc., (Sharpe & Dohme).....	19.1
20165	Waterbury.....	Apothecaries Hall Co.....	19.8
20105	Willimantic.....	Bay State Drug Co., (Norwich Pharmacal Co.).....	19.7
20110		Cartier, The Druggist, (Clafin).....	19.8

ZINC STEARATE.

This preparation is essentially a compound of zinc and stearic acid and should contain an amount of zinc corresponding to not

less than 13 per cent. nor more than 15.5 per cent. of zinc oxide (ZnO).¹

All of the fourteen samples examined fell within the limits prescribed.

TABLE XXIX. ASSAYS OF ZINC STEARATE.

D. C. No.	City or Town	Dealer and Manufacturer	Zinc Oxide, per cent.
20465	Danbury	Simons Pharmacy, (Lilly)	14.2
19728	Glastonbury	Peoples' Pharmacy, (Mallinckrodt Chem. Co.)	14.2
20178	Meriden	Louis Liggett Co., (United Drug Co.)	14.3
19646	New Britain	L. K. Liggett Co., (Merck & Co.)	14.4
20228	New Milford	Park Pharmacy	13.5
19637	Rockville	Thomas' Pharmacy, (American Druggists Syn.)	14.7
19431	Shelton	F. G. Sanford	13.3
19617	So. Manchester	J. H. Quinn & Co., (Norwich Pharmacal Co.)	14.2
20459	South Norwalk	L. K. Liggett Co., (United Drug Co.)	14.2
20453		Plaisted Drug Store, (E. Fougere & Co.)	14.4
19628	Stafford Springs	D. H. McCormick, (Merck & Co.)	13.5
19633		Ethel H. Wikes, (McKesson & Robins)	14.0
19650	Thompsonville	Thompsonville Drug Co., (Merck & Co.)	14.4
20166	Waterbury	Apothecaries Hall Co.	14.8

MISCELLANEOUS DRUGS, ETC.

Nine samples of this class have been examined, chiefly for health officers and physicians.

17658, 17659, 17660, 17661. Drugs distributed by the Direct Sales Co., Buffalo, N. Y., and submitted by Dr. S. B. Kleiner of New Haven.

Five grain *aspirin* tablets were found to contain 5.07 grains per tablet. Five grain *sodium bromide* tablets were found to contain 5.01 grains per tablet. One-fourth grain *mercury iodide* tablets were found to contain 0.223 grain of HgI. Blank tablets, examined for color only, were found to be colored with Naphthol yellow S, a harmless dye.

15891. *Unknown* powder submitted by the Department of Health, Bridgeport. The material had been seized by the local police and was found to consist of, or contain, cantharides.

16600. *Laxative* tablets submitted by Dr. A. B. Sturges, Wallingford. They were found to consist of, or contain, phenolphthalein, licorice and an unidentified bitter principle. Tests for alkaloids and emodin-bearing drugs were negative.

16599. *Eye* solution given to dilate the pupil of the eye instead

¹ U.S.P. IX, p. 493.

of which, it was claimed, contraction resulted. The prescription called for dionin and duboisine in water. It was thought that physostigmine had been substituted for one of the ingredients.

Tests for physostigmine were negative but dionin was identified and the solution further caused the pupil of a cat's eye to dilate markedly within 20 minutes.

15876 and 15877. *Medicines*, sent by Dr. John T. Black of the State Board of Health for identification of any medicaments. Iodides were identified in both preparations and no further examination was made.

Fourteen other materials were examined which do not require extended comment. Among these were *roach powders* consisting essentially of borax, naphthalene, ammonium carbonate and probably Persian insect powder or variations of these ingredients; *tobacco dust* and various *arsenicals* for dusting purposes; *tobacco* and *sal ammoniac*. A sample of Mrs. Potter's Walnut Tint Hair Stain was made up of paraphenylene-diamine and hydrogen peroxide in separate containers; this combination has been commented upon in previous reports.¹

¹ Conn. Exp. Sta. Bull. 227, p. 271; Report 1914, p. 289.

SUMMARY.

Materials	Sampled by, or at request of			Total	Adulterated, below standard or otherwise illegal
	Station Agent	Dairy and Food Commissioner	Individuals		
FOODS.					
Carbonated Beverages.....	.....	153	.....	153	21
Casein.....	6	.....	.....	6	.....
Calcium Casein.....	5	.....	.....	5	.....
Cider.....	.....	4	.....	4	3
Cocoa.....	.....	3	2	5	.....
Coffee.....	1	.....	1	2	.....
Diabetic Foods, etc.....	39	.....	25	64	.....
Fats and Oils:					
Olive Oil.....	.....	1	.....	1	.....
Cooking fats.....	.....	7	.....	7	.....
Butter.....	.....	10	5	15	1
Oleomargarine.....	.....	1	4	5	.....
Ice cream.....	.....	329	15	344	27
Milk and Milk Products:					
Cryoscopic studies of milk.....	103	.....	.....	103	.....
Market milk.....	.....	967	98	1,065	377
Cream.....	.....	4	22	26	.....
Condensed milk, etc.....	.....	2	6	8	2
Human milk.....	.....	.....	30	30	.....
Oysters.....	.....	3	.....	3	1
Tea.....	3	.....	.....	3	.....
Vinegar.....	.....	13	8	21	7
Miscellaneous Materials:					
Foods, etc.....	.....	3	18	21	3
Other materials.....	.....	8	23	31	.....
Total.....	157	1,508	257	1,922	442
DRUGS.					
Proprietary Remedies.....	3	2	.....	5	.....
U. S. P. Drugs:					
Bay Rum.....	.....	24	.....	24	19
Belladonna, Tincture of.....	.....	9	.....	9	.....
Belladonna Leaves, Powder.....	.....	1	.....	1	1
Bismuth, Milk of.....	.....	10	.....	10	2
Calcium Hydroxide, Solution of.....	.....	69	.....	69	12
Colchicum Seed, Tincture of.....	.....	2	.....	2	.....
Ferric Chloride, Tincture of.....	.....	18	.....	18	.....
Ferrous Iodide, Syrup of.....	.....	6	.....	6	.....
Hydriodic Acid, Syrup of.....	.....	16	.....	16	2
Iodine, Tincture of.....	.....	35	.....	35	1
Ipecac, Powdered.....	.....	4	.....	4	.....
Lime, Chlorinated.....	.....	8	.....	8	8
Linseed Oil.....	.....	15	1	16	.....
Magnesia, Milk of.....	.....	1	.....	1	.....
Mercurial Ointment.....	.....	1	.....	1	.....
Mercurial Ointment, Dilute.....	.....	15	.....	15	4
Nux Vomica, Tincture of.....	.....	1	.....	1	.....
Peppermint, Essence of.....	.....	58	.....	58	11
Turpentine.....	.....	20	.....	20	1
Witch Hazel.....	.....	4	.....	4	.....
Zinc Ointment.....	.....	34	.....	34	1
Zinc Stearate.....	.....	14	.....	14	.....
Miscellaneous Drugs, etc.....	.....	.....	23	23	.....
Total.....	3	367	24	394	62
Total for Foods and Drugs.....	160	1,875	281	2,316	504

Connecticut Agricultural
Experiment Station

NEW HAVEN, CONN.

BULLETIN 236

FEBRUARY, 1922

Forestry Publication No. 13

Control of White Pine Blister
Rust in Connecticut

1909-1921

By W. D. EILLEY, Forester and H. W. HICOCK, Assistant

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SAMUEL T. SEALY, *Deputy in Charge of Mosquito Control.*
MISS GLADYS M. FINLEY, *Stenographer.*

Forestry.

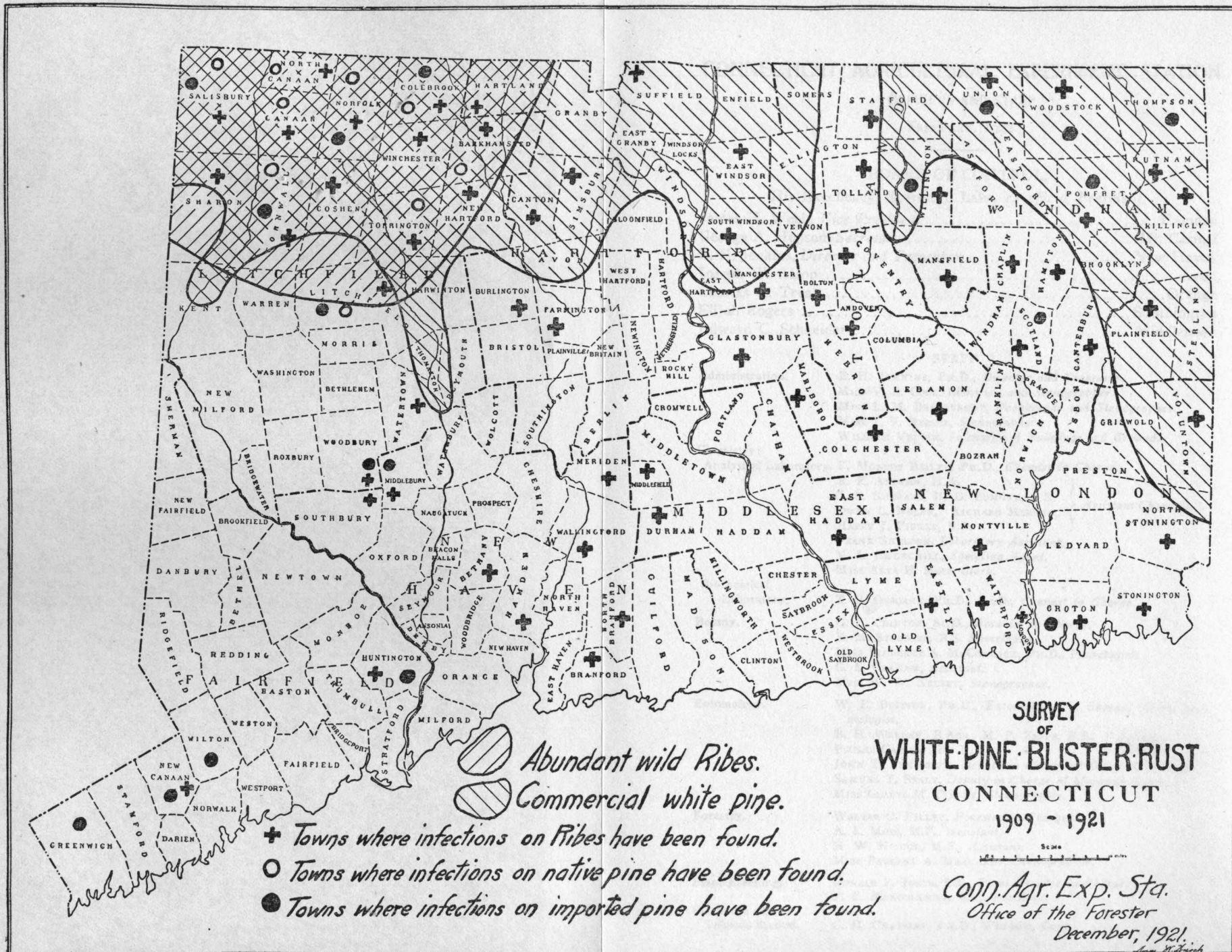
WALTER O. FILLEY, *Forester in Charge.*
A. E. MOSS, M.F., *Assistant.*
H. W. HICOCK, M.F., *Assistant.*
MISS PAULINE A. MERCHANT, *Stenographer.*

Plant Breeding.

DONALD F. JONES, S.D., *Plant Breeder in Charge.*
P. C. MANGELSDORF, B.S., *Assistant.*

In charge of the Tobacco Station.

G. H. CHAPMAN, Ph.D., Windsor, Conn.



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Control of White Pine Blister Rust in Connecticut

For a number of years it has been evident that the future of the eastern white pine forests depends on the control of a fungous disease known as the white pine blister rust. The purpose of this bulletin is to furnish information regarding this disease, its prevalence in Connecticut, and the practicability of control methods. In order to emphasize the necessity of protecting white pine growth from a very serious menace, a report on the value of white pine timber in the state is included.

In 1916 the rust was found in all the New England States, New York, New Jersey, Pennsylvania, Wisconsin, Minnesota and Ontario, Canada. All these states have taken measures to study and control the disease, and the Connecticut General Assembly of 1917 passed the following legislation for that purpose.

"The director of the Connecticut Agricultural Experiment Station shall have authority to investigate and control the fungous disease known as white pine blister rust or currant rust. Said director may appoint a member or members of the experiment station staff to administer such work under his direction, and may employ other assistance when necessary. All white pine, currants or gooseberries infected with said rust may be uprooted and destroyed forthwith. Said director may designate districts within which currant or gooseberry bushes growing wild, abandoned or escaped from cultivation may be uprooted and destroyed under his direction, and in the performance of his duties, he or any person authorized by him, may at any time enter any public or private grounds, and any person wilfully hindering the performance of such duty shall be fined not less than ten nor more than fifty dollars for each offense. The sum of seven thousand five hundred dollars is appropriated annually for carrying out the provisions of this section." (General Statutes of 1918, Section 2117.)

The discovery of the rust in Connecticut in 1909 resulted in immediate study of its nature and occurrence. This was made by members of the Experiment Station staff, all needed equipment being furnished by the Station. In 1916 it became apparent that active measures for the control of the disease should be undertaken as soon as possible, in addition to a continuation of the studies already begun.

Under an agreement with the Bureau of Plant Industry, United States Department of Agriculture, federal funds for coöperative control work were received in 1916 and have been available each year since. The disease has thus been under observation for twelve years, and for the last six years considerable control work has been done in coöperation with the Federal Government. Under the agreement mentioned the amount of federal funds

expended to September 30, 1921 was \$12,124.44, while the total amount expended by the State was \$24,080.11.

The work of the Experiment Station on the disease has been carried on jointly by the forestry and botanical departments; the former having charge of the administration of funds and of the active control measures, the latter in charge of research and investigations.

The control work has been on an experimental basis for the past six years. The disease develops comparatively slowly and three or more years must elapse before the effects of control are fully apparent. It was necessary to test and compare various field methods to determine which would accomplish the desired results at a minimum cost. Much has been learned regarding the rust and its control. It can now be confidently stated that the eradication of currant and gooseberry bushes to a distance of 1,000 feet from white pine will, in most cases, adequately protect the pine from the disease. The eradication of *Ribes* is practicable, even in regions where the wild species are abundant, and the work can be done by land owners at a comparatively low cost.

A detailed report of studies by Doctors Clinton and McCormick of the botanical department on new points in the life history of the fungus appeared in Bulletin 214 of the Connecticut Agricultural Experiment Station, but in order that the present bulletin may be as complete as possible, a resumé of these studies is included.

The Importance of White Pine.

At the time of settlement of this country by Europeans, the northeastern United States from Maine to Minnesota and from southern Canada to West Virginia (even as far south as Georgia along the mountain tops) contained many virgin stands of eastern white pine (*Pinus strobus*), both pure and in mixture with hardwoods. The forests were valuable to the early settlers only for fuel and for building materials. Implements for working up logs into boards, shingles and framing pieces were comparatively crude, and only trees which could be worked up easily were selected. Chief among these was white pine. Evidence of this is to be found in the older New England houses today. Built almost entirely of white pine except for the frame, and many of them unpainted, these houses have withstood the elements for nearly three hundred years and are still habitable. White pine was therefore one of the first woods to enter into the domestic life of our forefathers and it played an important part in the early development of New England.

The demand for wood in various forms has increased many fold in the last three centuries. For a considerable number of

these uses white pine has been the first choice, as it always will be if obtainable. Many woods have been substituted for it but few have proved as satisfactory. Inroads on the white pine stands by lumbering and fire have been enormous, so that today the annual cut is far less than the demand and is diminishing each year.

From this brief description of the past and present status of white pine, let us glance into the future to see what part this valuable tree is to play in the forest production of northeastern United States, and more specifically of Connecticut.

A plentiful supply of low priced lumber is essential for the prosperity of any community. This is particularly true of an industrial state like Connecticut. The ideal condition would be for every community to produce all the lumber it needs, thus eliminating high freight rates and stimulating local industry. Since this is impracticable in many cases, the question arises as to what species will most fully satisfy the needs of the community and make it most nearly self-supporting.

The killing of the chestnut trees by the bark disease has left the state practically bereft of a good general purpose timber tree. Of the many other native hardwoods, some produce very valuable materials, but few of them can be grown profitably because of the length of time required to mature. It is generally conceded by foresters that while some hardwood lumber is essential and must be produced, the bulk of the lumber in the northeast must come from coniferous trees. Of these, ten species are found growing native within this state as follows: cedars, three species; spruce, one; balsam fir, one; larch, one; hemlock, one; and pines, three. Because of slow growth, restricted range, or other adverse habits all these species except red pine (*Pinus resinosa*) and white pine may be eliminated in considering the future.

These two trees are quite similar in growth and habits, although the wood of red pine is considered to be slightly inferior to that of white pine. Planting stock of both species is easily raised and set out. With regard to immunity to insects and fungi, red pine has a decided advantage and it is less susceptible to damage by fire. White pine is found throughout most of the northern third of the state and if the species is favored, its range may be greatly extended without excessive cost. The range of red pine, on the other hand, covers only portions of the most northerly towns. Its further extension, therefore, must be by planting until the species is more widely established in the state.

Dr. Haven Metcalf of the Bureau of Plant Industry has stated that the practise of forestry in New England and New York is "impossible" without white pine. Perhaps it would be better to say "very difficult." At any rate it is generally conceded that white pine, because of its excellent qualities and many and diversified uses, is our most valuable timber tree. Foresters claim that

it is one of the few trees that can be grown as a crop with profit under intensive management.

If the future of our local lumber supply depends so much on this one species surely it is worth protecting from fire, insects and fungi. Fire is always destructive to growing timber, and white pine is more susceptible than many other species. There are several insects which damage white pine to some extent, but these pests are either not very serious or can be controlled. Of the various fungi parasitic on the tree, the only one which seems to endanger the existence of the species is that with which this report is concerned.

History of the Disease.

This disease is caused by a parasitic fungus known to science as *Cronartium ribicola*. It is classified among fungi as a heteroecious rust because it develops distinct stages of its existence on different host plants, of which it requires two for its development and spread. They are:—

- a. The several species of five needled pines.
- b. The several species of currants and gooseberries.

During a complete life cycle this rust produces four different kinds of spores, two on the pine and two on the Ribes host. *Ribes* is the scientific generic name for the plants commonly known as currants and gooseberries, and in this report the term "Ribes" is used to designate them.

About 1856 Dietrich, a German botanist, reported the two stages of the fungus on Ribes and on pine in northwestern Russia. He evidently did not recognize that he had two forms of the same rust on different hosts. Klebahn of Germany in 1888 was the first to prove the relationship of the two forms when he inoculated leaves of Ribes from the spore stage which was found on five needled pines. The fungus has, therefore, been known in Europe by botanists for many years. The five needled pines of the old world are relatively of small commercial importance and it was probably the destruction of the North American five needled pines, introduced extensively for forest and ornamental planting, which really directed the attention of Europeans to the disease.

According to Spaulding's 1911 report,* the blister rust has been found on one or both hosts in Norway, Sweden, Denmark, Russia, Siberia, Austro-Hungary, Italy, Switzerland, Germany, France, Belgium, Holland, England, Scotland and Japan. Losses as high as 100 % have been reported from Europe.

Prof. Tubeuf of Munich wrote a paper in 1905 on the ravages of the disease in Germany on American white pine, a tree which

* Bulletin 206, Bureau of Plant Industry.

has been used there for forest and ornamental purposes for two hundred years. He also cited the damage to nursery stock and young reproduction, and the fact that in some places the use of this species has been abandoned by nurserymen because of the rust.

Moir, after studying the disease in western Europe in 1920, reported* that in Norway, Sweden, Denmark and Belgium the use of white pine in the regeneration of forests had been practically given up because of the rust. Although the necessary control methods are well known there, the cultivated black currant (because its fruit is so highly prized for jam) is considered of more value than the exotic white pine. Moir also studied the effects of the disease on sugar pine (*Pinus lambertiana*), western white pine (*Pinus monticola*) and limber pine (*Pinus flexilis*) planted in western Europe and found all to be as severely damaged as eastern white pine.

It is very difficult to say just when the disease was first introduced into America. Stewart was the first to identify and definitely report it in this country. In 1906 he found a serious infection on various species of Ribes at Geneva, N. Y., although it was not until 1912 that it was discovered on white pine in that region. The rust was first reported on white pine in 1909 in several of the eastern states where seedlings imported from Europe had been planted. It is very probable that it had been brought into this country in small quantities for many years previous to 1909 when, as is now known, it was introduced in considerable quantities on forest planting stock, chiefly from Heins Nursery in Germany.

In 1908 and 1909 about 750,000 white pine transplants were imported from Germany for forest planting in Connecticut. After planting it was discovered that some of these trees were breaking out with the yellow blisters, or aecial stage of the rust. It was first discovered in April, 1909 by Mr. C. A. Metzger on trees which he was planting in Wilton, specimens being sent by him to this Station for identification.

From more recent investigations, there are indications that infected pines may have been introduced in at least one place in the state before the general introduction of the rust in 1908 and 1909. At the Bowditch nursery in Pomfret, there is a small forest planting about thirty years old which has developed the disease for a number of years. The trees are known to be of European origin and some of them appear to have been infected prior to 1908.

Life Cycle.

As previously stated, the disease is a rust which requires two hosts (one of the five needled pines and some species of Ribes) for

* Bulletin 6, American Plant Pest Committee.

the completion of its life cycle. In describing this cycle, let us assume that we start with a pine which has become infected and is producing spores. These spores (aeciospores) are blown to Ribes leaves in the spring, from early in April until June depending on the season. With proper atmospheric conditions the parasite develops in the leaf and shows on the under side in about two weeks as minute orange-yellow pustules, which mature and break, giving off an orange-colored powdery mass of spores (uredospores). This is the first spore stage on Ribes. These uredospores are capable only of infecting Ribes and during the early part of the summer spread the disease from one bush to another. From midsummer until the leaves fall the second spore stage on Ribes is produced. This takes the form of minute rusty brown hairs (telia) on the lower surface of the leaf. These hairs are made up of single-celled spores (teliospores) which adhere permanently together. Often uredospores and teliospores are both found on the same leaf. The latter upon germination produce minute temporary spores (sporidia) which cannot infect Ribes, but if carried to pine needles may cause infection.

Pines become infected, therefore, only after telia appear on Ribes. Doctors Clinton and McCormick have conclusively demonstrated that the rust enters the pine host through the stomata or breathing pores of the needles and works back into the bark and twig tissues. Needles of the current season are probably more susceptible to infection than older ones.

Once the disease has entered the tree it proceeds to develop parasitic threads (the mycelium) in the tissues of the host. The first outward sign of the work of the parasite is a discoloration of the bark to a yellow or orange-greenish hue accompanied by swelling. In one to several years after infection of its needles the swollen portion of the pine develops what are known as pycnia. These exude on the bark as drops of a sticky fluid containing spores (pycniospores) whose nature in this and other rusts has never been fully determined, but which are considered by some to be spores that have lost their function. When these drops dry out there remain on the bark yellowish spots of varying shape, which later turn a deep reddish brown. They are known as pycnial scars.

Usually during the spring after pycnia are borne the fungus develops the fruiting bodies known as aecia. These never appear until the third year after infection of the pine needles and their development may be delayed until the fourth year, or even longer under adverse conditions. Very small pines are often killed before aecia appear at all. The aecia are the orange spore cases, or blisters, which push through the bark as flattened pustules about one fourth of an inch high. They soon burst and send out a mass of aeciospores which, if carried to Ribes, cause the infection on the leaves mentioned at the beginning of the life cycle. After fruit-

ing, the bark through which the pustules have protruded becomes much seamed and cracked, often exuding pitch and frequently attacked by secondary fungi and insects. Older infections sometimes show constriction with swelling above.

Not infrequently a tree which has been diseased for several years will show a number of distinct zones as follows:—

- a. Dead, cracked bark where the disease has fruited in previous years.
- b. Fruiting pustules, or remnants of pustules, that have fruited during the current season.
- c. Zone of pycnial scars and pycnial drops.
- d. A discolored area usually surrounding all other stages and moving forward slowly into new tissues with each year's growth.

Some important points to be noted are:—

1. Two spore stages are borne on each host during the life cycle of this rust.
2. Two hosts must be present if the disease is to spread from pine to pine.
3. Spores from the stage on pine cannot directly infect other pines.
4. The rust is perennial on the pine but not on the Ribes host.
5. The fungus may grow within the pine host for a number of years without fruiting.

Experiments by members of the Bureau of Plant Industry and others show that all five needled pines are commonly infected by this rust. The botanical department of this Station has made extensive experiments with other pines and a summary of the results appears later in this report. Ribes vary considerably in their susceptibility to infection. Black currants are undoubtedly the most susceptible, followed closely by certain wild gooseberries, skunk currants and cultivated flowering currants. The thick leaved variety of cultivated red currant and certain cultivated gooseberries are probably the least susceptible in this state.

Moist, fairly cool weather is apparently the most favorable for the growth of the fungus and the production of spores. The aeciospores which develop on pine may travel long distances and over large barriers, such as mountain ranges, without losing their quality of infecting Ribes. The average longevity of the spores varies considerably according to their kind. The aeciospores which carry the disease from pine to Ribes may remain alive for several months. Dr. H. H. York has made tests showing that with a humidity of 90 and a temperature of 22-25 degrees C. (72°-77° Fahr.) the sporidia which carry the disease from Ribes to pine remain viable for less than ten minutes.

Legislation.

Under the Plant Quarantine Act of August 21, 1912, as amended March 4, 1917, the Secretary of Agriculture was given the power to "quarantine any state or territory or any district of the United States, or any portion thereof" to prevent "the spread of any plant disease or insect infestation." Under this Act the

Federal Horticultural Board established a quarantine against the shipment of five needled pines and black currants out of the New England States and New York, and against the shipment of these plants from the states east of and including Minnesota, Iowa, Missouri, Arkansas and Louisiana into territory further west. Congress also appropriated \$300,000 for the investigation and control of the disease, part of which was to be used coöperatively to balance money appropriated by the states.

In 1917, the Connecticut legislature passed two laws, which in brief are as follows:—

a. A general plant pest law authorizing the Director of the Connecticut Agricultural Experiment Station to control insects or diseases which are, or may become, serious pests to economic plants. He is given the power to destroy infected plants, prohibit or regulate transportation of the same, and to establish quarantine in such areas and against such pests as he may deem necessary. (G. S. 1918, Section 2106.)

No quarantine against Blister Rust has ever been put into effect in this state.

b. A Blister Rust law authorizing the Director of the Connecticut Agricultural Experiment Station to control the White Pine Blister Rust. He is given the power to order white pines, and currant and gooseberry plants to be unrooted and destroyed. (G. S. 1918, Section 2117.)

This latter act authorizes an expenditure of \$7,500 per year for the control of Blister Rust.

Control 1909-1915.

As was previously stated, 750,000 imported white pine trees were introduced into Connecticut in 1908-1909. Records of their distribution were available at the Experiment Station and soon after the infection on pine was discovered at Wilton by Mr. Metzger in April, 1909, most of the plantations originating from this stock were examined by members of the station staff, and by Drs. Spaulding and Graves representing the Bureau of Plant Industry. In addition to the infection in Wilton, five plantations were found to contain from one to several infections and five others had a few suspicious trees. The above eleven plantations and a number of others were inspected in 1910 and in subsequent years. As no further signs of the rust were found, it was concluded that all the infected trees were either destroyed or had died. The importation of foreign planting stock was discouraged by the forestry department of the Station after 1910. In 1912 one lot of stock received from Holland by a commercial nursery contained so many diseased trees that all were ordered destroyed by the state nursery inspector.

The rust was found on Ribes in Meriden in 1912 and again in 1916. In the summer and fall of 1915, the state nursery inspector

of Massachusetts reported many infections on Ribes in that state close to the Connecticut line, and one over the line in the town of North Canaan. Infections reported from other states indicated that the rust had become well established in this country and during the following winter (1915-1916) plans were made for coöperation between the Connecticut Agricultural Experiment Station and the Bureau of Plant Industry for more thorough scouting to determine how serious the infection might be.

Control 1916.

Under this coöperative agreement the salaries of extra men were paid by the Federal Government and their expenses paid by the State. The station forester, then ex-officio state forester, was placed in charge and other station employees were used on the work during all or part of the season. No state funds were available except the appropriation for the care of state forests, a part of which was used. Ten extra men were employed for varying periods from May 1 to September 30.

During May and June two crews inspected eighty plantations and sixteen nurseries where there was reason to think that the disease might exist. Infected trees were found in ten plantations in Wilton, Huntington, Groton, Middlebury, Woodbury, Cornwall, Litchfield (2) and Norfolk (2). Only in Norfolk was there any sign of the disease having spread from its point of introduction, but there numerous secondary infections on native pines were found and destroyed. Wild Ribes were very plentiful and on June 15 the first fruiting stage was found on this host. By July 1 it was too late to prevent the spread of the disease from pine and for the rest of the season, using the infected plantations as a center, a crew of six men worked on the eradication of Ribes. They removed and destroyed many thousand wild and escaped Ribes in an area of approximately three square miles.

In addition, cultivated Ribes were inspected over a large territory. It was thus determined that the infected area included about forty-five square miles inside a triangle with its apexes at Canaan Valley, North Colebrook and South Norfolk. Eradication was discontinued in September and several of the men were used to scout the state for Ribes infections. During the entire season scouting was done in 110 of the 168 towns. Infections were found in 65, of which only 20 were west of the Connecticut River. The infections in these 20 towns were widely scattered except in northern Litchfield County. In the 45 towns east of the river the infections were more numerous but could not be attributed to any known center of pine infection.

Control 1917.

From the work in 1916 it was apparent that the blister rust had become well established and that special funds would be needed to control the disease. Five thousand dollars was granted by the legislature for immediate use and ten thousand dollars for the two years ending September 30, 1919. The Director of the Experiment Station, being charged with the execution of the law, delegated the direct supervision to the forestry department. The botanical department took charge of the identification of specimens and investigational work.

The labor situation in the spring of 1917 was rather acute, but the early closing of the Connecticut Agricultural College to release students for agricultural work made available a number of men for blister rust control. In all thirty-two men were employed in this work but during the latter part of the summer many of the men left to enter some branch of military service, and for this reason the periods of service varied considerably. As in 1916 the Bureau of Plant Industry coöperated by paying the salaries of extra men employed. The plan of work was as follows:—

- a. Inspection of pine plantations throughout the state.
- b. Scouting for the disease on Ribes.
- c. Eradication of Ribes at Norfolk.

In May and June two crews found infections in eighteen plantations, eight of which had been located in 1916, the remaining ten being found for the first time in 1917. Two plantations and one nursery in which infected pines were found in 1916 seemed to be clean the following year. No infected stock, either pine or Ribes, was found in any nursery in the state, although inspections were made both in the spring and in the fall.

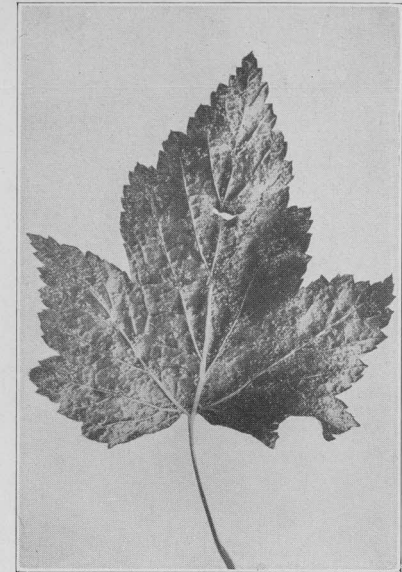
The most serious infection discovered outside of Norfolk was that on the Bowditch estate in Pomfret. Here the infected trees were over twenty years old and had evidently borne the rust for some time, but conditions were not favorable for its spread, as there is almost no native pine in this region and wild Ribes are very scarce.

To facilitate scouting for infection on Ribes, the state was divided into ten districts with a scout for each. These scouts inspected Ribes in yards and along roads in their respective districts once in two weeks and in this way kept track of any new infections that developed. A supervisor of scouts visited each district and spent a day with the scout about twice a month.

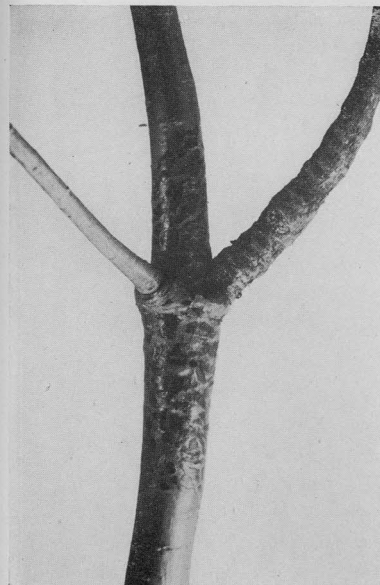
The most important result of this scouting was the finding of the pine infection center in Pomfret. Its presence was suspected from the early and general infection of Ribes reported by the scout in that vicinity. By a careful inspection of planted pine he



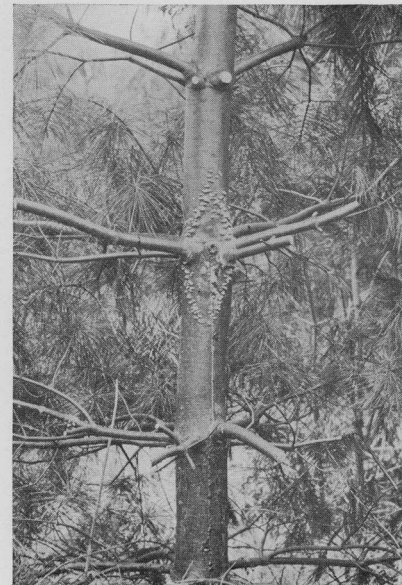
a. Primary infection on imported pine.



b. Telial stage on Ribes.



c. Pycnial stage on pine.



d. Aecial stage on pine.

WHITE PINE BLISTER RUST.



a. Natural reproduction in Cornwall.



b. Plantations in Middlebury.

FUTURE WHITE PINE FOREST.

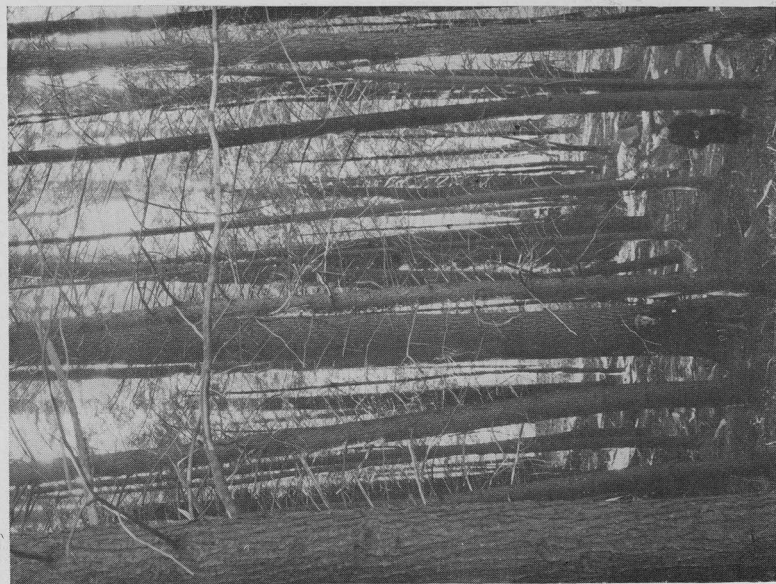


b. Natural stand thinned.



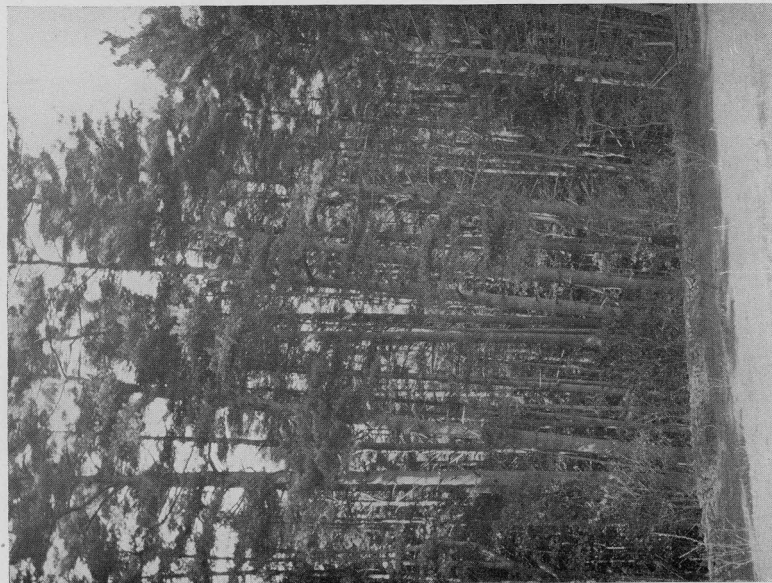
a. Natural stand unthinned.

YOUNG WHITE PINE FOREST IN UNION.



150 years old; 140 feet tall; 67,000 bd. ft. per acre.

MATURE WHITE PINE FOREST IN CORNWALL.



was able to locate a center of infection on the Bowditch estate. The Ribes infections in other parts of the state, with one exception, were too scattering to indicate infection centers close at hand. The exception was in the vicinity of Branford where there seemed reason to suspect the presence of pine infection, but a careful search failed to show any.

Control work was again confined to the Norfolk region, for nowhere else was there evidence that the disease had spread to pines outside the infection center. The control areas selected covered about ten square miles in the northern half of the town. Work with two crews was begun May 12th and another was organized in July. Early in the season an attempt was made to locate and remove pine infections on those areas from which Ribes was eradicated the previous year. Six hundred acres were covered in this way but the work was slow and expensive. The average cost of \$1.80 per acre did not seem justified when compared with the much lower cost of removing Ribes the previous year. Moreover, it is never possible to detect with certainty all pine infections, since some of them may be so well hidden as to be overlooked, while others may not be sufficiently developed to be recognizable.

Systematic scouting for pine infection was therefore abandoned and during the rest of the season Ribes were eradicated from about three thousand acres at an average cost of 85 cents per acre. While no accurate count was kept of the Ribes removed, the number varied from many thousand per acre in some of the swamps to almost none on the hardwood ridges. The cost naturally varied with the character of the land and the abundance of Ribes. From 50% to 60% of all Ribes destroyed showed infection.

Infection on Ribes was found to be fairly general, not only in the control area but for some distance east and west in the towns of Colebrook and Canaan. The various species of Ribes found in the order of abundance were as follows:—*Cynosbati* var. *glabratum*, *oxyacanthoides*, *vulgare*, *prostratum*, *nigrum*, *odoratum*, *Cynosbati*, *rotundifolium*, *gracile*, *triste* var. *albinervium*, and *Americanum*.

Control 1918.

On account of war conditions which prevailed in 1918 practically no eradication work was attempted. Members of the Station staff inspected pine and Ribes in different parts of the state throughout the summer. Two extra men were employed in Norfolk to check over areas previously worked, with gratifying results. On one and one-half square miles of territory worked in 1917 only 386 Ribes were found, or about one for each two acres.

From May 1 to September 1 selected red and black currant bushes were sprayed at ten day intervals with 4-4-50 Bordeaux mixture to determine the possibility of controlling the disease on Ribes by spraying. Unsprayed bushes were used as checks. The results indicated that it might be possible to hold the disease in check on Ribes by frequent spraying, but that the frequency required would make the plan impracticable.

As previously mentioned, infections on cultivated Ribes found in the town of Branford in 1916 aroused the suspicion of a pine infection nearby. Infected Ribes were plentiful at three places and at two of these all bushes were destroyed soon after discovery. The black currant bushes at the remaining place were inspected at frequent intervals, as were the few pines in the neighborhood, but without result. The nearest known pine infection was at Middlebury, some thirty miles away. In September 1918 an intensive survey was made of all cultivated Ribes within three miles of the infected black currants. Of 201 places visited 73 had Ribes and infection was found at 13, but the infections were too widely scattered to indicate the presence of a pine infection center.

Nine plantations and one nursery were inspected in 1918. In six plantations fruiting infections were found, while in two others there were specimens apparently killed by the rust. One new infection was found in the town of Greenwich in a plantation which had not previously been inspected.

During the summer practically all the scattered Ribes infections located in 1917 were visited at least once. A decrease in the number of infections was evident as compared with the previous year. Considerable time was spent in July and August inspecting Ribes in the southwest corner of the state, but infections were not sufficiently abundant to indicate the presence of unknown pine infections.

Control 1919.

From inspections in previous years it was apparent that many of the plantations of imported pine were in no danger from the rust, and these were consequently eliminated from the inspection of 1919. Six plantations were inspected and the disease was found in five, but only in small amounts and with no indication that it was spreading.

Eradication of Ribes was resumed May 1 on areas in Norfolk and Colebrook adjoining those worked in 1917. During the summer a crew of five men covered about 2,500 acres and destroyed 30,000 wild Ribes bushes. The cost of eradication averaged 93 cents per acre, including wages, sustenance, supervision, transportation and depreciation of equipment.

Checks were made to determine the efficiency of the crew in

eradicating Ribes. Four tracts worked earlier in the season were selected and a portion of each reworked. The results showed that the crew removed an average of 90% of all Ribes during the first working of the ground.

During June scouting for infection on cultivated Ribes in 24 towns in Tolland, Windham and New London Counties showed infection in four towns, but only at places where it had been found in previous years. Later in the summer nine towns in Litchfield County were scouted in the same manner and Ribes infection was found to be quite general.

The survey of the Branford area which was made in 1918 (see page 316) was checked up in 1919. All but two places showing infection on Ribes in 1918 showed it in 1919, and one new infection was found. All white pines in the area were inspected for infections but none found.

In order to determine the spread of the disease in Pomfret, a survey covering about 30 square miles adjoining the Bowditch estate was made in July and August, 1919. All pine plantations and cultivated Ribes in the region were inspected and mapped. Eighteen separate infections on Ribes were found, but no pine infection except at the Bowditch estate. Here the scout eradicated a large number of escaped Ribes bushes in and near the pine grove. Wild Ribes are very scarce in this vicinity.

In coöperation with the Bureau of Plant Industry, a pine survey of the state was begun in December, 1919. Its purpose was to obtain information regarding the amount and value of white pine in the state and to demonstrate the importance of protecting it from the rust. One man was employed until June, 1920, mapping the pine lands of Windham, New London and eastern Tolland Counties, reporting on the age, area, percentage of pine in mixture, quantity in board feet and value of all stands containing pine.

Control 1920.

Labor suitable for this work was difficult to obtain until after the schools and colleges closed, when twelve men were secured and put in the field. The area selected for eradication consisted of about 2,000 acres in the town of Colebrook, east of that eradicated in 1919. Forty three thousand Ribes bushes were removed and destroyed. Checks run frequently, according to methods prescribed by the Bureau of Plant Industry, showed that the men were getting 90% to 97% of all Ribes during the first trip over the ground.

As in former years inspection of cultivated Ribes was carried out to determine the approximate limits of the disease. In 1920 this work was confined to Litchfield County where infection on Ribes was found to be quite general. No attempt was made to

check over either the Branford or the Pomfret areas during the season, nor was there any inspection of plantations.

Work on the pine survey, started in 1919, was resumed in November, 1920 and a new line of work, the scouting of native white pine for infection, undertaken. This seemed necessary because of the amount of Ribes infection found throughout the state for a number of years. The Bureau of Plant Industry furnished one man for the survey and two for the scouting. The two lines of work were carried on simultaneously, as this method was considered more efficient than to cover the ground twice for mapping and scouting. The cost of the survey was 2 cents per acre for the area actually mapped and about 3 mills per acre for the entire area covered. The men located infections on native pine in the towns of Cornwall, Barkhamsted, and North Canaan, as well as many new infections in Norfolk and Colebrook. (For results of the survey see page 321.)

Owing to the fact that infection had been found on Ribes in the vicinity of Branford for a number of years, this region was again scouted for infections on pine previous to the start of the regular scouting and survey work. All pines, both native and ornamental, in the neighborhood of known Ribes infections were carefully looked over, but not a single pine infection was found.

Control 1921.

Beginning on April 14 seven plantations and one nursery were inspected for pine infection. One plantation contained several fruiting specimens of the rust and in another two suspected trees were removed. In the remaining plantations and in the nursery, no sign of rust was found.

A crew of five men organized a camp in Norfolk on May 1 and carried on eradication, scouting and checking until September 15. Some 8,000 acres in the towns of Norfolk, Colebrook and North Canaan were covered and 39,000 Ribes bushes were removed and destroyed. Of this area, 4,000 acres was new territory which had not been previously worked. In addition the crew scouted forest and ornamental plantings of imported stock in Litchfield, Cornwall, Norfolk and Colebrook and found infections in all plantations thus inspected.

The effectiveness of Ribes eradication cannot be determined until sufficient time has elapsed to allow Ribes grown from seed, or from incompletely removed root crowns, to become large enough so that they can be readily seen. Furthermore, on pines which have become infected since the Ribes were removed, the disease would require at least two years to reach a stage which could be unmistakably recognized. In order, therefore, to check up the results of previous Ribes eradication in Norfolk, some 4,000 acres

which were worked in 1916, 1917 and 1919 were reworked in 1921 with the following results:

a. Some large Ribes missed in previous years were found, but these were so few in number per acre as to be of minor importance. Numerous small Ribes, originating either from seed or from improperly removed root crowns were found, but the small amount of leaf surface and the fact that these plants were usually growing under dense shade reduces the liability of their acting as transmitters of the disease for several years. Judged by the comparatively small number of Ribes found in reworking, the first eradication appears to have been fairly effective but the necessity for rescuing these areas after a few years, and reworking them if necessary, is indicated.

b. The number of pines showing infection which had occurred since eradication was almost negligible. In contrast with this, on an area from which Ribes had not been removed prior to 1921, twenty-seven pine infections were found, 70% of which took place in 1918 and 1919.

During the winter of 1920 and 1921 scouts had discovered new infections on native pine in several additional towns in Litchfield County. Prior to this time, the only known infection on native pine was in the Norfolk-Colebrook region. Careful investigation of these newly located infections indicated that control must be undertaken on a much larger scale. It was considered advisable, however, to secure further information as a basis for future work in the new areas. During the summer and fall, therefore, a preliminary survey of the towns of Cornwall, Canaan, Salisbury and a part of North Canaan was completed. The towns were subdivided into blocks for each of which observations were made on the prevalence of Ribes, amount and character of pine infection, and other factors bearing on control. Pine infection was found to be quite generally distributed over all the territory scouted and in some places it was very heavy. Ribes were plentiful but not as abundant as in the Norfolk region.

During November a scout covered practically all the towns along the Rhode Island line inspecting native pine but was unable to locate any infection.

The survey made in Pomfret in 1919 was checked up this year. Four fruiting infections on pine were found at the Bowditch estate and one new infection on ornamental pine about one-half mile to the south. The cultivated Ribes scouted in 1919 showed less infection in 1921 than in the former year.

On July 1, 1921 the federal allotment for blister rust control in Connecticut was cut from \$5,000 to \$2,000. Moreover the Secretary of Agriculture ruled that this allotment should be used for education, demonstration and supervision, but not for eradication as in previous years. The federal money has therefore been used

since July 1 to pay part of the salary of a member of the Experiment Station staff whose time is largely spent in supervising the control work. As a result of this reduction in the federal funds available, the amount of control work which can be done with the present state appropriation is greatly reduced. Moreover the disease has recently been found in alarming amounts in several new sections. To check its spread, prompt action is necessary, or much young pine will be killed before reaching merchantable size. It is imperative, therefore, that owners of pine cooperate in the control work, since state and federal funds are wholly inadequate to care for the present situation.

Future Control Work.

Blister rust control has been in the experimental stage during the past six years. Although its principles were well understood in European countries they had never been practiced extensively there, and many points in the life history of the disease were not thoroughly understood. Its characteristics and life history are now well known as a result of the exhaustive studies which have been made in this country by federal and state agents. There are still many scientific points not fully understood and investigational studies must be continued, but the practicability of control methods has been firmly established. The cooperative work with the Bureau of Plant Industry in the various states has demonstrated that the application of simple field methods at a moderate cost per acre will hold the disease absolutely in check.

These control methods should be carried out locally by pine owners themselves, since they are the ones directly benefited by the results secured. Public funds should be used for supervision, for education and for further experimental work, but not, as in the past, for actual field control on a large scale. Education of pine owners through state and federal agencies is essential, because many of them do not realize the value of their young pine or the necessity of protecting it from the rust.

On average quality forest soil which could not profitably be used for agriculture, white pine either self-sown or planted will, in 40 to 50 years, produce a gross revenue of over \$200 per acre, as contrasted with \$75 per acre if the land grows only hardwoods. Unless the blister rust is kept under control, however, it may and probably will, destroy the pine before it reaches merchantable size, as the greatest danger is to trees less than 15 feet high to which the disease is fatal in a very few years.

Assistance must be given pine owners in recognizing the disease, for its presence on pine is very deceptive. It can be identified at the end of the first year only with the aid of a microscope. After the second year a careful scrutiny will reveal its presence,

although to an untrained eye a tree already diseased beyond recovery may outwardly seem to be healthy.

Supervision of Ribes eradication by state or federal agents is of great importance. Unless the work is done with sufficient thoroughness to remove practically all the Ribes in the vicinity of pine stands, the protection secured will not be sufficient to warrant the expense incurred. A trained supervisor will be able to maintain the efficiency of the work and to reduce its cost by eliminating areas where Ribes are not sufficiently abundant to require eradication.

The National Situation.

The introduction of this disease into the United States and its subsequent spread has brought about a condition very different from that in Europe. Our eastern white pine, sugar pine, limber pine and western white pine were formerly used quite extensively in western Europe for forest and ornamental planting. On account of damage by the blister rust the use of these trees is now being discontinued because the cultivated black currant is more highly prized for its fruit than the American soft pines for their lumber. In this country the necessity for protecting the five needled pines at the expense of Ribes should be beyond question, because of the greater importance and value of pine lumber as compared with currants and gooseberries.

In the northeastern United States where the rust was generally introduced some twelve years ago the disease, on account of its deceptive character, became firmly established before the damage it might do was generally realized. In many parts of the range of the eastern white pine, 10% to 15% of all the trees of this species are infected and in some areas infection runs as high as 100%. This condition is very serious because much of the present crop of young pine will be killed before it is large enough to cut and because, if the rust is not controlled in the immediate future, it may become so prevalent as to render the use of white pine impossible in the regeneration of our forests.

In Connecticut the situation is not as bad as in other New England states, because the area in which blister rust can become serious is limited to about 500 square miles in northern Litchfield County. This is the only section of the state where wild Ribes are abundant. It is very probable that infection will occur at many other points because of the presence of cultivated Ribes, but it is believed that such infections will be quite local and easily controlled.

In the western states the danger from blister rust is one of the future rather than of the present. Agents of the Bureau of Plant Industry are constantly on the watch for its appearance and every

possible means of enforcing the quarantine against the shipment of Ribes and five needled pines into the west are being used. Very recently (November 1921) an infection on eastern white pine planted in southern British Columbia has been discovered, and since that time several infections on western white pine have been found over the line in the state of Washington. However, these infections have apparently been located before the disease has spread to any extent, and with sufficient funds it should be possible to control it. Nevertheless, the danger of its becoming established in the west is very great. A strict enforcement of the federal quarantine and continued vigilance on the part of federal scouts will be necessary to prevent its introduction and spread into a region where control may prove impossible.

The territory between British Columbia and Mexico includes the range of the western white pine and sugar pine which are very important timber trees. Several other five needled species found in this section, while valuable to some extent for lumber, are even more valuable as a covering for high mountain water-sheds. Moreover, there are more than 60 species of Ribes native to this region. This combination of several species of pine susceptible to the rust and an extraordinarily large number of Ribes species affords ideal conditions for the development and spread of the disease throughout the entire range of the western five needled pines.

NEW INVESTIGATIONS BY THE BOTANICAL DEPARTMENT.

Though the general life history of the blister rust had previously been worked out in Europe there were some lesser phases, unknown or in doubt, when the botanical investigations were first undertaken by Doctors Clinton and McCormick of this Station. The life history in general has been covered by their work, but special emphasis was laid upon the doubtful or unknown points. A part of these investigations have been published in Bulletin 214 (pp. 428-459) of this Station, and in papers read before the Blister Rust Conferences and the Botanical Society of America. Additional details will be given in a bulletin of the Station to be published during 1922.

The main new points brought out in their investigations were along two lines. First, as regards the point of entrance of the fungus in the pine, it was shown by artificial infections that this takes place through the leaves, and that a very definite method is followed. The germinating sporidia gain entry by a germ tube through the stomates, or breathing pores, into the interior of the

leaf and immediately form an enlargement which may have several functions, such as a hold fast, storehouse for food, etc. From this swelling an infection thread proceeds through the stomatal cavity and comes in contact with the leaf cells. A tube is sent into the cell for food, and then a vigorous growth of threads results in the intercellular spaces, in time forming a sclerotial mass of fungous threads. This development kills the green coloring matter of the cells, with the result that a golden-yellow spot shows on the leaf near the spot where the fungus entered. In time the fungous threads come in contact with the food carrying ducts of the leaf, and then in an inconspicuous manner rapidly work lengthwise of the leaf, especially downward, until they reach the bark, where a vigorous development takes place resulting in the swelling already noted. These facts have all been confirmed by similar observations on infections taking place in nature. While natural infection of the leaves takes place in the fall, the external evidence, through the golden yellow spots on the leaves, is not conspicuous until the following spring or early summer.

The second point brought out was that not only the five needled pines but also seedlings of certain two and three needled pines could be artificially infected, some as readily and vigorously as the white pine. On some of these hosts the infection has proceeded as far as any that has taken place in infection work at this Station with white pine of the same age: namely, to where the infected stems produced the pycnial stage. Altogether some thirty different species of seedlings of the genus Pinus have been experimented with, and at least fifteen of these have become infected in the leaves. The varying vigor of the rust's development indicates difference in resistance of the species inoculated, so that no doubt with certain of them infection proceeds no further than invasion of the leaf, and so fails of true infection.

As regards infection of Ribes with the aeciopores from white pine, successful inoculations have been made with twenty-six species. Some species show much more resistance to infection than do others, cultivated black currants being one of the most susceptible.

A SURVEY OF WHITE PINE IN CONNECTICUT.

The pine survey for Connecticut, which was made during the winters of 1919-1920 and 1920-1921, has been briefly referred to in other parts of this report. The object of the work was to furnish data on the amount and location of white pine growing within the state. As such figures would manifestly not be accurate for any extended period, it was decided to accomplish the work at as low a cost as possible consistent with reasonable accuracy.

Since there is no considerable amount of white pine outside of Litchfield, Hartford, Tolland, Windham and New London Counties, the survey was limited to such portions of these counties as were known to contain pine.

The U. S. G. S. topographic sheets were used for the mapping. With the aid of a pocket compass and pacing, the boundaries of the various blocks of pine were sketched in. Three general types were plotted upon the map.

a. Pine reproduction; stands under 25 years of age with pine forming 60% or more of the mixture.

b. Pure pine; stands over 25 years of age with pine forming 60% or more of the mixture.

c. Pine-hardwoods; mixed stands with other species forming more than 40% of the mixture.

The country was divided into blocks with the highways as boundaries and further subdivided into the various types, for each of which notes were made showing:—

- | | |
|------------------------|-----------------------------------|
| a. Age class. | c. Area in acres. |
| b. Percentage of pine. | d. Volume in board feet per acre. |

Areas were obtained by scaling the map. Age was roughly determined by counting the whorls of branches. The estimates of percentage and value were, of necessity, made largely by eye but were checked by the frequent laying out of plots on which more careful estimates were made. In practically all cases supplemental notes regarding the character of the timber, reproduction, etc., were kept for each type.

From field data thus gathered it was possible to compile figures on area of reproduction, area of pure pine, area of pine in mixture with other species and the stand in board feet for each town surveyed. Figures of total forest area were taken from the Forest Survey of Connecticut, published in the annual report of this Station for 1915. Fifty-two towns were covered in whole or in part. A summary of the information for each county by towns follows.

HARTFORD COUNTY.

Town	Pure Pine Reproduction Acres	Pure Pine Acres	Pine-Hard- woods Acres	Forest Area Acres	Stand of Pine B. F.
Avon	686	445	110	7,400	1,260,000
Bloomfield	34	38	20	4,350	430,000
Canton	127	479	78	11,600	370,000
E. Granby	386	198	..	4,300	240,000
E. Hartford	35	123	..	2,100	800,000
E. Windsor	16	77	125	3,400	450,000
Enfield	832	765	424	7,000	6,760,000
Farmington	500	70	..	8,000	710,000
Granby	888	923	1,446	17,000	5,550,000
Hartland	108	9	613	15,700	350,000
Manchester	84	212	45	5,700	1,650,000
Simsbury	1,216	1,252	150	10,500	8,830,000
S. Windsor	12	92	145	4,800	990,000
Suffield	215	203	115	5,450	450,000
Windsor	30	455	352	7,300	4,210,000
Windsor Locks	685	271	..	2,550	890,000
Totals	5,854	5,612	3,623	117,150	33,940,000

LITCHFIELD COUNTY.

Town	Pure Pine Reproduction Acres	Pure Pine Acres	Pine-Hard- woods Acres	Forest Area Acres	Stand of Pine B. F.
Barkhamsted	1,129	336	3,141	15,300	5,480,000
Canaan	157	333	9,587	15,500	1,372,000
Colebrook	1,211	964	8,613	15,400	6,120,000
Cornwall	700	444	803	18,100	6,920,000
Goshen	20	133	192	15,100	2,040,000
Harwinton	75	36	150	11,700	340,000
Litchfield	35	67	73	16,000	780,000
Morris	28	6	40	3,550	130,000
New Hartford	781	257	1,092	13,000	2,250,000
Norfolk	835	1,437	10,394	22,300	12,100,000
North Canaan	768	889	3,928	5,850	1,980,000
Salisbury	496	1,424	6,581	17,800	10,420,000
Sharon	..	42	862	17,000	310,000
Thomaston	..	3	30	4,550	60,000
Torrington	46	154	55	16,200	680,000
Winchester	433	185	2,813	12,700	1,400,000
Totals	6,714	6,710	48,354	220,050	52,382,000

NEW LONDON COUNTY.

Town	Pure Pine Reproduction Acres	Pure Pine Acres	Pine-Hard- woods Acres	Forest Area Acres	Stand of Pine B. F.
Griswold	25	5	725	9,450	40,000
Voluntown	250	437	8,812	22,500	4,910,000
Totals	275	442	9,537	31,950	4,950,000

TOLLAND COUNTY.

Town	Pure Pine Reproduction Acres	Pure Pine Acres	Pine-Hard- woods Acres	Forest Area Acres	Stand of Pine B. F.
Ellington	20	40	20	11,300	90,000
Mansfield	..	3	..	12,600	35,000
Somers	392	424	280	9,000	1,800,000
Stafford	38	447	5,341	28,800	2,980,000
Tolland	20	58	89	16,500	250,000
Union	1,000	1,594	9,831	15,000	15,920,000
Willington	73	32	145	15,900	250,000
Totals	1,543	2,598	15,706	109,100	21,325,000

WINDHAM COUNTY.

Town	Pure Pine Reproduction Acres	Pure Pine Acres	Pine-Hard- woods Acres	Forest Area Acres	Stand of Pine B. F.
Ashford	..	342	3,093	14,600	1,590,000
Brooklyn	75	69	1,770	7,500	320,000
Canterbury	..	87	932	12,800	400,000
Eastford	150	417	3,261	13,100	4,720,000
Killingly	200	274	11,556	19,100	1,020,000
Plainfield	50	36	1,873	13,000	160,000
Pomfret	100	42	2,775	12,500	440,000
Putnam	100	409	3,495	5,550	1,290,000
Sterling	50	30	4,210	13,600	300,000
Thompson	400	672	11,760	16,400	2,480,000
Woodstock	600	1,352	11,836	19,800	10,050,000
Totals	1,725	3,730	56,561	147,950	22,770,000

TOTALS BY COUNTIES.

County	Pure Pine Reproduction Acres	Pure Pine Acres	Pine-Hard- woods Acres	Forest Area Acres	Stand of Pine B. F.
Hartford	5,854	5,612	3,623	117,150	33,940,000
Litchfield	6,714	6,710	48,354	220,050	52,382,000
New London	275	442	9,537	31,950	4,950,000
Tolland	1,543	2,598	15,706	109,100	21,325,000
Windham	1,725	3,730	56,561	147,950	22,770,000
Totals	16,111	19,092	133,781	626,200	135,367,000

In the remaining 117 towns there are scattered plantations and native stands of white pine which should be included in totals for the state. The following figures are therefore thought to be conservative.

	Pure Pine Reproduction Acres	Pure Pine Acres	Pine-Hard- woods Acres	Forest Area Acres	Stand of Pine B. F.
State of Connecticut	20,000	20,000	150,000	1,483,300	150,000,000

Connecticut Agricultural Experiment Station

NEW HAVEN, CONN.

BULLETIN 238

FEBRUARY, 1922

BEING THE Report on Commercial Feeding Stuffs

1921

By E. M. BAILEY

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The Bulletins of this Station are mailed free to citizens of Connecticut who apply for them, and to other applicants as far as the editions permit.

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February, 1922.

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Commercial Feeding Stuffs.

By E. M. BAILEY.*

PROVISIONS OF THE STATUTES RELATING TO FEEDING STUFFS.

Under the Connecticut statutes the term "concentrated commercial feeding stuffs" covers practically all feeds excepting hay and straw, whole seed, unmixed meal made directly from any of the cereals or from buckwheat, and feed ground from whole grain and sold directly from manufacturer to consumer.

Under the new fertilizer law cottonseed meal is classed as a commercial fertilizer and, as such, is subject to analysis fees and tonnage tax. Provision is made, however, to exempt meal sold exclusively for feeding purposes.¹

Section 4775 requires that every lot or parcel of concentrated commercial feeding stuff shall bear a statement giving the name and address of the manufacturer or importer, the number of net pounds in the package, the name of the article, and the percentage of protein and fat contained in it. The law forbids the use of any metal in affixing tags.

No registration of feed or payment of analysis or license fees is required.

The penalty for violation of the statute is not more than \$100 fine for the first offense and not more than \$200 for each subsequent offense.

The law authorizes this station to take samples from any manufacturer or dealer, in a prescribed manner, and requires the station to analyze annually at least one sample of each brand which it has collected, and to publish these analyses "together with such additional information in relation to the character, composition and use thereof as may be of importance."

CLASSIFICATION OF SAMPLES.

The classification and summary of commercial feeding stuffs and other materials requiring fodder analysis which have been examined during the past year are as follows:

* Analyses are by Messrs. Nolan, Merwin and Fisher; inspection and sampling are by Mr. Churchill; and the compilation of results for publication is largely due to Miss Moss.

¹ Chapt. 204, Public Acts, 1919.

Official samples taken by the Station Agent	159
Samples submitted by individuals	57
Samples examined in connection with field experiments at Storrs	267
Samples examined in connection with field experiments at this station ..	52
Total	535

Only the results of the official inspection and samples submitted by individuals are included in this report. Other data are discussed elsewhere.

Official samples taken by this station are classified as follows:

Cottonseed Meal	14	Maize Products	17
Linseed Meal	6	Distillers' Products	2
Wheat Bran	19	Brewers' Products	2
Wheat Middlings	14	Dried Beet Pulp	7
Red Dog Flour	3	Dried Buttermilk	1
Wheat Mixed Feed	6	Proprietary Stock Feeds	51
Rye Products	2	Poultry Feeds	15
Total	159		

STANDARDS FOR WHEAT MILL FEEDS.

Tentative standards for wheat mill feeds, with or without screenings, have been adopted by the Association of Feed Control Officials. The figures which refer to crude fiber and represent the maximum in each case, are as follows:

Standard Middlings	9.5%
Flour Middlings	6.0
Red Dog Flour	4.0
Brown Shorts	6.5
Gray Shorts	5.5
White Shorts	3.5
Wheat Mixed Feed	8.5

SIGNIFICANCE OF THE NUTRIENT GROUPS.

The significance of the several nutrient groups as shown by the conventional proximate analysis has been discussed in previous bulletins.¹ Occasional inquiries continue to be received as to the distinction between the terms "nitrogen-free extract" and "carbohydrates" appearing upon commercial feed tags. The sense of the Association of Feed Control Officials upon this point is embodied in resolutions adopted by them as follows:

"Resolved that it is the sense of this Association that we understand the term 'Nitrogen-free Extract' to cover the product indicated by the percentage obtained by subtracting from 100 per cent. the sum of the percentages of ash, moisture, protein, fat and fiber.

"Resolved that the term 'Carbohydrates' be interpreted to cover the

product indicated by the percentage obtained by the addition of the percentages of crude fiber and nitrogen-free extract."

In practice tags often bear declarations of both "fiber" and "carbohydrates" and in such cases the term "carbohydrates" must be regarded in the sense of "nitrogen-free extract."

The Association has adopted further resolutions to the effect that the practice of packing feeds in bags containing 99 lbs. and selling the same for 100 lbs. net is condemned; and that a ton of feed is 2000 lbs. net.

COEFFICIENTS OF DIGESTIBILITY AND NET ENERGY VALUES.

The question of digestion coefficients and energy values of feeding stuffs has been discussed in previous reports.¹ These factors for most of the types of feed reported herein are given in Table I, and for others the reader is referred to the authorities cited.

TABLE I—COEFFICIENTS OF DIGESTIBILITY AND NET ENERGY VALUES OF FEEDING STUFFS.¹

Feed.	Average dry matter, lbs. per hundred.	Coefficient of digestibility.				Net energy value, Therms per hundred lbs.
		Protein.	Fiber.	Carbohydrates.	Fat.	
Cottonseed Meal.....	92.2	84	37	75	95	90.0
Cottonseed Feed	...	58	45	61	90	...
Linseed Meal (old process)....	90.0	89	57	78	89	88.9
Linseed Meal (new process)....	90.4	86	73	87	95	85.1
Wheat Bran.....	89.9	76	43	74	62	53.0
Wheat Feed.....	...	77	36	76	87	...
Wheat Middlings.....	89.6	77	30	78	88	59.1
Red Dog Flour.....	...	88	36	88	86	...
Rye Flour.....	...	80	..	88	90	...
Barley, ground.....	90.7	88	70	93	86	89.9
Barley Bran.....	...	85	20	86	87	...
Corn Gluten Meal.....	90.9	85	55	90	93	84.2
Corn Gluten Feed.....	91.3	85	76	88	85	80.7
Hominy Feed.....	89.9	66	76	90	91	81.3
Brewer's Grains.....	92.5	81	49	57	89	53.4
Malt Sprouts.....	92.4	77	87	80	85	72.7
Distillers' Grains, Corn.....	93.4	73	95	81	95	85.1
Distillers' Grains, Rye.....	92.8	59	..	67	84	56.0
Beet Pulp, dried.....	91.8	52	83	83	..	75.9
Peanut Cake, without shells....	89.3	90	9	84	90	93.6
Soybean Meal, fat extracted....	88.2	92	99	100	68	99.7
Cocoonut Cake.....	90.4	90	23	87	100	83.5

¹ Henry and Morrison, 15th Ed., pp. 118-119; Armsby and Putney, Penn. Exp. Sta., Bull. 142, 1916.

¹ Conn. Exp. Sta. Bull. 212, p. 357, 1918; Bull. 221, pp. 347-351, 1919.

¹ Conn. Exp. Sta. Bull. 206, 1918; Bull. 212, 1919.

ETHER EXTRACT IN MOLASSES FEEDS.

Our experience with the determination of fat in feeds containing molasses or other saccharine material was summarized in our report last year.¹ Over a period of seven years nearly one half (42 per cent.) of the samples examined gave lower results for ether extract when the procedure of washing out saccharine substances with water before extracting with ether was followed; in the remaining cases the results were higher. The official direct method now prescribes extracting with water before extracting with ether in cases where large amounts of soluble carbohydrates are present. We have followed this plan in cases where the ether extract was below guaranty by direct extraction with ether.

INSPECTION OF 1921.

REMARKS ON ANALYSES.

(Analyses on pages 338-357.)

The definitions of the various feeding stuffs here given are those adopted by the Association of Feed Control Officials revised to October, 1921.

COTTONSEED MEAL.

41.12 Per cent. Protein Cottonseed Meal, Choice Quality, must be finely ground, not necessarily bolted, perfectly sound and sweet in odor, yellow, free from excess of lint, and by analysis must contain at least 41.12 per cent. crude protein, equivalent to 8 per cent. of ammonia.

Cotton seed meal not fulfilling the above requirements as to color, odor or texture, shall be branded Off Quality.

38.56 Per cent. Protein Cottonseed Meal, Prime Quality, must be finely ground, not necessarily bolted, of sweet odor, reasonably bright in color, yellow, not brown or reddish, free from excess of lint, and by analysis must contain at least 38.56 per cent. crude protein, equivalent to 7.5 per cent. of ammonia.

Cottonseed meal not fulfilling the above requirements as to color, odor or texture, shall be branded Off Quality.

36 Per cent. Protein Cottonseed Meal, Good Quality, must be finely ground, not necessarily bolted, of sweet odor, reasonably bright in color, and by analysis must contain at least 36 per cent. crude protein equivalent to 7 per cent. of ammonia.

Cottonseed meal not fulfilling the above requirements as to color, odor or texture shall be branded Off Quality.

Of fourteen samples examined all satisfied their guaranties with the single exception that 18067, Surety, was 2.62 per cent. low in protein. The average composition of samples examined this year is protein 39.1, fiber 10.9 and fat 7.4 per cent. This is substantially better than the average for the same constituents for the previous six years which shows protein 37.1, fiber 11.9 and fat 6.9 per cent. The average price has been \$49.30 per ton. The

¹ Conn. Exp. Sta., Bull. 229, p. 296, 1920.

average for the six-year period just mentioned was \$58.80 but this figure reflects the abnormal prices which prevailed at the close of the war when cottonseed meal sold for over \$80 per ton.

LINSEED MEAL.

Linseed Meal is the ground product obtained after extraction of part of the oil from ground flaxseed screened and cleaned of weed seeds and other foreign materials by the most improved commercial processes, provided that the final product shall not contain over six per cent. of weed seeds and other foreign materials and provided further that no portion of the stated six per cent. of weed seeds and other foreign materials shall be deliberately added.

Old Process Oil Meal is the ground product obtained after extraction of part of the oil by crushing, cooking and hydraulic pressure from seeds screened and cleaned of weed seeds and other foreign materials by the most improved commercial processes. When used alone the term "Old Process Oil Meal" shall be understood to designate linseed meal as defined, made by the old process. When used to cover any other product the name of the seed from which it is obtained shall be prefixed to "old process oil meal."

Six samples, all old process meals, substantially met their guaranties in all respects.

WHEAT BRAN.

Wheat Bran is the coarse outer coating of the wheat kernel as separated from cleaned and scoured wheat in the usual process of commercial milling.

All of the samples examined satisfied their guaranties as to protein and fat. So far as fiber guaranties were given or known they were not exceeded. The average composition, viz., protein 16.6, fiber 9.5 and fat 5.3 per cent. is substantially better than the average for the previous six years, viz., protein 15.7, fiber 10.1 and fat 5.0 per cent.

WHEAT MIDDINGS.

Standard Middlings (Red Shorts or Brown Shorts) consists mostly of the fine particles of bran, germ and very little of the fibrous offal obtained from the "tail of the mill." This product must be obtained in the usual commercial process of milling.

Gray Shorts (Gray Middlings or Total Shorts) consists of the fine particles of the outer bran, the inner bran or bee-wing bran, the germ, and the offal or fibrous material obtained from the "tail of the mill." This product must be obtained in the usual process of commercial milling.

White Shorts or White Middlings consists of a small portion of the fine bran particles and the germ and a large portion of the fibrous offal obtained from the "tail of the mill." This product must be obtained in the usual process of flour milling.

One sample, 17986, exceeded the maximum fiber guaranty by 2.04 per cent. and exceeded also the tentative limit of fiber pre-

scribed for standard middlings¹ by 1.04 per cent. No deficiencies were found in protein or fat.

The average composition of feeds classed as middlings without further qualification has been, for the previous six years, protein 16.7, fiber 6.9 and fat 5.2 per cent.; the average shown by analyses this year is protein 17.5, fiber 6.9 and fat 5.2 per cent.

RED DOG FLOUR.

Red Dog Flour consists of a mixture of low-grade flour, fine particles of bran and the fibrous offal from the "tail of the mill."

Only three samples of this material have been examined this year. The guaranties of protein and fat were met, or reasonably substantiated, and the average fiber content did not exceed the tentative standard set for this product, viz., 4 per cent. One sample, **18046**, contained 4.27 per cent. of fiber.

MIXED FEED.

Wheat Mixed Feed (Mill Run Wheat Feed) consists of pure wheat bran and the gray or total shorts or flour middlings combined in the proportions obtained in the usual process of commercial milling.

Six samples were examined and all satisfied their guaranties of protein and fat. One sample, **17972**, exceeded the fiber content fixed for wheat feed² but the average was well below the tentative standard. The average for protein, fiber and fat as shown by analyses this year is 17.06, 7.68 and 5.13 per cent. respectively while the average for the same ingredients for the previous six years is 16.3, 7.8 and 5.0 per cent. respectively. It is apparent that protein content has increased while the other constituents have maintained the average.

RYE PRODUCTS.

Rye Middlings or Rye Feed is the by-product obtained from the manufacture of ordinary "100 per cent" rye flour from cleaned and scoured rye grain.

The two samples of rye feed examined conformed to their guaranties for protein and fat.

CORN GLUTEN FEED.

Corn Gluten Feed is that portion of commercial shelled corn that remains after the separation of the larger part of the starch and the germs by the processes employed in the manufacture of cornstarch and glucose. It may or may not contain corn solubles.

¹ By the Association of Feed Control Officials, 1921.

² Ibid.

Four samples were examined which satisfied their guaranties of protein and fat except in case of **15724** where a deficiency of 1.41 per cent. in fat was found.

CORN GLUTEN MEAL.

Corn Gluten Meal is that part of commercial shelled corn that remains after the separation of the larger part of the starch, the germ and the bran, by the processes employed in the manufacture of cornstarch and glucose. It may or may not contain corn solubles.

Only one sample was examined. It exceeded its guaranty in both protein and fat.

HOMINY FEED.

Hominy Feed, Hominy Meal or Hominy Chop is the kiln-dried mixture of the mill run bran coating, the mill run germ, with or without a partial extraction of the oil and a part of the starchy portion of the white corn kernel obtained in the manufacture of hominy, hominy grits and corn meal by the degerminating process.

Eleven samples were examined. Three, **15752**, **18060** and **18022** were deficient in fat and one, **17983**, contained an excess of fiber.

CORN MEAL.

Only one sample was examined. It was of normal composition and quality.

DISTILLERY AND BREWERY PRODUCTS.

Two samples each of distillers' and brewers' dried grains were examined. They satisfied their respective guaranties except in case of **15755** which was 1.44 per cent. low in protein.

DRIED BEET PULP.

Dried Beet Pulp is the dried residue from sugar beets which have been cleaned and freed from crowns, leaves and sand, and which have been extracted in the process of manufacturing sugar.

Seven samples were examined. The guaranties of protein and fat were satisfactorily met and generally exceeded. No significant excess of fiber was found.

PROPRIETARY MIXED FEEDS.

The variety of sources from which these mixtures derive their nutrients results in a supplementing of nutritive qualities which is in harmony with modern ideas of efficient feeding. When compounded with materials of approved feeding value free from excess of hulls, screenings, etc., they are desirable feeds. As to

the economy of their use we are unable to discover any logical relation between selling price and composition. The ingredients of which these feeds are composed are generally stated on the tags and this information, although not required by law in this state, is valuable to the feeder.

Of fifty-one samples examined only five failed to satisfy their guaranties, and in only two of these were the deficiencies conspicuous. There was a deficiency in protein of 2.06 per cent. in 18023 and deficiencies in both protein and fat in 18047, the amounts being 1.37 and 0.91 per cent. respectively.

POULTRY FEEDS.

Fifteen samples were analyzed. A deficiency in protein of 5.75 per cent. was found in 18008.

SUMMARY OF DEFICIENCIES

Variations from guaranty greater than one per cent. in protein and in fiber and one-fourth of one per cent. in fat are summarized in Table II.

TABLE II.—FEEDS NOT CONFORMING TO GUARANTIES OR OTHERWISE ILLEGAL.

Station No.	Manufacturer and Brand.	Protein Deficiency.	Fat Deficiency.	Fiber Excess.	Remarks.
	<i>Cottonseed Meal</i>				
18067	Surety. American Cotton Oil Co., Memphis, Tenn.....	2.62	....	....	.....
17989	Danish. Humphreys-Godwin Co., Memphis, Tenn.....	....	....	....	Wire tags, illegal.
15728	Sun. A. C. Westervelt & Co., Mem- phis, Tenn.....	....	....	....	Wire tags, illegal.
	<i>Linseed Meal</i>				
17998	Oil Meal. Kelloggs & Miller, Amster- dam, N. Y.....	....	....	....	Wire tags, illegal.
	<i>Wheat Middlings</i>				
17986	Hecker-Jones-Jewell Milling Co., N. Y.....	....	....	2.04	.....
	<i>Wheat Feed (Mixed Feed)</i>				
15722	Wirthmore. St. Albans Grain Co., St. Albans, Vt.....	....	0.47	....	.....
	<i>Corn Gluten Feed</i>				
15724	Success. U. S. Food Products Corp. Peoria, Ill.....	....	1.41	....	.....
	<i>Hominy Feed</i>				
15752	Illinois Snowflake. Illinois Feed & Elevator Co., Bloomington, Ill..	....	0.48	....	.....
17983	White. Kellogg Toasted Corn Flake Co., Battle Creek, Mich.....	....	....	2.27	.....
18060	Plymouth. Plymouth Milling Co., Lemars, Iowa.....	....	2.00	....	.....
18022	Sparr Cereal Co., Marchfield, Wis..	....	0.55	....	.....
	<i>Brewers' Products</i>				
15755	Dried Brewers' Grains. Atlantic Ex- port Co., N. Y.....	1.44	....	....	.....
	<i>Proprietary Mixed Feeds.</i>				
18002	Blatchford's Calf Meal, Blatchford Calf Meal Co., Wauregan, Ill...	....	0.39	....	.....
18023	Vitality Milk Ration. Rosenbaum Bros., Chicago, Ill.....	2.06	....	....	.....
18026	Nobotheration Stock Feed. C. W. Campbell Co., Westerly, R. I...	....	1.09	....	.....
18047	Delaware. Delaware Mills, Deposit, N. Y.....	1.37	0.91	....	.....
	<i>Poultry Feeds</i>				
18008	Wirthmore. St. Albans Grain Co., St. Albans, Vt.....	5.75	....	....	.....

TABLE III.—ANALYSES OF COMMERCIAL FEEDS,

Station No.	Manufacturer and Brand.	Retail Dealer.
OIL SEED PRODUCTS.		
<i>Cottonseed Meal.</i>		
18001	Longhorn. American Cotton Oil Co., Memphis, Tenn.	Middletown: Meech & Stoddard, Inc.
18067	Surety. American Cotton Oil Co., Memphis, Tenn.	Guaranty
18065	Monarch. Ashcraft-Wilkinson Co., Atlanta, Ga.	Middletown: Meech & Stoddard, Inc.
15747	Paramount. Ashcraft-Wilkinson Co., Atlanta, Ga.	Guaranty
18028	St. Clair. East St. Louis Cotton Oil Co., National Stock Yards, Ill.	Hartford: Garber-Northam Grain Co.
15726	Bull. Humphreys-Godwin Co., Memphis, Tenn.	Guaranty
17989†	Danish. Humphreys-Godwin Co., Memphis, Tenn.	West Cheshire: G. W. Thorpe.
15765	Dixie. Humphreys-Godwin Co., Memphis, Tenn.	Guaranty
18054	Forfat. Humphreys-Godwin Co., Memphis, Tenn.	Westerly: C. W. Campbell Co.
17994	Economy. Lyle & Lyle, Huntsville, Ala.	Guaranty
15758	Syracold. Syracuse Milling Co., Syracuse, N. Y.	Willimantic: Willimantic Grain Co.
17999	Taylor Commission Co., Atlanta, Ga.	Guaranty
15721	Planet. A. C. Westervelt & Co., Memphis, Tenn.	Wallingford: A. E. Hall.
15728†	Sun. A. C. Westervelt & Co., Memphis, Tenn.	Guaranty
18043	Amco. American Milling Co., Peoria, Ill.	Rockville: Rockville Milling Co.
15729	Ground Oil Cake. Archer-Daniels Linseed Co., Buffalo, N. Y.	Guaranty
		Torrington: D. L. Talcott.
		Guaranty
		Plantsville: C. A. Cowles.
		Guaranty
		Somers: W. C. Everett.
		Guaranty
		Middletown: Meech & Stoddard, Inc.
		Guaranty
		So. Coventry: So. Coventry Grain Elevator.
		Guaranty
		Willimantic: E. A. Buck Co.
		Guaranty
		Average guaranty
		Average of analyses
		Average digestible
		New Haven: R. G. Davis & Sons.
		Guaranty
		Willimantic: E. A. Buck Co.
		Guaranty

INSPECTION OF 1921.

Station No.	Pounds per Hundred.						Price per ton.
	Water.	Ash.	Protein (N x 6.25).	Fiber.	Nitrogen-free Extract (Starch, gum, etc.).	Ether Extract (Crude Fat).	
18001	5.59	7.35	43.31	8.13	26.37	9.25	\$52.00
18067	6.50	5.67	33.38	14.74	33.55	6.16	.....
18065	5.38	7.35	44.06	7.73	27.49	7.99	51.00
15747	6.94	6.00	36.88	12.99	30.52	6.67	49.00
18028	7.03	6.41	36.88	11.70	31.64	6.34	50.00
15726	6.01	6.77	42.75	8.60	28.88	6.99	43.00
17989	6.48	5.61	36.75	14.11	30.31	6.74	49.00
15765	6.02	6.09	42.56	8.84	29.18	7.31	50.00
18054	5.93	7.34	39.50	9.51	30.00	7.72	52.00
17994	6.24	6.63	36.44	11.11	32.37	7.21	49.00
15758	6.57	6.60	36.56	12.98	30.23	7.06	48.00
17999	6.84	5.90	37.56	11.98	29.31	8.41	48.00
15721	6.36	7.08	43.38	7.40	27.01	8.77	52.00
15728	5.83	6.28	38.06	12.19	30.60	7.04	48.00
			36.00	15.00	25.00	5.00	.....
			38.53	12.92	25.69	5.32	.....
	6.26	6.50	39.14	10.85	29.85	7.40	49.30
			32.9	4.0	22.4	7.0	.....
18043	8.22	5.94	31.06	8.87	40.26	5.65	54.00
15729	7.07	5.94	30.31	8.65	39.37	8.66	48.00
			31.00	10.00	.....	6.00	.....

† Wire tags.

TABLE III.—ANALYSES OF COMMERCIAL FEEDS,

Station No.	Manufacturer and Brand.	Retail Dealer.
OIL SEED PRODUCTS— <i>Concluded</i> <i>Linseed Meal, Old Process—Concluded</i>		
17998†	Oil Meal. Kellogg & Miller, Amsterdam, N. Y.	Middlefield: Middlefield Grain & Coal Co..... Guaranty.....
18050	Linseed Cake. Linseed Products Co., Minneapolis, Minn.....	New Milford: Geo. T. Soule.. Guaranty.....
18016	Linseed Oil Meal. Mann Bros. Co., Buffalo, N. Y.....	Norwich: Yantic Grain & Products Co..... Guaranty.....
17988	Oil Meal. Spencer Kellogg & Sons, Inc., Undercliff, N. J.....	Wallingford: A. E. Hall..... Guaranty..... Average guaranty..... Average of analyses..... Average digestible.....
WHEAT PRODUCTS. <i>Wheat Bran.</i>		
18020	Pennant. E. W. Bailey & Co., Montpelier, Vt.	Norwich: Yantic Grain and Products Co..... Guaranty.....
18007	Bay State. Bay State Milling Co., Winona, Minn.....	New London: Conn. Grain Corp..... Guaranty.....
15734*	The Blair Milling Co., Atchison, Kans.....	East Haven: F. A. Forbes..... Guaranty.....
18056*	Granite. J. G. Davis Co., Rochester, N. Y.....	Torrington: D. L. Talcott..... Guaranty.....
15767*	Duluth Imperial. Duluth Superior Milling Co., Duluth, Minn.....	Rockville: Rockville Grain & Coal Co..... Guaranty.....
18019*	Duluth Imperial. Duluth Superior Milling Co., Duluth, Minn.....	Norwich: Yantic Grain & Products Co..... Guaranty.....
18053*	Lucky. Federal Mill & Lockport Elevator Co., N. Y.....	New Milford: Geo. E. Ackley Co..... Guaranty.....
15757	Pure. Grafton Roller Mill Co., Grafton, No. Dakota.....	Thompsonville: Geo. S. Phelps & Co..... Guaranty.....
17995*	Choice. Hecker-Jones-Jewell Milling Co., N. Y.	Plantsville: C. A. Cowles..... Guaranty.....
15751	The Jenkinson Mills Co., Williston, No. Dakota.	West Cheshire: G. W. Thorpe. Guaranty.....
15738*	The Kaul Milling Co., Kansas City Kans.....	Branford: S. V. Osborn..... Guaranty.....
15753	Niagara Pure. Niagara Falls Milling Co., Niagara Falls, N. Y.....	Thompsonville: Geo. S. Phelps & Co..... Guaranty.....

† Wire tags.

* With screenings.

INSPECTION OF 1921—*Continued.*

Station No.	Pounds per Hundred.						Price per ton.
	Water.	Ash.	Protein (N. x 6.25).	Fiber.	Nitrogen-free Extract (Starch, gum, etc.).	Ether Extract (Crude Fat).	
17998	7.97	6.20	31.13	8.73	39.62	6.35	\$54.00
18050	8.20	6.11	31.00	9.00	40.67	4.00	50.00
18016	8.25	5.18	29.75	7.84	30.00	7.43	50.00
17988	8.02	6.27	30.00	8.18	35.94	5.00	50.00
18020	8.84	6.91	31.00	10.00	40.78	6.00	50.00
18007	8.58	6.32	31.00	10.00	39.45	6.38	50.00
15734	8.01	6.58	27.9	4.8	30.8	5.16	51.00
18056	8.57	5.88	16.81	9.92	52.81	6.84	51.00
15767	8.72	6.01	14.50	10.00	4.00	6.1	51.00
18019	8.15	5.81	16.13	9.94	53.78	4.71	31.00
18053	8.40	6.48	13.00	9.94	53.34	4.00	30.00
15757	7.19	6.19	17.25	8.22	55.34	5.25	25.00
17995	8.16	6.48	14.50	10.00	56.56	4.60	34.00
15751	7.45	6.59	17.00	8.63	52.15	3.36	27.00
15738	8.74	6.54	15.00	9.59	53.43	4.00	31.00
15753	7.53	6.11	15.56	10.44	53.83	5.29	29.00
			12.00	9.50	54.63	3.50	27.00
			15.00	9.94	50.64	3.00	28.00
			14.50	12.00	51.55	8.78	25.00
			16.00	10.82	53.36	3.75	25.00
			15.49	8.29	53.54	5.78	27.00
			18.06	10.00	54.66	4.39	27.00
			14.50	8.48	54.66	4.83	27.00
			17.94	8.48	54.66	3.50	27.00
			16.00	8.48	54.66	3.50	27.00

TABLE III.—ANALYSES OF COMMERCIAL FEEDS,

Station No.	Manufacturer and Brand.	Retail Dealer.
WHEAT PRODUCTS—Continued.		
<i>Wheat Bran—Concluded.</i>		
17992	Niagara Choice. Niagara Falls Milling Co., Niagara Falls, N. Y.	Meriden: August Grulich Est. Guaranty
17971*	Pillsbury's. Pillsbury Mills, Minneapolis, Minn.	Ansonia: Ansonia Flour & Grain Co. Guaranty
17969	Quaker City Flour Mills Co., Philadelphia, Pa.	North Haven: W. L. Thorpe. Guaranty
15766*	Washburn Mills, Minneapolis, Minn.	Rockville: Rockville Milling Co. Guaranty
18068*	Washburn-Crosby Co., Minneapolis, Minn.	Middletown: Meech & Stod- dard, Inc. Guaranty
18024*	Pioneer. Western Canada Flour Mills Co., Canada	Jewett City: Jewett City Grain Co. Guaranty
17976*	Atkinson's. Made in Minneapolis, Minn.	Southport: C. Buckingham & Co. Guaranty
		Average guaranty
		Average of analyses
		Average digestible
<i>Wheat Middlings.</i>		
17973	Bay State. Bay State Milling Co., Winona, Minn.	Ansonia: Ansonia Flour & Grain Co. Guaranty
18010*	Dairy Maid. Federal Mill & Elev. Co., Lock- port, N. Y.	New London: P. Swartz Co. Guaranty
17986*	Hecker-Jones-Jewell Milling Co., New York.	Stamford: W. L. Crabb. Guaranty
15745*	Rex. Maple Leaf Milling Co., Toronto, Canada	Hamden: I. W. Beers. Guaranty
17991	Niagara. Niagara Falls Milling Co., Niagara Falls, N. Y.	Meriden: August Grulich Est. Guaranty
18033*	Pillsbury's B. Pillsbury Mills, Minneapolis, Minn.	Plainville: Eaton Bros. Guaranty
17966	Quaker City. Quaker City Flour Mills Co., Philadelphia, Pa.	North Haven: W. L. Thorpe. Guaranty
18021*	Alta. Russell Miller Milling Co., Minneapolis, Minn.	Norwich: Yantic Grain & Products Co. Guaranty
15742*	Snowball. Shane Bros. & Wilson Co., Minne- apolis, Minn.	Guilford: Fred C. Morse. Guaranty
18005*	Angelus. Thompson Milling Co., Lockport, N. Y.	New Britain: C. W. Lines Co. Guaranty
15740*	Geo. Urban Milling Co., Buffalo, N. Y.	Branford: S. V. Osborn. Guaranty

* With screenings.

INSPECTION OF 1921—Continued.

Station No.	Pounds per Hundred.						Price per ton.
	Water.	Ash.	Protein (N x 6.25).	Fiber.	Nitrogen-free Extract (Starch, gum, etc.).	Ether Extract (Crude Fat).	
17992	8.46	6.29	17.19	9.15	53.82	5.09	\$29.00
.....	.....	.....	16.00	.....	.....	3.50	.....
17971	8.77	5.98	16.50	9.91	53.70	5.14	28.00
.....	.....	.....	13.00	.....	.....	4.00	.....
17969	8.85	6.33	15.38	8.54	56.17	4.73	27.00
.....	.....	.....	13.00	.....	.....	3.00	.....
15766	9.18	6.36	16.50	9.89	53.00	5.07	25.00
.....	.....	.....	13.00	.....	.....	4.00	.....
18068	8.84	6.65	15.63	10.09	54.39	4.40	.....
.....	.....	.....	13.00	.....	.....	4.00	.....
18024	9.29	5.94	16.56	9.13	53.44	5.64	29.00
.....	.....	.....	14.50	.....	.....	3.50	.....
17976	7.13	6.52	16.25	9.78	54.97	5.35	30.00
.....	.....	.....	13.00	.....	.....	4.00	.....
.....	.....	.....	14.15	10.50	.....	3.64	.....
.....	8.36	6.31	16.60	9.51	53.92	5.30	28.27
.....	.....	.....	12.6	4.0	40.1	3.3	.....
17973	11.24	2.85	17.38	2.61	61.92	4.00	40.00
.....	.....	.....	14.00	.....	.....	2.00	.....
18010	8.25	4.72	16.38	6.36	59.25	5.04	30.00
.....	.....	.....	13.00	.....	.....	3.00	.....
17986	6.85	5.29	17.50	10.54	53.96	5.86	28.00
.....	.....	.....	15.50	8.50	54.24	4.50	.....
15745	8.72	4.47	17.63	7.93	55.42	5.83	28.00
.....	.....	.....	16.00	.....	.....	5.50	.....
17991	8.13	4.80	18.13	7.98	55.42	5.54	30.00
.....	.....	.....	16.50	.....	.....	3.50	.....
18033	9.09	5.35	16.88	8.56	55.58	4.54	33.00
.....	.....	.....	14.00	.....	.....	4.00	.....
17966	8.62	3.78	16.69	4.47	61.33	5.11	36.00
.....	.....	.....	14.00	.....	.....	4.00	.....
18021	7.99	5.10	19.00	8.01	53.50	6.40	34.00
.....	.....	.....	15.00	.....	.....	4.50	.....
15742	9.16	4.37	18.75	5.36	57.59	4.77	34.00
.....	.....	.....	16.00	.....	.....	4.00	.....
18005	8.38	4.76	16.94	7.16	57.85	4.91	32.00
.....	.....	.....	11.00	.....	.....	3.00	.....
15740	8.39	5.40	16.06	7.95	56.99	5.21	30.00
.....	.....	.....	15.00	9.50	.....	4.00	.....

TABLE III.—ANALYSES OF COMMERCIAL FEEDS,

Station No.	Manufacturer and Brand.	Retail Dealer.
<i>WHEAT PRODUCTS—Concluded</i>		
<i>Wheat Middlings—Concluded</i>		
18061*	Victor. Victor Flour Mills, Victor, N. Y.....	Winsted: E. Manchester & Sons..... Guaranty.....
15720*	Standard. Washburn-Crosby Co., Minneapolis. Minn.....	Stafford Springs: Dennis Grain Mill..... Guaranty.....
17974*	Atkinson's. Made in Minneapolis, Minn.....	Southport: C. Buckingham & Co..... Guaranty..... Average guaranty..... Average of analyses..... Average digestible.....
<i>Red Dog Flour.</i>		
18046	Marshall Milling Co., Marshall, Minn.....	Danbury: F. C. Benjamin.... Guaranty.....
18062	Komo. St. Paul Milling Co., St. Paul, Minn....	Hartford: Meech Grain Co.... Guaranty.....
18041	Adrian. Washburn-Crosby Co., Minneapolis, Minn.....	New Haven: R. G. Davis & Sons..... Guaranty..... Average guaranty..... Average of analyses..... Average digestible.....
<i>Wheat Feed (Mixed Feed).</i>		
15754	Grafton. Grafton Roller Mill Co., Grafton, No. Dakota.....	Thompsonville: Geo. S. Phelps & Co..... Guaranty.....
18045*	Pillsbury's Fancy. Pillsbury Mills, Minneapolis, Minn.....	Danbury: H. E. Meeker.... Guaranty.....
15741	Occident. Russell Miller Milling Co., Minneapolis, Minn.....	Guilford: Fred C. Morse.... Guaranty.....
15722	Wirthmore. St. Albans Grain Co., St. Albans, Vt.....	South Coventry: South Coventry Grain Elev..... Guaranty.....
17972	Gold Mine. Sheffield King Milling Co., Minneapolis, Minn.....	Ansonia: Ansonia Flour & Grain Co..... Guaranty.....
18057	Kent. Williams Bros. Co., Kent, Ohio.....	Winsted: E. Manchester & Sons Guaranty..... Average guaranty..... Average of analyses..... Average digestible.....

*With screenings.

INSPECTION OF 1921—Continued.

Station No.	Pounds per Hundred.						Price per ton.
	Water.	Ash.	Protein (N. x 6.25).	Fiber.	Nitrogen-free Extract (Starch, gum, etc.).	Ether Extract (Crude Fat).	
18061	8.56	5.37	17.50	7.38	55.29	5.90	\$33.00
....	....	....	17.50	....	....	5.00	....
15720	9.61	5.03	17.69	7.67	54.71	5.29	26.00
....	....	....	14.00	....	....	4.00	....
17974	9.46	4.13	18.25	5.08	58.14	4.94	30.00
....	....	....	15.00	....	....	5.00	....
....	....	....	14.75	....	....	4.00	....
....	8.74	4.67	17.48	6.93	56.95	5.23	31.71
....	....	....	13.5	2.1	44.4	4.6	....
18046	9.88	3.60	18.06	4.27	59.85	4.34	44.00
....	....	....	15.00	....	....	4.00	....
18062	8.87	4.63	19.50	3.61	57.74	5.65	54.00
....	....	....	16.00	....	....	4.00	....
18041	9.68	2.63	16.75	2.99	64.18	3.77	43.00
....	....	....	16.00	....	....	4.00	....
....	....	....	15.66	....	....	4.00	....
....	9.47	3.62	18.10	3.62	60.60	4.59	47.00
....	....	....	15.93	1.30	53.32	3.95	....
15754	8.17	5.62	17.13	8.25	55.23	5.60	29.00
....	....	....	14.00	....	....	2.70	....
18045	8.53	4.59	17.94	6.49	57.21	5.24	36.00
....	....	....	14.00	....	....	4.00	....
15741	8.87	5.72	19.00	8.41	52.04	5.96	28.00
....	....	....	16.00	....	....	4.50	....
15722	8.68	4.43	16.75	6.40	59.54	4.20	38.00
....	....	....	15.00	....	....	4.50	....
17972	8.74	5.34	16.44	9.39	54.79	5.30	30.00
....	....	....	15.00	....	....	4.50	....
18057	8.84	5.27	15.13	7.18	59.10	4.48	38.00
....	....	....	16.00	....	....	3.50	....
....	....	....	15.00	....	....	3.95	....
....	8.64	5.16	17.06	7.68	56.33	5.13	33.16
....	....	....	13.14	2.76	42.82	4.44	....

TABLE III.—ANALYSES OF COMMERCIAL FEEDS,

Station No.	Manufacturer and Brand.	Retail Dealer.
RYE PRODUCTS.		
18040	Feed. Boutwell Milling Co., Troy, N. Y.....	<i>New Haven:</i> R. G. Davis & Sons.....
18055	Irving Mills Feed. Van Vechting Milling Co., Rochester, N. Y.....	<i>Torrington:</i> D. L. Talcott.... Guaranty.....
MAIZE PRODUCTS.		
<i>Corn Gluten Feed.</i>		
15733	Buffalo. Corn Products Refining Co., N. Y....	<i>East Haven:</i> F. A. Forbes.... Guaranty.....
18000	Douglas. Penick & Ford., Inc., Chicago, Ill....	<i>Middletown:</i> Meech & Stoddard, Inc..... Guaranty.....
17970	Staley's. A. E. Staley Mfg. Co., Decatur, Ill...	<i>Ansonia:</i> Ansonia Flour & Grain Co..... Guaranty.....
15724	Success. U. S. Food Products Corp., Peoria, Ill.	<i>Willimantic:</i> Willimantic Grain Co..... Guaranty..... Average guaranty..... Average of analyses..... Average digestible.....
<i>Corn Gluten Meal.</i>		
18030	Diamond. Corn Products Refining Co., N. Y..	<i>Westerly:</i> C. W. Campbell Co..... Guaranty.....
<i>Hominy Feed.</i>		
17978	Homco. American Hominy Co., Indianapolis, Ind.....	<i>Norwalk:</i> C. E. Slauson Co.. Guaranty.....
15737	Emco. Evans Milling Co., Indianapolis, Ind...	<i>Branford:</i> S. V. Osborn..... Guaranty.....
15752	Illinois Snowflake. Illinois Feed & Elevator Co., Bloomington, Ill.....	<i>Thompsonville:</i> Geo. S. Phelps & Co..... Guaranty.....
17983	White. Kellogg Toasted Corn Flake Co., Battle Creek, Mich.....	<i>Stamford:</i> W. L. Crabb..... Guaranty.....
18003	Badger. Chas. A. Krause Milling Co., Milwaukee, Wis.....	<i>Middletown:</i> Meech & Stoddard, Inc..... Guaranty.....
15743	Choice Steam Cooked. Miner-Hillard Milling Co., Wilkes-Barre, Pa.....	<i>Guilford:</i> Fred C. Morse..... Guaranty.....
18066	Mystic. Mystic Mills, Sioux City, Iowa.....	<i>Hartford:</i> Garber-Northam.. Grain Co..... Guaranty.....

INSPECTION OF 1921—Continued.

Station No.	Pounds per Hundred.						Price per ton.
	Water.	Ash.	Protein (N x 6.25).	Fiber.	Nitrogen-free Extract (Starch, gum, etc.).	Ether Extract (Crude Fat).	
18040	8.79	3.81	15.44	4.29	64.49	3.18	\$32.00
18055	8.64	3.28	16.50	3.95	64.33	3.30	29.00
15733	6.50	5.13	25.50	7.15	52.52	3.20	38.00
18000	6.83	4.31	23.25	6.73	56.74	2.14	38.50
17970	8.50	3.60	24.44	6.62	54.43	2.41	40.00
15724	6.63	4.08	23.75	7.83	54.12	3.59	38.00
			23.00	9.00		5.00	
			23.00			2.00	
	7.11	4.28	24.23	7.08	54.47	2.83	38.62
			20.6	3.9	49.0	2.6	
18030	7.79	1.56	45.25	11.61	30.73	3.06	54.00
			40.00			1.00	
17978	6.67	2.72	10.94	5.07	66.59	8.01	35.00
15737	8.49	2.99	11.75	4.97	62.13	9.67	34.00
			10.00	7.00	55.00	7.50	
15752	9.94	1.25	9.50	1.90	73.39	4.02	30.00
			9.50	3.00		4.50	
17983	6.57	2.51	11.00	7.27	65.62	7.03	37.00
			10.00	5.00	55.00	5.00	
18003	8.08	3.01	12.25	3.46	65.78	7.42	31.00
15743	8.55	2.13	10.81	4.68	68.19	5.64	31.00
			10.00	5.00		4.00	
18066	8.24	2.31	10.56	4.10	68.07	6.72	32.00
			8.50	5.00	65.00	4.00	

TABLE III.—ANALYSES OF COMMERCIAL FEEDS,

Station No.	Manufacturer and Brand.	Retail Dealer.
MAIZE PRODUCTS—Concluded.		
15750	The Patent Cereal Co., Geneva, N. Y.	West Cheshire: G. W. Thorpe.
18017	Plymouth. Plymouth Milling Co., Lemars, Iowa.	Guaranty..... Yantic: Yantic Grain & Products Co.....
18060	Plymouth. Plymouth Milling Co., Lemars, Iowa.	Guaranty..... Winsted: E. Manchester & Sons.....
18022	Sparr Cereal Co., Marchfield, Wis.	Guaranty..... Yantic: Yantic Grain & Products Co.....
		Guaranty.....
		Average guaranty.....
		Average of analyses.....
		Average digestible.....
Corn Meal.		
18069	Meech & Stoddard, Inc., Middletown.	Middletown: Meech & Stoddard, Inc.....
DISTILLERS' PRODUCTS.		
18042	Corn Distillers' Dried Grains. American Milling Co., Peoria, Ill.	New Haven: R. G. Davis & Sons.....
18059	Rossville Distillers' Dried Grains. The Rossville Co., Lawrenceburg, Ind.	Guaranty..... Winsted: E. Manchester & Sons.....
		Guaranty.....
BREWERS' PRODUCTS.		
15755	Dried Brewers' Grains. Atlantic Export Co., N. Y.	Thompsonville: Geo. S. Phelps & Co.....
15732	Fleischmann's Dried Grains. Fleischmann Co., Peekskill, N. Y.	Guaranty..... East Haven: F. A. Forbes.....
		Guaranty.....
DRIED BEET PULP.		
18004	Dried Beet Pulp. Clover Leaf Milling Co., Buffalo, N. Y.	New Britain: Stanley Svea Grain & Coal Co.....
18027	Dried Molasses-Beet Pulp. Larowe Milling Co., Detroit, Mich.	Guaranty..... Westerly: C. W. Campbell.....
15744	Dried Beet Pulp. Larowe Milling Co., Detroit, Michigan	Guaranty..... Hamden: I. W. Beers.....
17980	Dried Beet Pulp. Larowe Milling Co., Detroit, Mich.	Guaranty..... Norwalk: C. E. Slauson Co.....
17987	Dried Beet Pulp. Larowe Milling Co., Detroit, Mich.	Guaranty..... Wallingford: A. E. Hall.....
17964	Dried Beet Pulp. Michigan Sugar Co., Saginaw, Mich.	Guaranty..... North Haven: W. L. Thorpe.....
		Guaranty.....

INSPECTION OF 1921—Continued.

Station No.	Pounds per Hundred.						Price per ton.
	Water.	Ash.	Protein (N, x 6.25).	Fiber.	Nitrogen-free Extract (Starch, gum, etc.).	Ether Extract (Crude Fat).	
15750	6.97	2.78	11.38	5.15	67.97	5.75	\$30.00
	.....	.....	10.00	5.00	60.00	5.00	.....
18017	6.84	2.62	11.31	4.22	66.40	8.61	34.00
	.....	.....	10.00	.....	.....	8.50	.....
18060	8.28	2.00	10.13	3.52	69.57	6.50	37.00
	.....	.....	10.00	.....	.....	8.50	.....
18022	7.76	2.16	10.25	4.10	68.28	7.45	34.00
	.....	.....	10.00	9.00	.....	8.00	.....
	.....	.....	9.81	5.55	58.44	6.00	.....
	7.85	2.40	10.89	4.40	67.48	6.98	33.18
	.....	.....	7.2	3.3	60.7	6.4	.....
18069	9.82	1.40	9.38	2.06	73.29	4.05	.....
18042	5.31	1.54	29.69	11.72	37.77	13.97	38.00
	.....	.....	28.00	15.00	30.00	8.00	.....
18059	5.34	3.15	31.13	12.17	35.40	12.81	53.00
	.....	.....	30.00	13.00	.....	10.00	.....
15755	5.85	3.45	23.56	12.28	47.55	7.31	39.00
	.....	.....	25.00	14.00	.....	6.00	.....
15732	5.03	2.45	19.94	16.33	48.46	7.79	25.00
	.....	.....	17.00	21.00	.....	6.00	.....
18004	7.69	3.21	9.38	19.45	58.81	1.46	37.00
	.....	.....	8.00	20.00	58.00	0.50	.....
18027	6.39	6.19	9.63	15.29	61.77	0.73	31.00
	.....	6.00	8.00	20.00	54.00	.....	.....
15744	6.21	3.09	8.93	20.13	60.98	0.66	35.00
	.....	.....	8.00	.....	.....	0.50	.....
17980	6.39	3.50	9.13	18.37	61.67	0.94	35.00
	.....	.....	8.00	20.00	58.00	0.50	.....
17987	5.83	2.67	9.88	20.09	60.59	0.94	.....
	.....	.....	8.00	20.00	58.00	0.50	.....
17964	6.32	3.53	9.69	19.95	59.63	0.88	32.00
	.....	.....	8.00	.....	.....	0.50	.....

TABLE III.—ANALYSES OF COMMERCIAL FEEDS,

Station No.	Manufacturer and Brand.	Retail Dealer.
18011	DRIED BEET PULP— <i>Concluded</i> Dried Beet Pulp. The Ubiko Milling Co., Cincinnati, Ohio.....	Mystic: Mystic Grain Co.... Guaranty..... Average guaranty..... Average of analyses..... Average digestible.....
	PROPRIETARY MIXED FEEDS. <i>Horse, Dairy and Stock Feeds.</i>	
18002	Blatchford's Calf Meal. Blatchford Calf Meal Co., Wauregan, Ill.....	Middletown: Meech & Stoddard, Inc..... Guaranty.....
18049	Schumacher Calf Meal. Quaker Oats Co., Chicago, Ill.....	New Milford: Geo. T. Soule.. Guaranty.....
18006	Portage Horse Feed. Akron Feed & Milling Co., Akron, Ohio.....	New London: Conn. Grain Corp..... Guaranty.....
17982	Armour's Horse Feed. Armour Grain Co., Chicago, Ill.....	Stamford: W. L. Crabb..... Guaranty.....
18038	Big 4 Horse Feed. Clover Leaf Milling Co., Buffalo, N. Y.....	New Haven: Crittenden-Benham Co..... Guaranty.....
15739	Morhaste Horse Feed. Curtiss Grain Corp., Buffalo, N. Y.....	Branford: S. V. Osborn..... Guaranty.....
15762	Kingalfa Horse Feed. Hales & Hunter Co., Chicago, Ill.....	Manchester: Little & McKinney..... Guaranty.....
15759	Hamlin's Quality Feed. Dwight Hamlin, Pittsburgh, Pa.....	Hazardville: A. D. Bridges Sons..... Guaranty.....
17967	Besco Heavy Grain Horse Feed. G. C. Haste, Inc., New York.....	North Haven: W. L. Thorpe.. Guaranty.....
18025	Algrane Horse Feed. H-O Co.'s Mills, Buffalo, N. Y.....	Westerly: C. W. Campbell Co. Guaranty.....
18037	Chelsea Horse Feed. Park & Pollard Co., Boston, Mass.....	Waterbury: Spencer Grain Co. Guaranty.....
18031	Peters Arab Horse Feed. M. C. Peters Mills Co., Omaha, Neb.....	Bristol: Goodsell Bros..... Guaranty.....
15756	Green Cross Horse Mixed Feed. Quaker Oats Co., Chicago, Ill.....	Thompsonville: Geo. S. Phelps & Co..... Guaranty.....
15763	Mogul Mixed Feed. Quaker Oats Co., Chicago, Ill.....	Manchester: Little & McKinney..... Guaranty.....
18048	Wirthmore Pig Feed. C. M. Cox, Boston, Mass.,	New Milford: Geo. T. Soule.. Guaranty.....
17963	Larrowe Hog Feed. Larrowe Milling Co., Detroit, Mich.....	Rockville: Rockville Grain & Coal Co..... Guaranty.....

INSPECTION OF 1921—Continued.

Station No.	Pounds per Hundred.						Price per ton.
	Water.	Ash.	Protein (N. x 6.25).	Fiber.	Nitrogen-free Extract (Starch, gum, etc.).	Ether Extract (Crude Fat).	
18011	5.81	2.96	10.06	19.73	60.34	1.10	\$32.00
.....	.....	.....	8.00	20.00	60.00	0.50	.....
.....	.....	.....	8.00	20.00	57.60	0.50	.....
.....	6.37	3.59	9.52	19.00	60.57	0.95	33.66
.....	.....	.....	5.0	15.8	50.2	.....	.....
18002	8.58	5.81	24.56	7.02	49.42	4.61	87.00
.....	.....	.....	24.00	.....	.....	5.00	.....
18049	7.24	6.22	20.63	2.42	54.48	9.01	98.00
.....	.....	.....	18.00	.....	.....	8.00	.....
18006	5.43	5.41	11.63	9.66	65.29	2.58	38.00
.....	.....	.....	10.00	.....	.....	2.00	.....
17982	6.50	4.53	12.13	10.64	61.30	4.90	44.00
.....	.....	.....	11.00	.....	.....	4.00	.....
18038	4.40	5.75	9.00	11.13	65.79	3.93	33.00
.....	.....	.....	9.00	.....	.....	2.00	.....
15739	6.48	5.86	9.63	8.85	65.45	3.73	35.00
.....	.....	.....	7.00	14.00	.....	3.00	.....
15762	5.49	6.93	11.56	12.04	61.60	2.38	42.00
.....	.....	.....	10.00	.....	.....	2.00	.....
15759	4.88	6.14	8.88	13.13	64.77	2.20	39.00
.....	.....	.....	9.00	.....	.....	1.50	.....
17967	5.27	4.11	10.81	8.28	67.61	3.92	42.00
.....	.....	.....	9.00	.....	.....	2.00	.....
18025	7.70	5.44	10.81	10.31	61.82	3.92	34.00
.....	.....	.....	11.00	9.75	.....	4.00	.....
18037	4.11	7.33	8.63	10.86	66.22	2.85	37.00
.....	.....	.....	9.00	.....	.....	2.00	.....
18031	5.64	6.30	11.00	10.73	63.64	2.69	43.00
.....	.....	.....	10.00	.....	.....	2.00	.....
15756	5.93	6.27	12.13	11.33	61.77	2.57	38.00
.....	.....	.....	10.00	.....	.....	2.50	.....
15763	5.16	7.36	9.25	16.80	58.99	2.44	42.00
.....	.....	.....	10.00	.....	.....	2.50	.....
18048	8.43	10.15	20.25	8.10	47.22	5.85	49.00
.....	.....	.....	18.00	.....	.....	5.00	.....
17963	8.14	5.99	23.13	7.60	48.46	6.68	58.00
.....	.....	.....	18.00	.....	.....	5.00	.....

TABLE III.—ANALYSES OF COMMERCIAL FEEDS,

Station No.	Manufacturer and Brand.	Retail Dealer.
	PROPRIETARY MIXED FEEDS— <i>Continued.</i> <i>Horse, Dairy and Stock Feeds—Continued.</i>	
18013	Nobotheration. C. W. Campbell Co., Westerly, R. I.	<i>Mystic</i> : J. L. Manning Co. Guaranty.
15760	Unicorn Dairy Ration. Chapin & Co., Hammond, Ind.	<i>Hazardville</i> : A. D. Bridge's Sons. Guaranty.
15748	Eshelman's 25 Dairy Ration. John W. Eshelman & Son, Lancaster, Pa.	<i>West Cheshire</i> : G. W. Thorpe. Guaranty.
15727	Grandin's Twin-Six Dairy Feed. D. H. Grandin, Milling Co., Jamestown, N. J.	<i>Willimantic</i> : Willimantic Grain Co. Guaranty.
17996	Read The Tag Dairy Feed. H-O Cereal Co., Inc., Buffalo, N. Y.	<i>Plantville</i> : C. A. Cowles. Guaranty.
17962	Larro Dairy Feed. Larowe Milling Co., Detroit, Mich.	<i>Rockville</i> : Rockville Grain & Coal Co. Guaranty.
18058	Red Star Dairy Feed. E. Manchester & Sons, Winsted.	<i>Winsted</i> : E. Manchester & Sons. Guaranty.
17990	Barford's Balanced Ration. Meech & Stoddard, Inc., Middletown.	<i>Meriden</i> : Meriden Grain & Coal Co. Guaranty.
18070	Experimental Dairy Ration. Meech & Stoddard, Inc., Middletown.	<i>Middletown</i> : Meech & Stoddard, Inc. Guaranty.
18036	Stevens 44 Dairy Ration. Park & Pollard Co., Boston, Mass.	<i>Waterbury</i> : Spencer Grain Co. Guaranty.
17965	Pillsbury's Dairy Ration. Pillsbury Flour Mills Co., Minneapolis, Minn.	<i>North Haven</i> : W. L. Thorpe. Guaranty.
17979	Protena Dairy Feed. Purina Mills Co., Ralston	<i>Norwalk</i> : C. E. Slauson Co. Guaranty.
18039	Purina Cow Chow. Purina Mills, St. Louis.	<i>New Haven</i> : Crittenden-Benham Co. Guaranty.
15719	Big Q Dairy Ration. Quaker Oats Co., Chicago, Ill.	<i>Stafford Springs</i> : Dennis Grain Mill. Guaranty.
18023	Vitality Milk Ration. Rosenbaum Bros., Chicago, Ill.	<i>Jewett City</i> : Jewett City Grain Co. Guaranty.
15730	Syracold Dairy Feed. Syracuse Milling Co., Syracuse, N. Y.	<i>Willimantic</i> : Boston Grain Co. Guaranty.
15749	Red Brand Ti-O-Ga Dairy Feed. Tioga Mill and Elev. Co., Waverly, N. Y.	<i>West Cheshire</i> : G. W. Thorpe. Guaranty.

INSPECTION OF 1921—*Continued.*

Station No.	Pounds per Hundred.						Price per ton.
	Water.	Ash.	Protein (N. x 6.25).	Fiber.	Nitrogen-free Extract (Starch, gum, etc.).	Ether Extract (Crude Fat).	
18013	8.25	4.04	20.44	6.10	56.36	4.81	\$37.00
.....	.....	.....	20.00	9.00	.....	4.00	.....
15760	6.72	8.02	25.25	8.23	45.76	6.02	47.00
.....	.....	.....	24.00	.....	.....	4.50	.....
15748	7.22	4.82	27.75	9.46	45.52	5.23	41.00
.....	.....	.....	25.00	.....	.....	5.00	.....
15727	7.04	5.57	24.44	9.01	48.10	5.84	41.00
.....	.....	.....	22.00	12.00	.....	5.00	.....
17996	5.98	5.27	23.63	7.26	52.62	5.24	40.00
.....	.....	.....	20.00	9.50	.....	5.00	.....
17962	8.42	4.88	21.50	11.72	49.05	4.43	45.00
.....	.....	.....	20.00	.....	.....	3.50	.....
18058	7.36	5.94	23.25	10.40	46.23	6.82	48.00
.....	.....	.....	23.00	.....	.....	4.00	.....
17990	7.35	5.17	20.06	8.84	51.83	6.75	44.00
.....	.....	.....	19.00	.....	.....	5.50	.....
18070	8.60	4.60	17.38	8.09	56.36	4.97	.....
.....							
18036	7.16	7.25	23.38	13.63	42.45	6.13	44.00
.....	.....	.....	24.00	.....	.....	5.00	.....
17965	8.03	7.27	19.75	9.75	50.21	4.99	45.00
.....	.....	.....	19.00	.....	.....	4.00	.....
17979	4.86	7.56	19.56	9.51	53.86	4.65	35.00
.....	.....	.....	16.50	.....	.....	3.50	.....
18039	3.28	7.11	26.56	11.47	46.33	5.25	51.00
.....	.....	.....	24.00	.....	.....	4.30	.....
15719	7.47	5.59	20.56	10.33	49.69	6.36	48.00
.....	.....	.....	21.00	.....	.....	4.50	.....
18023	7.02	7.15	22.94	9.44	48.53	4.92	48.00
.....	.....	.....	25.00	.....	.....	4.50	.....
15730	6.84	6.21	25.50	9.14	44.23	8.08	43.00
.....	.....	.....	24.00	.....	.....	4.50	.....
15749	7.12	6.50	27.88	10.38	42.36	5.76	42.00
.....	.....	.....	23.00	11.00	.....	3.50	.....

TABLE III.—ANALYSES OF COMMERCIAL FEEDS,

Station No.	Manufacturer and Brand.	Retail Dealer.
	PROPRIETARY MIXED FEEDS— <i>Concluded.</i> <i>Horse, Dairy and Stock Feeds—Concluded.</i>	
18018	Biles Ready Dairy Ration. Ubiko Milling Co., Cincinnati, Ohio.....	<i>Yantic:</i> Yantic Grain & Products Co..... Guaranty.....
15725	Hi-Lo Dairy Ration. U. S. Food Products Co., Peoria, Ill.....	<i>Willimantic:</i> Willimantic Grain Co..... Guaranty.....
18044	Tes-Ted Dairy Feed. U. S. Food Products Co., Peoria, Ill.....	<i>New Haven:</i> R. G. Davis & Sons..... Guaranty.....
18009	Iroquois Stock Feed. Armour Grain Co., Chicago, Ill.....	<i>New London:</i> P. Swartz Co..... Guaranty.....
18012	Pennant Brand Stock Feed. E. W. Bailey & Co., Swanton, Vt.....	<i>Mystic:</i> Mystic Grain Co..... Guaranty.....
18026	Nobotheration Stock Feed. C. W. Campbell Co., Westerly, R. I.....	<i>Westerly:</i> C. W. Campbell Co..... Guaranty.....
18047	Delaware. Delaware Mills, Deposite, N. Y....	<i>Brookfield:</i> C. R. Dubia..... Guaranty.....
18014	New England Stock Feed. H-O Co.'s Mills, Buffalo, N. Y.....	<i>Mystic:</i> J. L. Manning Co..... Guaranty.....
18015	Homestead Stock Feed. Illinois Feed & Elevator Co., Bloomington, Ill.....	<i>Yantic:</i> Yantic Grain & Products Co..... Guaranty.....
18052	Bull Brand Stock Feed. Maritime Milling Co., Buffalo, N. Y.....	<i>New Milford:</i> Geo. E. Ackley Co..... Guaranty.....
18051	M. & S. Stock Feed. Meech & Stoddard, Inc., Middletown.....	<i>New Milford:</i> Geo. E. Ackley Co..... Guaranty.....
18035	Stock Feed. Park & Pollard Co., Boston, Mass.	<i>Waterbury:</i> Spencer Grain Co..... Guaranty.....
18968	Iowa Stock Feed. Purity Oats Co., Davenport, Iowa.....	<i>North Haven:</i> W. L. Thorpe..... Guaranty.....
15746	Schumacher Sugured Feed. Quaker Oats Co., Chicago, Ill.....	<i>Hamden:</i> I. W. Beers..... Guaranty.....
15764	White Diamond Stock Feed. Quaker Oats Co., Chicago, Ill.....	<i>Manchester:</i> Little & McKinney..... Guaranty.....
15731	Charlestock Feed. St. Albans Grain Co., St. Albans, Vt.....	<i>Willimantic:</i> Boston Grain Co..... Guaranty.....
15723	Wirthmore Stock Feed. St. Albans Grain Co., St. Albans, Vt.....	<i>South Coventry:</i> South Coventry Grain Elev..... Guaranty.....
17975	Syracold Stock Feed. Syracuse Milling Co., Syracuse, N. Y.....	<i>Southport:</i> C. Buckingham & Co..... Guaranty.....

INSPECTION OF 1921—Continued.

Station No.	Pounds per Hundred.						Price per ton.
	Water.	Ash.	Protein (N. x 6.25)	Fiber.	Nitrogen-free Extract (Starch, gum, etc.).	Ether Extract (Crude Fat).	
18018	7.30	7.82	23.06	8.91	44.76	8.15	\$47.00
.....	.....	.....	24.00	10.00	50.00	5.00	.....
15725	6.89	6.51	23.94	8.63	49.16	4.87	39.00
.....	.....	.....	22.00	9.00	.....	4.00	.....
18044	8.04	7.71	26.13	8.97	44.18	4.97	43.00
.....	.....	.....	24.00	9.00	.....	5.00	.....
18009	7.46	5.51	11.38	12.51	57.07	6.07	28.50
.....	.....	.....	10.00	.....	.....	4.00	.....
18012	7.04	4.03	9.13	10.62	63.00	6.18	32.00
.....	.....	.....	9.00	10.00	.....	5.00	.....
18026	9.06	4.24	11.00	11.63	60.16	3.91	31.00
.....	.....	.....	10.00	12.00	.....	5.00	.....
18047	9.74	4.46	8.63	8.52	65.56	3.09	36.00
.....	.....	.....	10.00	.....	.....	4.00	.....
18014	7.33	4.71	9.44	11.40	62.82	4.30	36.00
.....	.....	.....	9.50	.....	.....	4.00	.....
18015	8.78	2.58	8.75	8.20	68.44	3.25	34.00
.....	.....	.....	9.00	.....	.....	3.00	.....
18052	8.12	3.76	11.56	11.12	61.26	4.18	33.00
.....	.....	.....	11.00	.....	.....	4.00	.....
18051	8.47	3.51	9.63	9.27	64.69	4.43	33.00
.....	.....	.....	9.00	.....	.....	3.00	.....
18035	8.67	5.02	8.38	9.74	65.11	3.08	32.00
.....	.....	.....	9.00	.....	.....	2.50	.....
17968	7.61	4.26	9.69	12.11	62.34	3.99	34.00
.....	.....	.....	10.00	12.75	.....	4.00	.....
15746	6.92	4.98	11.38	11.95	60.59	4.18	34.00
.....	.....	.....	10.00	.....	.....	3.25	.....
15764	6.95	3.77	8.56	11.16	66.06	3.50	32.00
.....	.....	.....	8.00	14.00	60.00	3.00	.....
15731	6.76	3.56	10.00	9.71	64.79	5.18	31.00
.....	.....	.....	10.00	14.00	50.00	4.00	.....
15723	8.12	2.48	9.31	5.90	69.30	4.89	32.00
.....	.....	.....	9.00	.....	.....	4.00	.....
17975	8.06	4.96	11.00	11.68	59.71	4.59	32.00
.....	.....	.....	9.00	.....	.....	3.00	.....

TABLE III.—ANALYSES OF COMMERCIAL FEEDS,

Station No.	Manufacturer and Brand.	Retail Dealer.
POULTRY FEEDS		
17984	Cak-Cak Laying Mash. Armour Grain Co., Chicago, Ill.	Stamford: W. L. Crabb..... Guaranty.....
17985	Iroquois Poultry Mash. Armour Grain Co., Chicago, Ill.	Stamford: W. L. Crabb..... Guaranty.....
17977	Blatchford's Fill the Basket Egg Mash. Blatchford's Calf Meal Co., Wauregan, Ill.	Norwalk: C. E. Slauson Co... Guaranty.....
18029	Nobotheration Dry Mash. C. W. Campbell Co., Westerly, R. I.	Westerly: C. W. Campbell Co. Guaranty.....
18034	Eshelman's Laying Mash. John W. Eshelman & Son, Lancaster, Pa.	Plainville: F. B. Newtown Est..... Guaranty.....
15761	Red Comb Egg Mash. Hales & Hunter Co., Chicago, Ill.	Manchester: Little & McKinney..... Guaranty.....
18032	Laying Mash. H-O Cereal Co., Inc., Buffalo, N. Y.	Bristol: Goodsell Bros..... Guaranty.....
18064	Blue Top Laying Mash. Chas. A. Krause Milling Co., Milwaukee, Wis.	Hartford: Garber-Northam Grain Co..... Guaranty.....
17997	M. & S. Dry Mash. Meech & Stoddard, Inc., Middletown.	Middlefield: Middlefield Grain & Coal Co..... Guaranty.....
18063	M. & S. Dry Mash. Meech & Stoddard, Inc., Middletown.	Hartford: Meech Grain Co... Guaranty.....
17981	Lay or Bust. Park & Pollard Co., Boston, Mass.	Norwalk: C. E. Slauson Co... Guaranty.....
17993	Purina Chicken Chowder. Purina Mills, St. Louis.	Meriden: August Grulick Est. Guaranty.....
15718	Ful-O-Pep Dry Mash. Quaker Oats Co., Chicago, Ill.	Stafford Springs: Dennis Grain Mill..... Guaranty.....
18008	Chic-Chuck Concentrated Poultry Food. Russia Cement Co., Gloucester, Mass.	New London: P. Swartz Co... Guaranty.....
15735	Wirthmore Buttermilk Mash Feed. C. M. Cox Co., Boston, Mass.	East Haven: F. A. Forbes.... Guaranty.....
15736	Dried Buttermilk. Buttermilk Sales Co., Chicago, Ill.	East Haven: F. A. Forbes....

MISCELLANEOUS SAMPLES.

Partial or complete analyses of feeding stuffs submitted by individuals during the past year are given in Table IV. This station is not responsible for the sampling of these materials but only for the accuracy of the analyses of the samples as received by us. We are justified in making such examinations only insofar

INSPECTION OF 1921—Concluded.

Station No.	Pounds per Hundred.						Price per ton.
	Water.	Ash.	Protein (N. x 6.25).	Fiber.	Nitrogen-free Extract (Starch, gum, etc.).	Ether Extract (Crude Fat).	
17984	7.07	7.15	21.75	8.01	50.18	5.84	\$54.00
			20.00	.....	.....	3.00	.....
17985	8.07	4.42	16.69	20.22	43.58	7.02	51.00
			15.00	.....	.....	4.00	.....
17977	6.10	14.35	20.63	8.67	45.19	5.06	75.00
			19.00	.....	.....	4.00	.....
18029	8.81	10.41	18.88	7.54	48.43	5.93	47.00
			18.00	.....	.....	2.00	.....
18034	8.59	8.10	23.50	5.70	47.08	7.03	53.00
			20.00	.....	.....	5.00	.....
15761	7.07	8.83	16.13	5.00	57.31	5.66	63.00
			16.00	.....	.....	4.50	.....
18032	7.45	4.86	17.56	4.50	60.10	5.53	47.00
			17.00	6.00	.....	4.50	.....
18064	8.28	7.09	20.38	7.03	51.98	5.24	60.00
			20.00	.....	.....	5.00	.....
17997	7.77	7.72	18.13	6.81	54.64	4.93	56.00
			12.00	8.00	.....	3.00	.....
18063	7.47	8.01	19.31	6.87	53.38	4.96	58.00
			12.00	.....	.....	3.00	.....
17981	6.60	9.58	20.56	5.79	52.92	4.55	53.00
			18.00	.....	.....	1.50	.....
17993	7.56	7.27	19.75	8.58	51.42	5.42	60.00
			19.00	.....	.....	4.00	.....
15718	8.09	9.67	21.75	7.54	47.32	5.63	68.00
			20.00	.....	.....	4.00	.....
18008	6.31	48.39	39.25	1.17	3.26	1.62	72.00
			45.00	.....	.....	2.00	.....
15735	7.33	6.05	19.75	6.15	56.12	4.60	52.00
			20.00	.....	.....	4.00	.....
15736	8.01	10.71	33.00	.....	38.86	9.42	165.00

as they may be of public interest and concern and to this end as complete information as may be given should accompany samples thus submitted; that is to say, brand, name, manufacturer and guaranty should be stated if known. Most of the samples thus examined were for the purpose of checking guaranties or for information to be used in the compounding of rations.

TABLE IV.—ANALYSES OF FEEDING STUFFS,

Station No.	Material.	Submitted by
HAY, ENSILAGE, ETC.		
16576	Hay.....	Orange: Fairlea Farm.....
18589	Silage.....	Fairlea Farm.....
16574	Silage.....	Fairlea Farm.....
18573	Alfalfa.....	Fairlea Farm.....
16575	Alfalfa.....	Fairlea Farm.....
16572	Alfalfa Meal.....	Fairlea Farm.....
WHEAT PRODUCTS.		
18250	Wheat Feed.....	Middletown: Meech & Stoddard, Inc.....
18251	Red Dog.....	Meech & Stoddard, Inc....
CORN PRODUCTS.		
17003	Farmer Jones Gluten Feed.....	Newtown: E. S. Lovell.....
16467	Stowell's Evergreen Sweet Corn Seed.....	Middletown: F. C. Hubbard..
COTTONSEED PRODUCTS.		
18668	Cottonseed Feed.....	Wallingford: W. S. Fushey...
OAT PRODUCTS.		
18477	Ground Oats.....	Rockville: H. B. Pomeroy....
18478	Ground Oats.....	H. B. Pomeroy.....
16606	Ground Oats.....	Colchester: L. Broder.....
BEET PULP.		
16573	Beet Pulp.....	Orange: Fairlea Farm.....
17408	Beet Pulp.....	Suffield: Hill Top Farm.....
DISTILLERS' GRAINS.		
17820	Distillers' Grains.....	Bridgeport: C. L. Bill.....
16653	Distillers' Grains.....	Fairfield: R. H. Holcomb....
STOCK FEED, POULTRY FEEDS, ETC.		
17787	Delaware Dairy Feed.....	Brookfield: C. R. Dubia.....
18562	Dairy Ration.....	Farmington: Winchell Smith's Grist Mill.....
16969	Mule and Horse Feed.....	Hartford: American Sumatra Tobacco Co.....
16970	Mule and Horse Feed.....	American Sumatra Tobacco Co.....
16728	Horse Feed.....	American Sumatra Tobacco Co.....
16727	Horse Feed.....	American Sumatra Tobacco Co.....
16980	Arrow Head Mule Feed.....	American Sumatra Tobacco Co.....
18475	Badger Stock Feed.....	Garber-Northam Grain Co.
18476	Badger Stock Feed.....	Garber Northam Grain Co.

SUBMITTED BY INDIVIDUALS.

Station No.	Pounds per Hundred.						Remarks.
	Water.	Ash.	Protein (N x 6.25).	Fiber.	Nitrogen-free Extract (Starch, gum, etc.).	Ether Extract (Crude Fat).	
16576	15.35	5.16	8.90	13.31	53.53	3.75	
18589	66.05	1.68	2.25	9.98	19.26	0.78	
16574	82.14	1.12	1.72	5.72	8.85	0.45	
18573	8.95	5.71	12.64	36.64	34.29	1.77	
16575	14.85	10.21	21.66	31.94	19.76	1.58	
16572	7.66	7.92	12.75	33.45	36.50	1.72	
18250	7.04	.....	17.25	7.51	.....	7.00	Guaranty, Protein 13, Fiber 12, Fat 3.
18251	7.67	.....	17.50	1.77	.....	4.31	Guaranty, Protein 15, Fiber 10, Fat 4.
17003	.....	.....	25.75	.....	.....	.....	Guaranty, Protein 23.
16467	15.22	.....	.....	.....	.....	.....	
18668	.....	.....	35.94	.....	.....	.....	
18477	.....	.....	13.00	.....	.....	.....	
18478	.....	.....	12.75	.....	.....	.....	
16606	.....	.....	12.38	.....	.....	.....	
16573	8.34	3.58	9.38	18.11	59.57	1.02	
17408	.....	4.26	9.50	.....	.....	.....	Ash insol. in acid 0.83.
17820	91.6	.....	1.60	.....	.....	.....	
16653	78.04	0.99	4.22	1.46	13.96	1.33	
17787	.....	.....	24.13	.....	.....	.....	
18562	7.68	.....	22.50	.....	.....	5.49	
16969	.....	.....	12.38	.....	.....	.....	
16970	.....	.....	11.31	.....	.....	.....	
16728	.....	.....	10.63	.....	.....	.....	
16727	.....	.....	10.50	.....	.....	.....	
16980	.....	.....	9.73	.....	.....	.....	
18475	.....	.....	8.75	.....	.....	.....	
18476	.....	.....	8.69	.....	.....	.....	

TABLE IV.—ANALYSES OF FEEDING STUFFS

Station No.	Material.	Submitted by
17625	STOCK FEED, POULTRY FEEDS, ETC.— <i>Concluded</i> Stock Feed.....	Middletown: State Hospital for Insane.....
17626	Stock Feed.....	State Hospital for Insane..
18523	Stock Feed.....	State Hospital for Insane..
18524	Special Dairy Feed.....	The Coles Co.....
17406	Four All Stock Feed.....	Milwaukee: Wis., Smith Milling Co.....
17405	Smith's Balanced Ration.....	Smith Milling Co.....
17407	Vitex Dairy Ration.....	Smith Milling Co.....
17894	Hog Feed.....	New Milford: W. B. Hatch...
18637	Meat Scrap.....	Herman F. Engleman.....
18647	Dried Buttermilk.....	Norwich: H. Ojyerman.....
16571	Dairy Ration.....	Orange: Fairlea Farm.....
16570	Stock Feed.....	Fairlea Farm.....
18568	Stock Feed.....	Fairlea Farm.....
18567	Dairy Ration.....	Fairlea Farm.....
17907	Crosby's Ready Ration.....	Shelton: J. H. Loverin.....
18141	Chick Feed.....	West Hartford: G. L. Ellsworth.....
18179	Beef Scrap.....	Yantic: Yantic Grain Co.....
MISCELLANEOUS.		
18252	Stock Molasses.....	West Cornwall: S. R. Scoville.
17641	Feed Molasses.....	Lakeville: H. F. Hamlin.....
17642	Feed Molasses.....	H. F. Hamlin.....
17643	Feed Molasses.....	H. F. Hamlin.....
17657	Corn Juice from Silo.....	Hartford: Thos. Holt.....
17867	Silo Liquid.....	Guilford: Wilcox Bros.....
18235	Low Grade Flour.....	Storrs: Conn. Agr. College..
18711	Bean Meal.....	Middletown: John H. Fay....
16719	Feed.....	Cromwell: A. N. Pierson.....
16368	Nears Mixture Stock Food.....	Kent: F. B. Segar.....
16369	Gold Medal Stock Food.....	F. B. Segar.....
16370	Carpenter Stock Food.....	F. B. Segar.....
16526	Gold Medal Stock Food.....	Washington: Dodge Farm

SUBMITTED BY INDIVIDUALS—*Concluded.*

Station No.	Pounds per Hundred.						Remarks.
	Water.	Ash.	Protein (N x 6.25).	Fiber.	Nitrogen-free Extract (Starch, gum, etc.).	Ether Extract (Crude Fat).	
17625	10.76	.....	15.25	.....	.....	4.80	
17626	10.76	.....	15.25	.....	.....	4.88	
18523	6.57	5.89	22.75	9.43	47.78	7.58	
18524	.....	.....	22.81	.....	.....	.....	
17406	10.04	.....	15.13	12.01	.....	4.30	Guaranty, Protein 12, Fiber 12, Fat 4.
17405	10.29	.....	18.25	10.39	.....	5.09	
17407	9.73	.....	27.13	12.56	.....	6.17	
17894	.....	.....	55.88	.....	.....	.....	Guaranty, Protein 55-65.
18637	5.30	22.41	39.95	.....	.....	.....	
18647	8.02	10.70	34.89	.....	36.59	9.80	Guar., Moisture 6, Ash 8.7 Protein 36.1, Fat 7.2.
16571	8.54	6.58	21.25	10.33	47.48	5.82	
16570	9.05	4.01	14.50	7.28	59.31	5.85	
18568	6.85	5.24	19.38	8.28	54.87	5.38	
18567	7.31	5.18	19.63	8.09	54.41	5.38	
17907	.....	.....	26.88	.....	.....	.....	
18141	.....	.....	17.06	.....	.....	.....	
18179	.....	.....	45.13	.....	.....	.....	Guaranty, Protein 45.
18252	19.41	9.02	4.19	.....	58.58	.....	Sugar, calc. as in vert, 58.58
17641	18.37	.....	2.74	.....	62.72	.....	" " " " 62.72
17642	24.62	.....	4.13	.....	58.93	.....	" " " " 58.93
17643	24.69	.....	4.25	.....	55.94	.....	" " " " 55.94
17657	92.40	1.37	1.31	.....	0.72	.....	" " " " 0.72; alcohol 1.10.
17867	.....	.....	.....	.....	.....	.....	Alcohol 1.22.
18235	.....	.....	15.75	.....	.....	.....	
17811	.....	.....	4.88	.....	.....	.....	Probably carob bean and pod meal.
16719	.....	.....	12.25	.....	.....	.....	
16368	.....	.....	.....	.....	.....	.....	1
16369	.....	.....	.....	.....	.....	.....	2
16370	.....	.....	.....	.....	.....	.....	3
16526	.....	17.23	16.25	.....	.....	.....	4

¹ Contains charcoal, sulphur, salt, carbonates, Epsom salt, vegetable bitters; probably also fenugreek.

² Substantially same as 16368.

³ Contains charcoal, sulphur, salt; probably also flaxseed meal and fenugreek.

⁴ Substantially same as 16368.

CONNECTICUT
AGRICULTURAL EXPERIMENT STATION

NEW HAVEN, CONN.

BULLETIN 239

MAY, 1922

WILDFIRE OF TOBACCO IN
CONNECTICUT

By GEORGE P. CLINTON and FLORENCE A. McCORMICK

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The Bulletins of this Station are mailed free to citizens of Connecticut who apply for them, and to other applicants as far as the editions permit.

CONNECTICUT AGRICULTURAL EXPERIMENT STATION

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MAY, 1922

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WILDFIRE OF TOBACCO IN CONNECTICUT.

GEORGE P. CLINTON AND FLORENCE A. MCCORMICK.

Introduction.

State Survey. The question of establishing a sub-station for tobacco experimentation having been presented to the Director of the New Haven Station early in 1920 by County Agent B. G. Southwick of Hartford County, it was decided that before any definite decision was given there should be made some preliminary investigations. These were to include a canvass of the opinions of tobacco growers toward such a proposition and a survey of the tobacco districts, to determine the diseases and injuries with which the growers had to contend. In 1920 this survey was undertaken by the joint financial coöperation of the Experiment Station, the Hartford County Farm Bureau and the Extension Service of the Connecticut Agricultural College. Somewhat similar work was undertaken by the Massachusetts Station in that state. In Connecticut the work resolved itself largely into a disease survey of tobacco seedbeds and fields, for which Mr. Southwick served as a scout, in connection with his interviews with the growers, and the writers as the botanical investigators of the troubles brought to light.

After the preliminary work of seedbed examinations by Mr. Southwick and Dr. Clinton in May and June, it was decided to facilitate the field work by establishing, during July and August, a small laboratory at the Farm Bureau headquarters in Hartford with Dr. McCormick in charge, Dr. Clinton being in Europe. During the entire season of 1921 the work was continued with even more intensity. No field laboratory was maintained this year at Hartford, the work being done at New Haven, but considerable experimental work was carried on at the Station's new tobacco farm at Windsor, the state by that time having authorized by law tobacco investigations for which an appropriation was given. Mr. G. E. Graham, assistant in the botanical department of the Experiment Station, helped with the various experiments there and elsewhere in 1921.

In the disease survey considerable data were obtained, much of which, however, was merely an extension of the knowledge of diseases and injuries that had been previously studied more or less intensively by the Station botanist. It is hoped to present this and further data in future bulletins from this department. One of the striking features of the survey was the discovery of a tobacco disease, new to the state, which has now proved to be quite serious under certain conditions. It is with this trouble, popularly known as wildfire, that this bulletin has to deal.

Nature of the Disease. As a result of one of the field examinations in late June, 1920, Mr. Southwick sent to New Haven plants from Tariffville showing an unusual leaf spot trouble, but no definite information concerning it was obtained at that time because of the poor condition of the material when received. Later at Hartford Dr. McCormick, in examinations of other material brought to the laboratory by a grower from Poquonock, found the diseased spots accompanied by bacteria with which she was able to produce infection on healthy plants.

The subsequent studies of the disease by the writers have been made, 1st, to thoroughly convince themselves of its bacterial nature, since some growers have been very sceptical as to its identity and the damage it might cause, and 2d, to find practical methods for its control, since, in 1920 and even more so in 1921, it proved a serious trouble in certain localities and fields.

General Description. The disease is generally limited to the leaves, and under certain conditions does not prove serious, but with the right weather conditions its possibilities of injury are unusually great. It belongs with the leaf spot troubles of which several have been found in this state. It differs, however, from all the other leaf spots by certain definite characters, usually evident to the ordinary observer. In both the seedbed and field, infected plants develop yellow discolorations in the normally green tissues and these spots are usually rounded and about the size of a finger tip. In their center there is a small point of white to brownish dead tissue that indicates the origin of the spot. In time the dead center encroaches on the yellow discoloration limiting it to a more or less narrow encircling band, the so-called halo. If numerous enough the spots cause death of intervening tissues so that eventually a very large part of the leaf surface is killed in an irregular way as if by sun scorch. The appearance then is much like the so-called rust that follows calico, but usually even at this late stage the yellow halo rings are still evident for definite identification.

Distribution.

In Other Countries. Because the blue mold, a menace to tobacco in certain parts of Asia and Australia, has recently appeared in this country, some persons have thought that wildfire has been imported from similar tobacco districts into the United States. Wolf and Moss (33, p. 25.) in 1919 stated that "it is presumably identical with a disease which has been recently reported from Connecticut and from the Philippine Islands." So far as Connecticut is concerned their statement was correct. The disease mentioned from the Philippine Islands is evidently that briefly described by Reinking (22, p. 130.) also in 1919. It is impossible to tell definitely from Reinking's preliminary descrip-

tion whether or not he is dealing with the wildfire or some of the other bacterial spots now known on tobacco.

Very recently Fromme (7, p. 37.) called attention to a disease in Africa which is described (evidently by the editor Klerck, 19.) in the Journal of the Department of Agriculture, Union of South Africa, in March, 1921, as follows:

"A tobacco disease occurring in the Piet-Retief District and known to farmers as 'Verterende roest,' was brought to our notice by the Chief of the Tobacco and Cotton Division. An officer of this Division was detailed to investigate the matter; the disease starts on the lower leaves which at first appear to be maturing prematurely, and spreads to the upper leaves. The disease was prevalent on the experiment station as well as on neighboring farms, and it was stated that only 10 per cent. of the 1920 crop reached its normal development, the remaining plants being stunted. Considerable losses had also been suffered on other farms which were visited. The 'verterende roest' is due to a bacterium which is being carefully studied in the laboratory, with a view to devising preventive measures which may be tested on a practical scale next season. Specimens of the tobacco affected by a similar trouble have also been received from Rhodesia; these are also under investigation." A month later he further states "The bacterial disease of tobacco previously recorded from the Piet-Retief District is now spreading rapidly at Marikana in the Rustenburg District, and is probably very widespread. So far as this investigation of this disease has gone, it bears a very strong resemblance to the wildfire in tobacco recorded in the United States."

In the same publication, Evans (34) in January, 1922, makes the following definite statement:

"Tobacco Wild Fire (*Bacterium tabacum*), a serious disease, was investigated. It occurs extensively in the Pietersburg and Rustenburg Districts. It was sent to us first from Rhodesia. Preliminary studies from Rhodesian material were made, and it is intended, if possible, to carry out field experiments in connection with preventive measures during the coming season."

The preceding quotation would seem definitely to decide the nature of the South African disease but Klerck (19), in the February issue of the Journal, again put it in the doubtful category by the following remarks:

"Wild-fire and angular spot of tobacco has been causing considerable anxiety amongst tobacco growers, and appears to be spreading rapidly. During the season 1920-21, this disease was only reported from the Government experiment stations at Rustenburg and Piet-Retief, from certain farms in the Piet-Retief District, and one in the Rustenburg District. During the present season specimens have been identified from three more farms within fifty miles of Rustenburg, and also from Groot Marico and Swaziland. A detailed study of this disease and the organisms concerned has been carried out by Mr. W. E. Schlitz, of this Division, and the South African organism compared with cultures obtained from America, and some interesting results have been obtained. The South African organism is identical with *Bacterium angulatum*, the bacterium connected in the states with angular leaf spot. The lesions on tobacco leaves found in the field and those produced by inoculation resemble 'wild-fire' but the organism concerned is not the 'wild-fire' organism, *B. tabacum*, which has not once been isolated. A full account of these investigations will be published at a later date."

It is evident from the testimony, so far as published, that this disease in S. Africa needs even more critical examination as to its relationships and it suggests to us that perhaps wildfire and angular spot in the United States also should be more carefully compared. The following data, however, satisfies the writers as to the identity of the African trouble with the American wildfire.

In January, receiving a letter from Wolf, in which he stated that Miss E. M. Doidge, of Pretoria, South Africa, had written him that wildfire had appeared in that section, we wrote Miss Doidge and received the following letter, dated March 6th:

"In reply to your letter of the 30th January, I may say that nothing further has been published on the occurrence of Wildfire in South Africa, but that there appears to be no doubt as to the identity of the disease which was prevalent in our tobacco fields last season with the American Wildfire. I am sending under separate cover some dried specimens as requested."

An examination of these specimens from Rustenburg (dated Jan. 2, 1922) showed their similarity in appearance to our Connecticut disease. Attempts to inoculate pricked greenhouse plants with water in which the crushed infected tissues had been soaked for several hours, were unusually successful despite the fact that the specimens had been enclosed in an envelope containing naphthalene flakes, apparently for the purpose of disinfecting them.

In the recent visit to the New Haven Station, Dr. Butler, of Kew, England, stated that he had seen a somewhat similar leaf spot of tobacco in India or in the adjacent islands, but had made no special study of it, and was in doubt as to its nature.

In the United States. The discovery of wildfire in this country seems to have been made first in North Carolina, at least Wolf and Foster, (31, p. 361.) in 1917, noted it as a new disease found there in the seedbeds and fields and gave a name to the germ which caused it. Early the next year they (32.) published a scientific description of the germ, *Bacterium tabacum*, and gave a more detailed account of the trouble which they listed as also occurring in Virginia. In September, 1920, Garner (3.) reported it from Maryland, Chapman (3.) from Massachusetts, and Valteau (3.) from Kentucky; while in October, Hesler (13.) recorded it from Tennessee and Johnson (13.) (*in litt.*, temporary escapes at Madison) from Wisconsin. In 1921 it was reported, in June, by Westbrook (29.) from Georgia, and in July, by Orton (20.) from Pennsylvania, and Clayton (4, apparently also reported in 1920,) from Ohio. Besides the above states Ludwig (10.) in August, 1921, reported it questioningly from South Carolina, and the writers received in the fall a dried specimen from Vermont, sent by Lutman, that proved to be this disease. In a letter recently received from Burger, he states that the disease has now also been identified in Florida. It seems, therefore, to have been found in thirteen or fourteen states east of the Mississippi where tobacco is most commonly grown.

In Connecticut. Wolf and Moss' note that "presumably" wildfire occurred in Connecticut, was based on statements of Johnson, in charge of U. S. Department of Agriculture tobacco experiments in New England, who has since told the writers that he saw the disease during the growing season of 1919 at a certain farm in Suffield. As no previous mention of this was made to Station authorities here, his observations were unknown to them until after the definite identification of the disease a year later.

In the summer of 1918 Beinhart, at that time the U. S. Government tobacco agent in New England, called to the senior writer's attention a leaf spot trouble of tobacco in a tent in which he had experiments at Buckland. This trouble seemed to be different from the ordinary spots seen here, and both thought it might be either a fertilizer or bacterial spot, but no study was made of it, and apparently specimens were not collected, or if collected were lost, so we cannot be sure of its identity. During the last of July, 1919, the senior writer collected an inconspicuous tobacco leaf spot at East Windsor Hill that was not carefully examined at the time. Recent more critical examination of this specimen shows it to be the wildfire, so far as one can be positive from the examination of dried material.

Late in June, 1920, as stated before, County Agent Southwick obtained specimens of an unusual tobacco trouble at Tariffville, which later was found elsewhere. Dr. McCormick, at the Hartford laboratory, upon examination of material from various sources, showed these to be a bacterial trouble, both by the presence of bacteria in the diseased tissues and by the production of similar spots on healthy tobacco leaves from crushed tissue of the diseased leaves. Specimens of the disease were sent by her to Dr. Smith, of the U. S. Department of Agriculture, and he definitely pronounced it wildfire. This then, was the first positive identification of the trouble in the state, so far as the writers are concerned.

Following the newspaper agitation of the subject in 1921, occasional growers have expressed the belief that the disease was not necessarily new but that outbreaks of it had occurred locally years before. This does not seem very plausible, since with all the United States tobacco investigators who have been in the state, and the local ones, who have watched the tobacco troubles rather closely, it is unlikely that it would have entirely escaped detection. If not native this brings up for consideration the manner in which it may have been introduced into Connecticut.

Possible Methods of Introduction.

Theoretically there are a number of different ways in which the germ of wildfire may have been brought into the state. We can discuss them briefly under the following headings.

Mats, etc. Some growers have advanced the theory that the germ was brought in from foreign countries on the matting used to bale imported tobacco, especially Sumatra. This matting is sometimes sold to the growers and used on their beds for shade in sunny and for protection in freezing weather. One grower who used it on the ground just before the plants came up had an idea that he got infection in his seedbed in this manner. He, at least, by this use obtained favorable moisture conditions for the spread of wildfire possibly already there. If the disease is foreign in origin, it is quite reasonable to suppose that mats, etc., from infected districts may have been the means of introducing the germs here. However, there is no direct evidence to this effect.

Fertilizers. Another of the out-of-state materials used on tobacco farms are the fertilizers and of these cotton seed meal, coming from the south, both because of its source and its organic nature, has come under suspicion more generally than the strictly chemical fertilizers. Our attempts to produce the disease on leaves of individual plants in the greenhouse, by sprinkling cotton seed meal from various sources on them, failed in every case. It would seem, therefore, that cotton seed meal was not a very probable means of its introduction.

Tobacco stems, imported from the south as a source of potash fertilizer, have also been under suspicion. Ordinarily the grower does not use them in his seedbeds, though he may sometimes make the seedbed on an old tobacco field or very close to it. Wolf and Foster (32, p. 457.), who investigated tobacco stems as one of the possible sources of infection, failed to get cultures from them, and conclude as follows: "Furthermore, in the preparation of tobacco stems for incorporation with fertilizer material they are subjected to a sufficient degree of heat to insure complete sterilization." Whether the ordinary tobacco stems as shipped direct from the factories after stripping off the leaves, and possibly more or less mixed with unfermented tissues, are a source of infection, has never been proven. Such few attempts at producing the disease from tobacco stems as we attempted were negative. It is conceivable, even if unproven, that they may be an occasional agent of introduction, but now that the disease is already here they do not seem to be such a serious menace as to prohibit their use for general field purposes. For this possible occasional danger, and other reasons, however, it is unwise to ever use tobacco stems on seedbeds.

Seed. We now come to the most probable agent of wildfire introduction into the state. Both Fromme and Wolf are convinced from their studies that it is a seed-borne disease, and that this is a common way in which it is carried over winter, and so naturally tobacco seed would most satisfactorily account for its distribution to new districts, especially from the south, where the

disease was first noticed, to our own state where it appeared more recently. For example Wolf and Moss (33, p. 30.) say: "As has already been stated, the pods are subject to attack, thus making it entirely possible for the seed to become contaminated." Fromme (6, p. 29.) makes the following statements along similar lines:

"If seed were selected from plants entirely free from disease there would be no danger of infection from this source. Unfortunately, the diseases are now so general that it is difficult to find disease free fields, and the selection of disease free seed is therefore possible in only an occasional field. Seed treatment is therefore necessary to insure against introduction of the disease into the bed on the seed."

Having shown that the disease is carried by the seed in some cases, the question of its introduction here in this way may now be considered. There is no doubt that growers, Government and Station investigators have at different times grown plants from seed produced outside the state or even outside the country. So far as we can learn the Station has only upon two occasions, many years ago, used seed that was grown elsewhere. On one of these occasions Sumatra seed from Florida was obtained for the first shade tobacco grown here. In recent years we know personally of others who have used tobacco seed here that was grown in states where the wildfire has since been found. It is entirely supposable that the wildfire may have been brought in with this seed and escaped especial notice on the plants grown therefrom.

Just to show that seed grown elsewhere has been used here, we quote from a bulletin by Shamel (23, pp. 6, 11.) published some years ago before wildfire was known.

"In all of the crops grown from freshly imported seed, there appeared a large proportion of abnormally early, small heavy leaved types, commonly called freaks. * * * * These freaks were particularly noticeable in the crops grown from freshly imported Cuban seed. * * * If it is desirable for the grower to test foreign, imported or new seed of any kind, it should be done on a small scale, etc. * * * * 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."

Seedlings. It is not a common thing for seedling plants to be brought into the state from elsewhere. No doubt it is sometimes done on the border line of this state and Massachusetts in the Connecticut valley, but such cases would hardly account for the introduction of wildfire since it was found here shortly before it was in Massachusetts. Upon one occasion we know of experimental plants used here that were grown either at Washington or Kentucky, but here again we have no evidence that they were infected either before or after they were brought in. Altogether this source does not seem quite as probable a method of introduction as by seed, though within the realm of possibility.

Upon the whole it seems too late now to actually prove the exact

way by which the disease first got a foothold here, and certainly no one intentionally brought it in. Introduction through seed, however, seems to have been the most probable method.

Agents of Dispersal.

Almost equally well do certain of the ways already discussed, concerning the means of introduction of the germs into the state, apply to their dispersal over the state when once introduced. State spread, however, often involves only short distances and there are additional factors that need to be considered. The discussion presented here, under similar headings, avoids repetition of preceding statements so far as possible.

Seed. We have taken for granted the conclusion of Fromme and Wolf that the disease is in part seed-borne, and so have made no extensive efforts to isolate the germ from seed. While others have observed the wildfire spots on the seed-pods, we failed to find any so affected in a careful search during the season of 1921. In 1920 Mr. Southwick gave us seed-pods that were supposed to have shown wildfire spots on them, but we failed to obtain any diseased seedlings grown from the same. We do not doubt that seed-pods can become so infected, but from our experience it seems probable that this takes place only in certain favorable seasons and perhaps then not to so great an extent here as in the south. There can be no question that seed may be contaminated in other ways than through infected seed-pods. For example, in the process of blowing or cleaning seed there is a chance that seed free from the germs might become contaminated by dust laden with the germs. One cannot be too careful, therefore, in obtaining seed originally free from these bacteria to protect it from later exposure to them. Our experience leads us to doubt that seed has been the chief source of yearly infection in Connecticut. Quite a number of farmers have told us that their seed was gathered a few years before the wildfire was known here and that they had no trouble with wildfire in their seedbeds from the same seed until last year or the year before. It would seem in some of these cases, therefore, that the seed was not the source of the infection.

On the other hand there have come to us one or two cases where it seemed probable that the seed was the source of infection. For example, a grower who was known to have had it in his fields in 1920, grew some of the Round Tip tobacco in 1920, and used the seed next year. The wildfire appeared in his seedbed where this was grown, and also in at least three other seedbeds of growers to whom he had given the seed. In two of these places it appeared earlier, if not confined to the seedbeds containing this Round Tip seed. Some of this seed was obtained by us and planted in the greenhouse late in the season and at least one of the young plants

showed a wildfire spot on a leaf or two. It would seem that this seed then may have been a source of spreading the disease somewhat, though we failed in our attempts to isolate the germ from it.

Seedlings. There is no doubt that one of the most common methods of spreading the disease has been by the seedling plants set in the fields. A great many growers either do not, for one cause or another, grow all the plants they need, or in some cases depend entirely on outside sources for the same. No doubt for economical reasons this is the best course to pursue for certain small growers. With the advent of the wildfire, however, one needs to be especially careful how he buys his plants. He cannot watch another's seedbed as he can his own, and as wildfire is often masked in the plants, he cannot be sure of what he is getting unless the plants come from a region where wildfire has not yet appeared or he has evidence that the plants were grown under the best possible conditions for its prevention.

We have heard of a number of cases where persons knowingly or unknowingly have purchased plants from seedbeds that contained wildfire infected plants. In some instances this has happened where the purchaser had seedbeds of his own in which wildfire did not occur and thus he brought it into his field from outside sources. Perhaps the best illustration of this was a case in Suffield, where a grower in 1920 furnished plants to a number of growers who had wildfire in their fields that year apparently for the first time. Yet the seedbeds of this man looked unusually well and wildfire was not found in them until the planting season was over.

Tools, Cloth, etc. We do not have any direct evidence of spread of the disease by means of tools, etc., used in a diseased seedbed or field, carrying the germs later to another free from the trouble. We doubt if this frequently happens, yet a reasonable amount of care should be used as regards planters, cultivators, etc., in seeing that they are clean when taken from one field to another. Refuse tobacco should not be used on seedbeds under any condition.

Another factor that needs to be taken into consideration is the use of old tent cloth as a seedbed covering. If this came from an infected field the year previous it has been shown by Fromme and Wolf that it may prove a source of infection. We have no personal evidence along this line but do know that Florida authorities are considering barring the importation of second-hand tent cloth from Connecticut into that state. Wolf and Moss (33, p. 32.) make the following definite statement:

"When seeds of known healthy origin were used in certain of these beds [free from the disease], and the beds were covered with new cloths, the plants remained free from wildfire. When, however, other of the beds were planted with seed from the same source and covered with cloths taken from beds which had been affected with wildfire during the previous year, the disease appeared."

Insects. In the same article from which we have just quoted, the writers (p. 30.) state, that they failed to find wildfire carried by thrips that were abundant on diseased plants but that,

"Flea-beetles, however, are to be regarded as carriers of infection, since the wildfire organism has been isolated from individuals which had been feeding upon diseased plants. Transmission of wildfire by these insects is a fact supported indirectly by the frequency with which the disease appears around the holes which they have eaten through the leaves."

In Connecticut the most suspicious insect carriers that we have noticed are also the tobacco flea-beetles and these chiefly in the seedbeds. We have frequently seen them abundant in certain seedbeds and absent or infrequent in others. Some of these beds were abundantly infected with wildfire and often the halos centered around the small spots which had been eaten by the flea-beetles. In an effort to confirm this evidence Dr. McCormick, with Mr. Zappe of the entomological department, tried to produce wildfire with flea-beetles. These were gathered from infected plants, or fed with them for a short time, and then placed on healthy plants under bell-jars and imprisoned there for some days. In none of the plants experimented with did any wildfire develop. However the experiments were too limited in number to be of great value. We are convinced that they may in some cases become an important factor in the spread of the wildfire within the seedbeds, and possibly carry it outside to adjacent beds. Similar experiments with lice also failed.

Man. Here, perhaps next to seed and seedlings, one finds the most common carrier of the disease. Usually no care is taken when the beds are pulled that the workers do not carry the disease to the other beds which, after handling diseased plants, they might do. Again growers from one locality visit seedbeds in another and more or less miscellaneous handling of the plants occurs. Growers seem to be somewhat alert in this respect now, as many of them have been rather cautious as to indiscriminate inspection of their beds, while some few have posted signs for visitors to keep away from the beds. Perhaps in the exchange of plants from one locality to another infected dirt may be carried in on the shoes or in the uncleaned baskets used to transfer the plants. Care is needed in these respects also.

To illustrate how the disease may be carried into a bed in an inconspicuous way, which after it occurs would be impossible of detection if one did not have the facts, we may cite the following personal experience. In a seedbed at New Haven, planted under conditions where wildfire would not occur, we tried to inoculate some of the plants with a fungous disease, somewhat related to the blue mold, that occurs on certain weeds not uncommon in tobacco beds. The infected leaves were gathered twice in regions

of the state where wildfire did not occur and these, under proper moisture conditions, were placed on the tobacco seedlings in marked spots in the bed. Both having failed, they were gathered a third time from a seedbed where wildfire was common. This time the fungus again failed to develop but wildfire appeared on the plants within a few days, at the particular spot where the leaves were placed. Now this weed, Lambs Quarters (*Chaenopodium albidum*), is not infected with wildfire but by contact with infected tobacco plants evidently carried some of the germs mechanically on the leaves to the experimental seedbed and infection resulted from these under the favorable moisture conditions provided.

Wind and Rain. While certain weather conditions have much to do with the development of wildfire in the seedbed, once it gains entrance there, we cannot be so positive about the wind and rain as agents of its introduction into the seedbed. It seems reasonable to suppose that even if one did sterilize his seed, soil, frames, etc., that the germs of adjacent soil might be spattered in by rains or even more probably be blown in with infected dust. This would not mean much if it were not for the fact that it is vitally necessary to keep the disease *entirely out of the seedbed* if one wishes to escape injury in the field. We have more positive observations on these points, however, when it comes to spread in the field, but we shall speak of them later on.

Overwintering of the Germs.

Seeds. Our discussion of infected seeds under the preceding headings will largely cover the possibility of one year old seed overwintering the germ and the re-infection of seedlings the next year. Just how long the germs can remain attached to the dry seeds and still retain their viability is not known. So far no one has shown that the seed itself is invaded by the germs so it is presumed that the overwintering is by germs accidentally attached to the seed coats. It is very doubtful if such germs can retain their vitality as long as the tobacco seed, which often germinates fairly well when eight to ten years old. Rapp (Okla. Agr. Sta. Bull. 131: 37.) has recently found with the bacterial blight of beans that two and three year old seed gave blight-free plants. This is a case where the beans themselves are sometimes invaded, and so presumably a longer viability of the bacteria would be found here than with the tobacco germ, other things being equal.

Cloth, Sash, etc. We have no data of our own showing that the germ may be carried over the winter on the boards, sash, or cloth used on diseased beds or fields the previous year. Yet there seem to be sufficient data, as far as the cloth is concerned, furnished by Wolf and Fromme from the south. What difference the

greater severity of our winters would have regarding overwintering we cannot tell, but if at all it would be unfavorable rather than favorable. Fromme (8, p. 1.) has recently published the following incidents to show infection from the use of old cloth.

"The germs of blackfire (angular spot) and wildfire may be carried on old canvas and cause infection in the plant bed. This was proved by experiments and also by the following cases. R. H. Mantiply of Amherst County used seed that had been treated but did not boil his canvas. Tilden Gooch used the same seed and boiled his canvas. Wildfire and blackfire were found in Mr. Mantiply's bed and not a trace of either could be found in the bed of Mr. Gooch."

The only incident along this line that we can cite for Connecticut is where a grower sterilized both the seed and the soil but not the sash, cloth or boards used on his beds. It was in those beds that the first appearance of wildfire in Connecticut in 1921 was found. Apparently in this case the germs carried over in the materials used in making the seedbeds, or, less probably, were carried in from other unknown sources.

Soil. Soil probably may be the source of infection in some seedbeds and fields, yet data absolutely proving this is difficult to obtain. We have little convincing data along this line, in fact so far as field infection goes, it does not seem to hold a very important part. But an occasional holding over in the field is quite a different matter from that in the seedbed where an infection, no matter how slight or infrequent, can become an important means of further spread. As yet we have made no attempt to isolate the germ from wintered-over soil exposed to infection the previous year, but our attempts to infect tobacco plants in the greenhouse directly with such soil were successful in one out of several different trials. Wolf and Moss, *loc. cit.* pp. 30-1, also, make the following definite statement of a case in North Carolina:

"In the tests on transmission through soil, old plant beds, which had borne diseased plants and which were not 'fired' prior to planting, were used. Seed from a locality where wildfire was absent were sown in these beds, and new cloth was used as covers. The disease developed in some of these beds."

Tobacco Refuse. It seems certain that where a field or seedbed has been badly infected with wildfire and the diseased plants were left there that the germs can, to a certain extent, be carried over in the more or less disintegrated tissues. This might be the way it is carried in the soil where it is supposed to have survived as stated above. Infected tobacco refuse from indoors thrown on the fields or seedbeds in the spring might also supply the infecting germs in some cases. Our few attempts to inoculate greenhouse plants with outdoor overwintered tobacco refuse were successful in one case. Evidence along this line is also indicated in the following extract from Fromme (8, p. 1.):

"The disease may live over in the field and infect the next crop where

tobacco follows tobacco. Evidence of this was obtained in several cases but in some other cases it was equally true that the disease had not lived over in the field. It is believed that the time of plowing had a great deal to do with this and that the danger from this can be greatly lessened if the land is plowed in the fall or early spring, so that the suckers have time to rot in the soil before the crop is set. There was also more carry-over of the disease in the field during the mild winter of 1920-21 than would be true in ordinary seasons."

Detailed Distribution in the State.

Survey. As previously mentioned, a tobacco disease survey of the state was started in 1920 and continued in 1921. For Hartford County, B. G. Southwick, County Agent, gave valuable help in both seasons. In the spring of 1920 Mr. Southwick and Dr. Clinton spent considerable time on the seedbeds and during the summer Mr. Southwick frequently, and Dr. McCormick occasionally, made field trips. The work was not undertaken especially for wildfire investigation, though the discovery the first year that the disease was widespread in the state was the most important feature of the work, and largely influenced the nature of the work the second year. In 1921 Mr. Southwick, with Dr. Clinton, again gave much of his time during the whole season to the examination of seedbeds and fields. The writers are especially indebted to him for first information about, and aid in visiting, many of the farms containing infected plants in Hartford County.

Little work outside of Hartford County was done in 1920, but in 1921 tobacco seedbeds and fields in Tolland, Middlesex, Litchfield and Fairfield counties were also examined and additional data obtained. County Agents E. E. Tucker, of Tolland, and J. H. Fay, of Middlesex, were also helpful in aiding investigations in their respective counties.

In 1920. In the survey of seedbeds in 1920, which ended about the first of June, no cases of wildfire were found. However later in the season, after it had been found in the fields, Mr. Southwick reported that he examined one or two seedbeds from which infected fields had been set, and found a few infected plants in these. Of course in the early seedbed examinations, as nothing was known then about the presence of wildfire in the state, the disease may have been overlooked. On the other hand, it could not have been at all conspicuous since care was taken to find all troubles of any nature that showed either on the leaves or the roots.

This same year in the fields the disease was first discovered the latter part of June, and during the remainder of the season it was looked for particularly, and was eventually found in twenty-one other fields. The known distribution by the end of the 1920 season is shown in Table I.

TABLE I. KNOWN INFECTIONS PREVIOUS TO 1921.

<i>Infected Fields, 1918.</i>			
No.	Place.	Town.	County.
1(?)	Buckland,	Manchester,	Hartford.
<i>Infected Fields, 1919.</i>			
No.	Place.	Town.	County.
1(?)	East Windsor Hill,	South Windsor,	Hartford.
1	West Suffield,	Suffield,	Hartford.
<i>Infected Seed Beds, 1920.</i>			
No.	Place.	Town.	County.
1(?)	Floydville,	E. Granby,	Hartford.
1	West Suffield,	Suffield,	Hartford.
<i>Infected Fields, 1920.</i>			
No.	Place.	Town.	County.
2	East Granby,	E. Granby,	Hartford.
1	Warehouse Point,	E. Windsor,	Hartford.
1	S. Glastonbury,	Glastonbury,	Hartford.
11	Suffield,	Suffield,	Hartford.
6	Poquonock:	Windsor,	Hartford.
	Windsor:		
1	Windsor Locks,	Windsor Locks,	Hartford.

In 1921. As this year especial attention was given to the disease, wildfire was found in a great many more seedbeds and fields than in 1920. This was partly due to the extra search for the trouble, and also in part because it was undoubtedly more widespread and serious than the previous year. Of the 122 seedbeds (122 growers) that were examined, it was found in fifty-one, and seventy-one were free from the trouble so far as could be seen at the time of the examination. As most of these beds were examined only once there is more or less doubt whether all of these listed as free remained so during all of the season. In fact we have data showing that, in a few cases, beds pronounced apparently free of wildfire at the time of the examination were either not entirely free, or later developed the trouble, so that it was carried in sufficient amount into the fields to eventually cause serious injury.

In the field inspections 125 fields, belonging to about as many different growers, were examined and in sixty-seven wildfire was more or less prominent as compared with fifty-eight fields that were apparently free of the disease. Of the sixty-seven infected fields we can loosely classify them, according to the amount of wildfire that showed at the time of the last examination, as follows: thirty-four with little injury, that is less than 5% loss; eighteen with a moderate amount; eight with much; and seven with very serious injury, in a few cases reaching almost a total loss. The condensed data of distribution obtained in 1921 is given in Table II.

TABLE II. INFECTED AND FREE SEEDBEDS AND FIELDS, 1921.

Town.	County.	<i>Seed Beds.</i>		<i>Fields.</i>	
		Infected.	Free.	Infected.	Free.
Brookfield,	Fairfield,	0	6	0	4
Sherman,	Fairfield,	0	0	0	9
Barkhamsted,	Litchfield,	1	0	3	1
Kent,	Litchfield,	0	6	0	0
New Hartford,	Litchfield,	0	0	0	1
New Milford,	Litchfield,	0	19	0	15
Avon,	Hartford,	1	0	1	0
Berlin,	Hartford,	0	0	0	1
Bloomfield,	Hartford,	3	0	1	0
Canton,	Hartford,	0	0	0	1
E. Granby,	Hartford,	5	0	7	0
E. Hartford,	Hartford,	2	7	6	2
E. Windsor,	Hartford,	1	3	2	0
Enfield,	Hartford,	2	0	5	1
Glastonbury,	Hartford,	1	2	0	0
Granby,	Hartford,	1	1	5	0
Hartland,	Hartford,	0	0	0	7
Manchester,	Hartford,	2	1	3	0
Simsbury,	Hartford,	3	1	4	0
Suffield,	Hartford,	3	3	5	0
S. Windsor,	Hartford,	3	1	4	0
Windsor,	Hartford,	16	2	8	1
Windsor Locks,	Hartford,	0	0	2	0
Cromwell,	Middlesex,	0	9	0	8
Middletown,	Middlesex,	0	0	0	3
Portland,	Middlesex,	0	7	0	3
Ellington,	Tolland,	4	3	7	0
Somers,	Tolland,	2	0	4	1
Vernon,	Tolland,	1	0	0	0
Totals 29.		5	51	71	58

Distribution. Examination of these tables shows that wildfire has now been found in three of the five counties of the state where tobacco is grown commercially, namely in Hartford, Tolland and Litchfield counties, but not, so far as we have data, in Middlesex or Fairfield counties. By far the greatest center of infection lies in Hartford county north of the city of Hartford. The disease has been found in over half of the towns of this county and these include nearly all of the towns where tobacco is grown to any extent. Much less is found in the southern towns than in the northern ones. Hartford county grows more tobacco than all the rest of the New England counties combined. Of the twenty-nine towns in the county four grew no tobacco, nine in less amount than twenty-five acres, while the other sixteen grew it as one of, if not their chief crop.

In Tolland county to the east of Hartford, the tobacco region is largely limited to the towns bordering on Hartford county, and in the three most northern of these wildfire has been found just as abundantly as in the adjacent towns in that county. Tolland next

to Hartford grows the most tobacco in this state, but not one-tenth of that grown in Hartford.

Middlesex county to the south of Hartford grows tobacco in three or four towns on its northern border. Fortunately, so far, we have been unable to find wildfire in any of these. As this district is somewhat cut off from the infected region to the north there is some hope that with care the disease may be kept out of it.

Litchfield county to the west of Hartford grows tobacco in two distinct regions. One of these embraces two or more of the towns bordering on Hartford, and wildfire has been found in one of these to a slight extent. To the north of Hartford county come the tobacco counties of Massachusetts and wildfire exists there also. The counties already mentioned in general make up the tobacco region of the Connecticut river valley, the great tobacco district of New England.

The second tobacco region in this state lies in the valley of the Housatonic river in the northern part of Fairfield and the southwestern part of Litchfield county, embraced chiefly in five or six towns. So far a general survey of this region has not revealed the presence of wildfire there. As this district is even more isolated from the infected region than is the tobacco grown in Middlesex county, there is a still better possibility of keeping the disease out of it. This region has a small tobacco acreage, like that in Middlesex, in fact all of the tobacco grown in these three counties is less than that grown in Tolland county.

Disease in the Seedbeds.

Appearance. On May 2, 1921, Mr. Southwick asked Dr. Clinton to examine, at East Windsor Hill, tobacco beds with which the grower was having trouble. The plants at this time were quite small, the largest leaves being about one-half inch long. The trouble showed at the tips, or less frequently at the upper edges of the leaves, the infected tissues rapidly rotting and drying up (Plate XXIX f). With favorable moisture conditions present the rot continued until nothing of the blades remained and the plants then shriveled up, leaving vacant spots in the beds (Plate XXIX e). With less favorable moisture conditions the rotten tissues, of greater or less extent, dried up and fell off, leaving the rest of the mutilated leaf apparently healthy. The general appearance was so much like the result of dampening-off fungi, common in tobacco seedbeds, that we were surprised, upon a preliminary examination at that time, to find no suspicious mycelium present in the tissues. On the other hand in certain intercellular spaces in the rotten tissues evident masses of bacteria were present, so that we concluded, temporarily, that the trouble was of a bacterial nature, possibly the bacterial soft rot. Specimens brought to the laboratory seemed to confirm this view.

About a week after the first examination, Mr. Southwick asked Dr. Clinton to examine another bed at Poquonock having similar trouble. At this time the plants had grown so that some of the leaves were an inch or more in length. While the dampening-off rot was present as before, it was not so conspicuous, and there were beginning to appear yellow bordering areas in advance of these rotted tissues; also isolated yellow "halo" spots within the leaf blades were to be seen. This proved that the trouble was the true wildfire disease. An examination on this date, May 8th, also showed that the first beds seen had now developed these characteristic halo spots.

So far as we are aware this rot stage of wildfire has not been described before, in fact Wolf and the other writers do not give a very detailed description of the disease in the seedbed. We have since seen it in many other seedbeds and in every case the halo or yellow spots developed later. This convinces us that this wet rot is the first stage of the disease in the seedbeds. We have not seen it on the larger plants. It seems probable that with very young plants the first leaves come in contact with the ground and, if the wildfire germs are present, this favors early invasion through the large stomates at the tip or margin of the leaf into the intercellular spaces. This environment, especially with the greater amount of moisture present, facilitates a rapid rotting of the tissues and a greater production of bacteria. We have not as yet studied this stage carefully enough to state positively that these more abundant bacteria are all wildfire germs. The first stage then, according to our belief, develops more as a soft rot trouble and chiefly from the tip or edges of the leaves inward.

The second stage we consider the halo or yellow spot which comes on quickly after the first and on the somewhat larger plants. These spots also may begin at the tip or edge of the leaf, in which case they are semicircular in outline, or they may start more slowly within the tissues as small circular yellow spots that gradually enlarge, eventually becoming about half an inch in diameter. Their abundance on the leaf depends upon the number of infections and the size of the leaf. In leaves of plants of the size for transplanting half a dozen or more may show on a single leaf, and eventually may run together and become somewhat irregular in shape. At the center of each of these circular yellow spots is a small whitish or blackish speck, the point of origin of the disease. In some cases this is insect-injured tissue, usually a small hole eaten out by flea-beetles, but in most cases it is merely the position of the stomates or breathing pores through which the bacteria originally gained entrance between the guard cells into the intercellular space beneath. There they multiplied, killed the tissue in their immediate vicinity and caused a slow death of the surrounding tissue, showing first by the injury to the chlorophyll grains, thus forming the yellow halo spot. Plate XXX a.

The third stage does not usually appear to any extent in the seedbeds. This is where the yellow spots die, turning white or brown, and if placed thickly enough on leaves, cause the intervening healthy tissues also to die. Before the disease reaches this stage the plants have usually been transplanted into the field. Our experience so far has been that the plants left in the infected seedbed do not seem to continue the disease in the progressive way that one would expect from its aggressive first appearance there. This may be because the moisture conditions, after the covers are permanently removed and watering is infrequent, are not so favorable, but it is also probably due in part to the slow growth of the thickly set and competing plants, a condition that seems unfavorable for rapid development of the disease anywhere.

Conditions favoring the Disease. Of course the first essential is that the germ should already be present in the seedbed or be carried there in some manner. We have already discussed the various sources of infection such as soil, equipment, fertilizers, and such active agents of introduction as spattering rain, wind, insects and man. But even if present the active development of the germs depends on other conditions, such as the weather, the method of watering, and the airing of the beds. These latter are quite important factors and will be discussed further, but before doing so it might be well to mention one phase of the fertilizer proposition. A good many growers have the idea that nitrate of soda has some influence on the development of wildfire in seedbeds. The only evidence we have obtained is that with the disease present in the seedbeds the liberal use of this fertilizer incidentally has some part in a more rapid spread of the disease, other things being the same, because of the quick growth of the plants, a condition that favors the spread.

Weather. It was quite evident in the spring of 1921 that there were certain periods in which seedbed infection appeared and progressed more rapidly than at other times. The first favorable period was when the plants were quite young, about the first of May, as has already been pointed out. After this first outbreak, due in part to the greater care given the seedbeds by the growers because of the agitation started against wildfire, the spread did not seem so rapid, and certainly infected plants were not so conspicuous in the beds.

During the first part of the week of May 22-28 there were several days of cold wet weather so that by the end of the week there began a second outbreak that was even more conspicuous than the first because of the large size of the plants at this time and the consequent prominent halo spots that appeared abundantly on the leaves. Even when plants were selected from beds that did not show the disease to the ordinary observer, the grower did not always escape trouble in the field because incipient or masked infections were already there.

Glass versus Cloth. The grower cannot control weather conditions, though he can usually provide somewhat against their ill effect. For example he can help by the type of covering used in the seedbeds. Our inspections in the infected regions indicated that the beds with glass are less likely to develop serious cases of wildfire than the cloth beds. If we take the percent. each of glass and cloth-covered beds that developed wildfire as compared with those free, as shown by our total inspection, we find that the cloth beds really had a much smaller percentage. This means nothing, however, as most of the growers in the districts free from wildfire, especially in the Housatonic valley, happen to use cloth almost entirely, while in the infected regions of the Connecticut valley, glass seems to have the preference. The cloth beds do not keep out the rain and so at times they are much damper than the glass beds. Also they are not aired so well, and on the whole they are colder and shadier and water does not evaporate so quickly from the leaves. It is this water on the leaves, if it stands on them any great length of time, that causes serious development of wildfire. With the glass bed the rain does not get on the plants if care is used, and the sash can be partially raised even in rainy weather so that the plants can be aired and water kept out at the same time. However, if the sash leaks and water becomes abundant in spots, wildfire often gets a start there. Plate XXIX a-b.

Watering and Airing. As a rule watering of the beds should be as light as compatible with good growth and should be made at that time of day when the plants have opportunity to dry off. Perhaps the early morning or late afternoon is the best time, since there is less likelihood of sun scorch at these times. Beds made on wet soils or well protected against wind are difficult to keep dry and free from wildfire. Much of the water that stands on the leaves, however, is water of transpiration given off from the leaves. If the air of the bed is saturated, this water does not evaporate into the air, but accumulates as small drops all over the leaves. Airing the beds prevents this. Airing somewhat at night, when there is no danger of frost, helps to keep water of transpiration off the leaves.

Susceptible Varieties. So far as the seedbed inspection revealed there was no indication whatever that the varieties commonly grown in Connecticut had any degree of immunity. Wildfire was found bad on Broadleaf, Cuban, Havana and Round Tip. There were also beds of each of these that showed large, moderate and little amounts of the disease, and the percent. of beds showing these different amounts was not very different for any of the above varieties. Whether particular resistant strains of the above can be found we do not know, but it seems very doubtful unless the nature of the variety is changed; so control of the disease will not come along this line, at least for some time to come.

Damage. While we have seen wildfire very prominent in certain beds, if it were confined to the seedbeds as certain fungous troubles are, we would not consider it a disease of sufficient importance to cause much anxiety on the part of the grower. Of course in the wet rot stage it does cause the loss of some plants, clearing out small spots in the bed. Older plants, too, are often injured enough to misshape them or cause them to be smaller and less vigorous. The real danger, however, comes from the menace of infected plants when transferred to the field. Even a few infected plants in the bed because of this menace are very undesirable, and of course if abundant are the possible source of complete failure of the crop. The approximate amount of wildfire in the seedbeds examined in 1921 is shown in the following table:

TABLE III. WILDFIRE IN SEEDBEDS IN 1921.

Variety.	No. Bad.	No. Moderate.	No. Little.	No. Free.
Broadleaf,	3	2	9	19*
Cuban,	3	4	8	5
Havana,	4	3	6	46**
Round Tip,	2	3	4	1

* Many of these were in Portland wildfire-free district.

** These were mostly in the Housatonic wildfire-free district.

The seedbed then is the strategic point for control of the disease, and fortunately this is where it can be controlled with the least effort. This leads up to a discussion of the best methods for control.

Control Measures. Seed Treatment. Certain precautionary measures against introduction of the germs and care in ventilating and watering the plants, have been discussed. In the south the investigators place considerable stress on seed treatment. We doubt if this is quite so important a factor in the spread of the trouble in the north. While we have evidence of its being carried by the seed, there seems to be so many other ways by which infection occurs that seed treatment alone would prove of little value. Virginia investigators have been the most active in the seed treatment campaign in the south. In 1921 it is stated by Thomas (26.) that about 2,500 farmers planted treated seed. Fromme (6, p. 30.) first advocated soaking the seed in formalin 1 oz. to 1 pint of water for 15 minutes. Later the same investigator (8, p. 2.) recommended the corrosive sublimate treatment, using 1 part of this poison to 1,000 parts water and soaking the seed also for 15 minutes. Our experience with both of these treatments has been that with certain seed the treatments, especially with the formalin, have been rather severe, killing part of the seed so that we believe that 10 minutes is long enough for the formalin. Where seed was gathered several years ago, before the appearance

of wildfire, or where gathered recently from free fields, there is no particular need of treating it. We know of only one Connecticut grower who treated (in part) his seed in 1921, and it was at his place that we first found the wildfire.

Soil, etc., Sterilization. Where infection has occurred in the bed the preceding year, steam sterilization of the soil should be practiced the next, or else the beds moved to new land not in tobacco recently. If we were to judge from our examination of seedbeds alone we would find that sterilized seedbeds gave a far higher percentage of wildfire than the unsterilized beds, but here again it was a question merely of location, since very few of the beds in the Housatonic valley, which is free from wildfire, are sterilized. The beds should receive a good steam sterilization, say for 30 minutes at a pressure above 100 lbs. It is well, where possible, to extend this sterilization to the paths immediately around the beds. Sterilization of the soil and seed is not sufficient, as has been shown in the south, so that this should include the boards, sash and cloth used in the construction of the beds, if these materials have at all been exposed to the germs. This can best be done by sprinkling them all over thoroughly with formalin at the rate of 1 to 30 of water, and piling them up under cover to dry out slowly; or the cloth can be boiled for an hour.

We are quite sure that steam sterilization of the soil alone is not effective against the appearance of wildfire. In the Connecticut river valley steam sterilization of soil is a common practice, yet wildfire was found just as commonly in the infected districts in the steam sterilized beds as in those that were not. This was, at least largely, because the seed, boards, sash and cloth were not sterilized also. We know of no place where all of these precautions were taken.

Spraying. In 1921 wildfire appearing in the seedbeds in so many places, it was necessary to devise other methods of control. There were apparently just two things that could be done under these conditions, namely, spraying the beds and careful watering and ventilation of them. Both of these seemed to give promising results where put in practice. The writers had had no experience in spraying tobacco seedbeds and the opinion of scientists had been that spraying is not generally effective against bacterial diseases. Bordeaux mixture, where no injury results, has on the whole proved the most satisfactory fungicide, so this was selected for experimentation, and as flea-beetles seemed to be concerned with spreading the trouble, lead arsenate was added as an insecticide. We did not know, however, whether injury might result from this spray, but, from the relationship of tobacco to the potato, with which we have had much experience in spraying, concluded to try the above on a badly infected bed at Poquonock. The senior writer sprayed this bed on May 8th, and the grower sprayed it

again the next day. This was the first time, to the writers' knowledge, Bordeaux was used as a treatment against wildfire. No harm resulting from these treatments, at the meeting at Windsor of tobacco growers called to discuss wildfire, Dr. Clinton advocated the spraying of tobacco beds with 4-4.50 Bordeaux, with lead arsenate added. Many growers sprayed their beds from one to several times during the rest of the season with either homemade or commercial Bordeaux mixtures.

As a result, from our subsequent experience and that of others, we are convinced that spraying of tobacco beds should be made one of the routine practices of tobacco growing as long as there is danger from wildfire. We have seen no serious injury from spraying with Bordeaux mixture, though in some cases we have sprayed the young plants fourteen different times covering an interval of as many weeks. We have seen a little injury from spraying, of a sun-scorch type, when the plants were uncovered and sprayed in strong sunlight. Similar injury might result from careless watering.

We have evidence that plants thoroughly coated with the spray do not become infected anything like unsprayed plants in the same beds. Spraying to be most effective, however, must start before the appearance of wildfire and be continued until the end of the transplanting season. We would start with the young plants that have just taken root and whose largest leaves are about the size of a thumb nail, and spray every week thereafter. Spraying we believe is the only remedy that prevents spread of the wildfire in a seedbed no matter what the source of its introduction. Homemade Bordeaux being cheaper and apparently somewhat more effective, we prefer it to commercial brands though most growers like to buy a prepared mixture rather than make it themselves. We do not as yet advocate commercial lime-sulphur and have had little experience with the dusts. A fifty gallon barrel of Bordeaux properly applied should be sufficient to go over once a six-foot bed of 400 to 500 feet in length.

One cannot be too careful to see that the plants he is to set out are absolutely free from the trouble. This does not mean that if a grower finds a little of it in his seedbed, he should neglect this bed and purchase plants elsewhere. Unless he has had opportunity to thoroughly acquaint himself with the seedbeds from which he purchases plants and knows that they are free from this disease (or at least better than his own if he cannot obtain plants from wildfire-disease-free beds) he had better stick to his own beds and make efforts to eliminate or at least prevent further spread of the wildfire.

If a grower finds that the best thing for him to do is use his own plants in which wildfire has appeared because of his neglect, he should start at once to attempt to eradicate the disease. We

use the word *attempt* since we believe it will be difficult to absolutely eradicate it once it has appeared, although it may be so masked as to seem to disappear entirely. Growers in 1921 attempted this by killing certain beds or parts of beds, (Plate XXIX d) with formalin (one to fifteen parts water) sprinkled over the bad spots. Care in airing has to be used in this case so that the fumes do not extend beyond the sprinkled spot and injure other plants. One sprinkling will not always entirely kill plants of some size. If these spots are few in number it is just as well to pull up all the plants in these spots and those on their border and destroy them. Spraying, as advocated above, should then be begun and especial care given in airing and watering, and the beds be watched for any further infection, always removing any suspicious plants at once.

Disease in the Fields.

General Appearance. The first stage in the field is the halo yellow spot state (Plate XXXI a) already described under the seedbed infections. On the larger leaves of the field plants, of course, many more of these halo spots eventually appear. Naturally badly infected plants are rarely set out by the growers. Growth of plants is slow at first after transplanting and little spread takes place then. If the weather is also dry no spread occurs, and as the older infected leaves wither up and fall off there comes a time when the disease seems to have largely disappeared. The grower is then apt to conclude that his plants have outgrown the trouble. With later wet or muggy weather of several days duration, however, the wildfire can reappear with startling suddenness. As the plants gain in size it will be found that the wildfire is largely confined to the older and lower leaves. With age and conditions favorable for spreading, the upper leaves also become infected, until at the end of the season the uppermost small leaves of the flowering branches may even show the trouble.

Once the disease gets a good start the old yellow halo spots gradually give place to white or brown spots of varying shades, the chlorophyll having disappeared and the tissues die (Plate XXXI b). This is when the serious injury from the disease really begins. These spots are still roundish and usually show a more or less evident yellow border, the remnant of the halo stage. If the spots are now abundant enough on the leaf the intervening tissue may die and the whole leaf become irregularly spotted and eventually brittle and worthless. The final injury is indicated by the number of leaves thus destroyed and the partial injury to the remaining spotted ones. The greatest injury comes just after the disease spreads over the plants during the period of wet weather and the sun suddenly appears again. The halo spots then turn to brown irregular burn-like areas (Plate XXXI c). This transfor-

mation often takes place quickly and so probably is largely a mechanical injury to the badly infected tissues. One grower claimed that most of the injury in his field occurred in a few hours after such a rainy period was followed by bright sunshine.

Conditions favoring Spread. Infected Seedlings. The first, and by far the most important, factor we need to consider in field infections is the seedlings used in setting out. Our experience last year indicated that if the grower can set his field with plants absolutely free of wildfire he has very little to fear from this disease. As a rule the greater amount of infection in the seedbed the greater amount of injury one may expect in his field. This does not always hold, however, and it does not necessarily mean that if one grower has it bad in his seedbed and his neighbor has only a moderate amount, that the former will have the poorer crop. Often the field conditions are factors in the greater or less spread of the disease. It is likewise true that a moderate number of the diseased plants scattered over the field, with very favorable conditions for spread, can by the end of the season injure the crop as completely as would a large number.

It is always best, however, to play safe if one can do so. For example, we know of a grower who had a moderate amount of wildfire develop in his beds. These beds were later sprayed a few times and the disease was kept down so that it no longer appeared conspicuous. The plants as a whole were unusually nice looking and healthy. This grower would not use these plants but went to a district some distance away and bought plants that were known to be free of this disease. The plants otherwise were not as good as those in his own seedbeds. A neighbor knowing that wildfire had occurred in this man's beds, but seeing how well they looked, bought the beds for his own use. He did not use especial effort to throw out the wildfire plants though they at that time were not prominent as such. He did notice after the plants were set out that there were some in the field. However, dry weather followed and the wildfire seemed to be disappearing. Then, suddenly, there came on a more favorable period and the wildfire spread rapidly through that part of the field where diseased plants had been seen, and to a less extent where they were not so conspicuous. He became alarmed and began to prime his plants earlier than he naturally would have done, and in this way avoided a part of the very serious injury that would have resulted had the plants not been primed. The other man grew a crop not injured at all, although his field had a less favorable start than it would have had with his own plants. A little wildfire in one or two spots on just a few plants finally appeared, but whether from the soil or accidentally carried into the field in some manner we could not determine.

It is not an uncommon practice for a grower who runs short of

plants to purchase additional ones from another grower without especial attention being paid to them except their general vigorous appearance, which may be very deceptive so far as the presence of wildfire is concerned. Such plants in setting are often scattered more or less throughout the fields with his own plants. In case they happen to come from beds containing wildfire while his own were entirely free, their presence thus scattered through the fields may largely nullify the advantage he had with his own disease-free plants.

If it is necessary to buy plants outside, one should be sure that they are as free from this trouble as his own, and if possible plant them in blocks by themselves to prevent any outside spreading if infected, or to protect them if free, from his own possibly infected plants. We know of growers who were fairly free from wildfire in their own seedbeds but who brought the disease in by purchased plants which they happened to keep together in certain parts of their fields, and as a consequence the disease developed much more prominently there than elsewhere.

Method of Handling Seedlings. Another factor that seems to be very favorable to spreading the disease before planting is the manner in which the seed plants are handled after pulling from the beds. Often the plants are wet down all over and allowed to stand for some time before planting. Where wet closely packed plants, some of which are infected with wildfire, are left in the baskets over night in a damp atmosphere, the disease will spread further according to our experience. If the plants cannot be used soon after pulling, it is just as well to keep water off the leaves, although if necessary the basket may be kept on moist ground with a good air circulation above.

Certain of the crosses experimented with at the Windsor farm in 1921 came from a seedbed in which wildfire was present. This could not be avoided as they were the only plants of the kind to be obtained. Another mistake was made in pulling the plants on a Saturday or Sunday and keeping them in a damp place until Monday. As a result of this treatment wildfire developed in this field even worse than it did in another set with badly diseased plants as a wildfire experiment. At least two growers have told us of a somewhat similar experience where they kept wet plants in baskets in cellars over night. These wet plants were set together in fields otherwise planted with freshly pulled seedlings from the same bed. Wildfire in each field first showed prominently in those particular parts set with the hold-over plants.

Infected Fields. The next point to consider is, will a field set with plants free from the disease later become infected? We believe it can under certain conditions. This will not likely happen, however, in such isolated regions as the Housatonic valley, or the towns of Cromwell, Portland or Middletown of Middlesex county.

It may not even occur in fields in a badly infected region. That it does occur is shown in the example cited under conditions favoring spread. In any case it is not likely to become serious if the field is at all isolated from infected fields. Where an infected crop was grown on the land the previous year, the rotted or rotting leaves, especially of the suckers, may possibly be the source of an infection here and there. The encouraging thing about this is that they apparently are not the source of any serious field infections.

We know a grower who had a little wildfire in his field in 1919 but paid no especial attention to it. In 1920 in the same field he had it so seriously that he made an effort to keep wildfire out of his seedbed in 1921, with the result that the plants set that year were fairly if not entirely free, and so in much better shape than the year before. His crop this year on the same land showed no ill effects from wildfire, although showing some slight signs of it. This would not have been the case if the germ had carried over abundantly in the soil, as the season on the whole was favorable for the development of the trouble.

Soil, Fertilizers, etc. We cannot speak very definitely about different types of soil as regards the development of this disease, since we have seen it on all types, sometimes worse on one and sometimes worse on an entirely different type. In general we are inclined to believe that a soil that dries out quickly would not favor the spread of the trouble as readily as a wet one. Likewise a field on a hillside would not be so bad as one in a lower or less protected position. Yet we have seen fields where the worst infections were on the higher, drier spots. This was when the field as a whole was too wet, however. Perhaps a favorable location for the spread may be held back by the slight infection to start with, or an unfavorable one be aided by an original heavy infection of the plants. In such cases neither will prove as bad as where both factors are favorable for the rapid spread.

So far as fertilizers are concerned we can only say that the use of any fertilizer that favors rapid growth is more likely to help infection, during a period of weather favorable to the spread of the disease, than where the fertilization is such that slower or less satisfactory growth takes place. Our field fertilization experiments were not extensive, but so far as they proved anything they showed that the plants with added fertilizer, especially that with nitrate of soda, giving more rapid growth, were the worst infected.

Speaking along this line before tobacco growers at Suffield in 1921 Garner (11.), of the U. S. Department of Agriculture, said:

"It has been found that, other things being equal, an increase in the nitrogen supply of the plant increases its susceptibility to leaf spot, for nitrogen promotes a rapid, tender, 'watery' type of development. This conclusion is based on extensive observations in the field by means of fertilizer plot tests and other field and laboratory studies. * * * * As a general proposition applying nitrate of soda or other quickly available form

of nitrogen to young tobacco seedlings should be avoided as far as possible and if used at all, an excess should be guarded against. On the other hand, a liberal supply of potash in suitable form tends to increase the resistance of the plant against leaf spot by promoting a more substantial hardy type of growth. Potash alone cannot be relied upon as a means of control but at times it is of great value and is to be recommended as a safeguard both in the field and in the seedbed."

Rain and Wind. These factors have to be considered somewhat together since they often act simultaneously; at least wind without rain has no effect unless it is by occasionally carrying the wildfire germs into fields through dust. This last statement is based largely on supposition rather than proof. We do know positively, however, that rainy weather of some duration, with or without wind, is favorable to the rapid development of wildfire. There were only two periods during 1921 that favored spread of wildfire in the fields. The first of these came the week of June 26th to July 2d, the latter half being especially favorable for the spread. Growers first began to notice this increase on July 2d, and by the 4th the injury was very pronounced. Previous to this time the disease had spread little or none even in fields that were set with plants badly infected. This led some growers to believe that there was nothing to fear from this trouble.

The only other time during the year when there was a general spread was about the last of July and the first of August when there was a similar prolonged moist period. This was when the most damage occurred, as the previous period had spread the disease so that it was abundant or wide spread in many fields. However, even with this last serious development there were some rather badly injured fields that had spots in which the plants were not hurt to any great extent.

In the first spread the rain was accompanied by a high wind that in itself caused much damage to the plants, but entirely independent of this was its effect on the spread of the wildfire. This wind came from the west, or more accurately from the northwest. That it had something to do with the spread of the wildfire was shown in fields exposed to its full sweep. Here the wildfire developed at first most prominently on that side of the plants exposed to the wind. This phenomenon had been noticed the previous year. It can be explained by the dashing of the rain drops onto the ground with consequent spattering of the muddy water containing the germs onto the leaves. These germs may have been washed off the plants or may have been carried into the soil by the infected dead leaves that gradually disintegrated there. These suppositions are borne out somewhat by our infection experiments with muddy water from infected soil.

In contrast to this condition there were other fields, more protected from the wind, that showed no special infection of the plants on one side over the other. There were also particularly protected

fields or spots where the total spread was not nearly so great. In some of these cases other factors entered. In the Station field, for instance, where the plants were shaded by barns, hedge rows, etc., there never was the spread that there was in the more open places. Protection against the wind and rain accounted for this in part, but it was also due to the slower, smaller growth from shading and poorer fertilizing. We saw another field, protected on two sides by a forest, where the growth and the wildfire infection were both much less than in the more open and exposed part. In a dry season rather unfavorable for wildfire it is quite possible that the reverse of these results might occur since here the shaded parts would have better moisture conditions.

The effect of a rainy or a dry season on wildfire development has been evident in the southern states where this disease first appeared. It has not increased each year but its severity has been entirely regulated by the moisture of the growing season. For example, in most of the southern states last year it was much drier than usual, and the result was that wildfire was inconspicuous. In other wet years wildfire has threatened the industry by its severity. We may expect similar variations in this state; in other words, if one were able to foretell the weather he could predict the severity of wildfire that year.

Distance of Spread. We have no records of the spread of the disease from a distance into an isolated field by means of wind or even by insects. In fact infection by these agents would be an extremely difficult matter to absolutely prove, but so far as our observations go, it does not seem that either is a common method of field infections. If this does occur the infections are so infrequent as to prove of little consequence. On the other hand we have seen many cases where we are sure that the disease has spread from infected plants in the field to those near by and even from one field to another separated only by a short distance. In such cases the spread seems to go most rapidly with the wind or the wind driven rain. A few examples will illustrate this.

At the Station's Windsor farm several rows of disease-free seedlings from New Haven were set out late. These had badly diseased plants on one side and plants with little disease on the other. While the rain storms of late June and early July were largely away from these plants toward the badly infected, they soon became infected, at first largely on the side toward the badly infected but in time all over. In another place disease-free tobacco plants were beside infected, but so that the wind came from the diseased ones to them, and here the general infection was much more rapid. A more isolated field entirely out of the direction of the wind from the diseased plants, showed only slight infections here and there, but mostly on the end towards the diseased plants. The wildfire, however, was so slow here in getting a start that it never became serious.

A grower near Windsor Locks set out a couple of rows containing infected plants on one side of his field in which there was no disease. It spread slowly to the next row or two but not further in, at least not before the middle of the season when last seen by us. Another grower near Broadbrook had in July a badly infected field with the last one or two rows from another source fairly free. Just beyond these and a narrow grass roadway was another field almost entirely free, the wildfire having spread only to a few plants in the first row or two next the diseased field. We know of another field at East Granby badly injured, while the adjacent field of another farmer separated by a rod or two of grass remained practically uninjured during the whole season, the most infections being next the badly infected field. In another badly infected field at Hockanum wildfire spread only slightly to the corner of a field overlapping but separated by a grass roadway.

These and other instances, together with the probable fact that the germs do not carry over to any great extent in the fields, lead us to conclude that if the grower keeps the trouble out of his seedbed he need not fear serious injury in his field.

Varieties Injured. While we have proved that the different varieties grown in the seedbeds showed no difference in susceptibility to this disease, the fact remains that in the field they are not all injured to the same degree, even when the percent. of infected plants set out was the same. This does not mean that in the field certain varieties acquire immunity but rather that the type of growth and the manner of handling the plants seem to influence the spread of the disease as the plants grow to maturity. In general we can classify Broadleaf and Havana as being more subject to injury, and Round Tip and Cuban as being less.

There is little doubt that Broadleaf on the whole will suffer more from this disease than Havana, though fields of the latter are also frequently severely injured. The large drooping Broadleaf leaves coming in greater contact with the ground, seem to offer the best conditions for infection of any of the varieties. The fact that Havana has the leaves more erect and so not so frequently in touch with the ground, especially the higher ones, seems to help lessen infection somewhat. Where Havana plants are primed the infection is somewhat checked by removal of the infected leaves before the end of the growing season. Some growers take advantage of this and by early priming try to keep partially ahead of the spread, or at least pick the leaves if possible before serious injury occurs. This is never done with Broadleaf so all the leaves are exposed throughout the season.

Round Tip as compared with Havana suffered less, partly because the leaves of this variety are always primed. Other factors tending to lessen its infection are the shorter and broader leaves, separated more widely on the stem with the last ones borne much higher from the ground and the more vigorous root system that

keeps the plants from lopping over in heavy winds. We have not had opportunity to examine a sufficient number of Round Tip fields to state that these advantages always hold. We got some rather badly infected plants in certain of our field experiments where there was no priming made.

Undoubtedly the Cuban tobacco grown in the tents suffered the least of any of the varieties and we have no records of any very serious losses with this variety. Not only does it have all of the advantages mentioned for the Round Tip (except the strong root system) but it also has the further one of partial protection of the tent against the whipping rain storms that seem to bring the most infections. Even in cases where we know considerable infection on the young plants was carried into the tents the resulting injury was not nearly as serious as similar infections produced out in the open on Broadleaf and Havana. However, it can be said that on the whole the grower of tent tobacco took more precautions to prevent this trouble, both in the seedbeds and the fields, than did the growers of Havana and Broadleaf.

Damage. According to the variety and the degree of freedom from the disease we could find all the way from no loss up to a total loss. In a number of fields we estimated the damage around 60 to 70%. When a field is injured to this extent it is very doubtful if it pays to harvest the crop, because the subsequent cost of harvesting, curing, etc., will sometimes be greater than the return from such a crop.

The damage caused in all of the 125 fields inspected, estimated at the time of the last inspection, is shown by varieties in the following table. Of course these fields were inspected at different dates and some only once, so the final damage may have been greater than given here. Apparently no further injury results after the crop is harvested, as there is no evidence that the wildfire spreads on the leaves after hanging in the barns.

Variety.	Very bad, over 50%.	Bad, 25-50%.	Moderate, 5-10%.	Little, Less than 5%.	Free.
Broadleaf,	5	5	8	12	8
Cuban,	0	0	2	9	0
Havana,	2	3	6	10	50*
Round Tip.	0	0	2	3	0

* Chiefly in the wildfire-free Housatonic valley.

The damage by wildfire to Connecticut tobacco is more serious, even with the same percent. of injury, than it is in most other states for the simple reason that all the tobacco grown here is for wrappers. The same injury to a leaf used as a wrapper means much more than it does to a leaf used for a binder, filler, or for other purposes. The injured tissues have that lifeless quality which

is so objectionable because of brittleness but whether or not the burn is affected we cannot state. In the field the infected tissues do not often fall out to any extent but are more subject to injury in the handling during curing, fermentation, etc. The color is also affected. These factors would not be so objectionable in tobacco used for other purposes. If the spots are small and infrequent perhaps no great objection would be raised as spots of various kinds in the past have sometimes been sought for rather than avoided. Another consideration besides the use to which the tobacco is put, in estimating the financial loss, is the value of the product. Wrapper tobacco is sold for a higher price than any other tobacco, and in the tent-grown reaches its highest value in this country. Therefore a 50% injury to a dollar-a-pound tobacco means a loss of fifty cents as compared with a loss of five cents on a ten cent tobacco similarly injured. In view of these facts it is much more essential that the disease be controlled here than it would be in some of the southern states.

Control Measures. What are the control measures that can be taken when the grower finds that he has the wildfire in his field? In the first place these must be confined largely to the early stage, as not much can be done with the older fields. There are only two measures of any value of which we know and these are: 1st, Destruction of infected plants, and 2d, Removal of the infected leaves. A third measure that has been suggested is spraying or dusting the plants with a fungicide. We have tried spraying in a preliminary way, but feel that even if this may be helpful in retarding the spread, as it did in our experiments, it is generally not a practical method of control because of the cost and the unknown effect of the spray on the quality of the mature leaf. The other two methods may be discussed further under their separate headings.

Destruction of Infected Plants. This may involve only a few plants or the plowing up of the whole field. Let us consider the former first. After setting out their fields in 1921 a good many growers found that the disease was showing on the small plants. Some few then went over their fields and removed these diseased plants and reset with healthy ones. Where the diseased plants are not very abundant we believe that this is a good practice. The time to do this is within two or three weeks after the plants are set out and are just beginning to grow. The plants pulled up we believe should be placed in baskets and carried off the field. As the plants are small at this time this will not involve much extra labor. Handling of the healthy plants should be avoided, and the field reset as soon as possible with healthy plants. We doubt if this method is practical after the plants have grown to any considerable extent, because of the greater amount of work involved, and the resulting unevenness of the field if reset.

We have no positive data as to the value of this treatment but

only the knowledge that theoretically we have removed so many plants that would have served as centers of spread under favorable conditions. Not all of the infected plants will have been removed, even with a second careful inspection of the field, as the disease will be so masked on some of the leaves as to escape detection. If, however, a large percentage has been removed, this should help delay the spread and under some conditions certainly would serve to protect the field against the more serious injury that would have resulted with a greater infection to start with.

Where there was considerable infection in a field some of the growers plowed up the whole field and reset with other plants. This is a practice that can be followed only when the plants are small and one is sure that the new plants put out are free of the disease than those plowed up. The question arises whether or not these plants plowed in may not serve as source of infection for the new plants. We believe that this infection is at least possible under some conditions, but whether or not it is ever a serious menace we have no data as yet to make a positive statement. We do know of at least one field where the infected plants were plowed under, which after replanting remained fairly free from the disease until danger of serious infection, at least, was past. We heard of another field seriously injured in 1920 that was plowed up when the plants were of some size and reset, and in this case also the disease did not make any headway later. The late replanting gave a fair growth but quality was lacking in the crop. This is a thing that must be taken into consideration in plowing up infected fields, namely, it must be done in time so that the replanted crop can thoroughly mature. The season of 1921 was more favorable than most seasons in this respect since the frosts held off unusually late, allowing late planted fields to mature.

It is not always easy to decide whether or not to plow up a field. We know, for example, of a grower of tent tobacco who had a considerable amount of wildfire in the plants when set out. The plants were of some size when, because of the abundance of wildfire, he was advised to plow up the field. Because of the difficulty of plowing them under, he let them grow finally, and got a crop fairly free from injury. He might not have been so lucky if this crop had been Broadleaf, for no doubt the tent and priming helped to keep down the disease in this case. Each grower will have to settle his own policy after careful inspection of his field as no hard and fast rule can be laid down to govern all cases.

Removal of Infected Leaves. If the infected crop has begun to grow and it is too late or inadvisable to plow it up, there is still a possibility of partial control by picking off all lower leaves showing any signs of infection. In fact, if the plants have only a few infected leaves it is better to pick off all the leaves below these as well, whether or not they show halo spots. On such leaves the infection may be present and still not be very

evident because of their yellowed and often withered condition. They are of no commercial value anyway. On young plants the removal of these leaves, if there are still several healthy green ones remaining, does little injury to the growth. After the plants have made some growth it may be found that the first removal was not sufficient and a second or even a third be required. In the latter case if many large leaves are removed the plants are later hindered in their growth. In other words, the removal of leaves once or twice before or shortly after the plants have started to grow seems practical, but if required again, where the final leaves of commercial value have to be removed, it is of very doubtful value. The removal therefore should be with fairly small plants and include leaves of no commercial value and should take place before there has been much chance for field infection from the infections actually brought from the seedbed. Leaves removed should, for greater security, be carried off the field.

We know of one or two growers who practiced this removal and felt that it had resulted in a more limited field infection. These were cases of Cuban tent-grown tobacco and it looks as if the best results would be obtained with this variety. These lower leaves are of no value and often are picked off and thrown on the ground so that only a little more care and effort is required to do a good job. The advantage would be to get rid of a considerable number of infections and also to remove those lower leaves that come in contact with the ground from which secondary infection might start. The usual priming that follows in these fields then should help to keep in check further serious injury.

With primed Havana similar treatment might be helpful to a less degree but with unprimed Havana and Broadleaf the value is uncertain. In these cases it would naturally be limited to the very early stages of growth. Once it becomes necessary to pull off the large or commercial leaves, it is doubtful if one can check the disease enough to pay for the extra expense of removal, loss of leaves removed and injury to the growth of the plant that results. We know of a few cases of infected Broadleaf of some size where removal under these conditions did not seem to be of any value.

Our own experiments at Windsor were rather unfavorable to removal of leaves as a means of retarding the spread of the disease. The leaves here were removed from some of the rows once and from others twice, with check rows with leaves unremoved. Eventually the disease spread about as badly to those rows with leaves removed once or twice as to those with leaves unremoved, and the second late removal checked somewhat the rapidly growing plants. In this experiment, however, there was no protection against re-infection of the plants after their infected leaves were removed, since they were always side by side or nearly so with rows from which no leaves were removed. Because

of this it is quite possible that much of the value of removal was lost compared with an entire field in which total removal is practiced.

Seedbed and Field Experiments.

These are miscellaneous experiments tried during 1921 in an effort to learn something about the development, spread and control of wildfire. It is partly from these and the laboratory studies that our preceding statements have been made. Quite a number of the field experiments were not followed closely after it became evident that wildfire was general in the plants experimented with, as little further information was to be gained. Upon the whole we did not aim to collect figures to illustrate the results, but rather depended on general examinations.

Spraying and Dusting Seedbeds. It must be borne in mind that the treatment of seedbeds was begun in most cases after the wildfire appeared in them. In a few cases wildfire did not develop much further, or at all, either in the sprayed or unsprayed parts, so here conclusions could be drawn only of the general effect of the fungicides on the young plants. In most cases Bordeaux mixture was used, and this was usually the homemade 4-4-50 strength, and almost always had lead arsenate in it. In one or two cases Bowker's Pyrox or other commercial Bordeaux mixtures were used, and in one place Bordeaux dust was compared with Bordeaux mixture. Altogether spraying tests were made in nine different beds in the following places: three at Rainbow; one at Poquonock; three at East Hartford; one at East Windsor Hill; one at New Haven.

Seedbeds 1-2, Rainbow. Each seedbed had the same treatment and other conditions were the same: Havana, glass, soil sterilized, flea-beetles rather abundant; used lead arsenate in each spraying; sprayed five times, May 9, May 20, May 27, June 3, June 20; wildfire scattered irregularly in spots in beds before treatments began. Plot 1, Check, no treatment (except received spraying first time), 35 feet of each bed. Plot 2, Homemade Bordeaux, 4-4-50, on twenty-five feet of each bed. *Results:* Final examinations showed that wildfire did not develop further in the sprayed plots, and while its spread in the checks was not so rapid as earlier, the difference between them was marked by the characteristic halo spots on unsprayed plants close up to the line separating the two plots. Likewise the flea-beetle injury was much more evident on the unsprayed plants. The grower did not use these beds (he also destroyed with formalin four other more badly infected beds, see Plate XXIX d) but bought disease-free plants elsewhere; he had no trouble in his fields. Another farmer bought the experimental beds but we did not examine his field except very early in the season when very little wildfire showed.

Seedbed 3, Rainbow. Same place and variety as beds 1-2, but

with soil unsterilized, cloth covers and planted very late, after appearance of wildfire in the other beds. Spraying was started on the very young plants soon after coming up (largest leaves size of finger-nail) and before any wildfire showed. Care was used in watering, and airing was always good. Sprays, all containing lead arsenate, applied seven times, as follows: May 27, June 3, June 10, June 20, June 28, July 6, July 14. Plot 1, Check, no treatment, first 20 feet of bed. Plot 2, General Chemical Co. Bordeaux, $3\frac{1}{2}$ lbs. to 50 gals. water, next 20 feet of bed. Plot 3, Bordeaux mixture, homemade, 4-4-50, 20 feet of bed. Plot 4, Bowker's Pyrox, 10 lbs. to 50 gals. water, last 20 feet of bed. *Results:* June 20th wildfire appeared in the Check plot in a single spot, and eventually showed abundantly in several spots, one or two entirely isolated from first. Weather was not very favorable, except once for spread, so disease finally became more or less masked. Eventually it also appeared in a very small spot in Plot 2, but did not seem to spread. This plot was nearest to the check, and seemed least protected by spray as the sediment was not so evident on leaves after spraying. No wildfire was seen at any time in the other two sprayed plots.

Seedbed 4, Poquonock. Havana, soil sterilized, beds with glass but uncovered most if not all of the time. Wildfire showed a little in spots over bed before treatment began. Spray, containing lead arsenate, was applied five times, May 11, May 15, May 20, May 27, June 3. Plot 1, Check, no treatment (except received spray the first time) first 12 feet in bed. Plot 2, Bordeaux mixture, homemade, 4-4-50, on rest of bed, 50 feet. *Results:* This and the other beds of the grower were among the first to show wildfire, but because of care in airing and one or two general sprayings, the disease never became very prominent after its first appearance. In our experimental plots there was no further development in the sprayed one, and apparently but little more in the check. However, plants used from the other beds developed a conspicuous wildfire outbreak in the field in early July.

Seedbed 5, East Hartford. Broadleaf, soil sterilized, glass alternating with cloth sash. Wildfire appeared shortly before first spraying, spotting bed more in some plots than in others. Used lead arsenate in all sprays which were applied four times, May 18, May 24, June 1, June 8. Plot 1, Check, no treatment, 8 feet at end of bed. Plot 2, Bordeaux mixture, homemade, 4-4-50, next 40 feet. Plot 3, Bordeaux mixture, homemade, 2-2-50, 32 feet of bed. Plot 4, Bowker's Pyrox, 10 lbs. to 50 gals. water, last 48 feet of bed. *Results:* Before treatment most wildfire showed in the Bordeaux plots, but did not increase afterward and really became less conspicuous; also no further development occurred in the Pyrox plot. The check plot had least of any to start with, and because of good airing and watering, it did not increase very

much. Care was used in selecting plants from this and bed 6 for field planting, and wildfire was never conspicuous there.

Seedbed 6, East Hartford. Same grower and conditions as bed 5, but only three sprayings given, the first being omitted. Experimental plots 1-4 with same treatment as in bed 5. Wildfire more prominent in this bed when treatments began, especially in the sprayed plots. *Results:* Wildfire checked in all the sprayed plots, as there was no further development there, but in the check plot it developed further in spots. A little burn, of the sun-scorch type, resulted after the second spraying of June 1st, probably because made in too strong sunlight on recently uncovered plants.

Seedbed 7, East Hartford. Same grower as of beds 5-6 but bed late planted and in more shaded, damper spot, covered with cloth only. Four treatments on same dates as bed 5. Plot 1, Check. Plot 2, 2-2-50 Bordeaux. Plot 3, 4-4-50 Bordeaux. *Results:* Very good place for development of wildfire but germs apparently absent as no wildfire was seen either before or after the experiment in any of the plots. No spray injury.

Seedbed 8, East Windsor Hill. Broadleaf, beds not sterilized, glass. No lead arsenate used in any of the three sprayings (as flea-beetles not evident) made on May 18, May 24, and June 1. Wildfire evident in about two-thirds of bed before spraying began. Plot 1, Check, no treatment, 8 feet of bed. Plot 2, Bordeaux, homemade, 4-4-50, remaining 40 feet. *Results:* Wildfire was checked entirely in sprayed part of bed and became less conspicuous in time. In the check it developed so that it was more prominent even though masked and hidden by the crowded plants at the end of the experiment. Other beds were sprayed at least once by the grower, kept well aired, and he took his plants only from the least infected parts of the beds. However he got a fair sprinkling of infected plants in the field, and eventually suffered about 15% loss from wildfire. If he had not used this care in the beds and in selecting his plants, his loss, without doubt, would have been much greater.

Seedbed 9, New Haven. Havana, soil unsterilized, cloth cover. This was planned to test value of dusting as compared with spraying, using both Bordeaux and Lime Sulphur dust as well as Bordeaux mixture and commercial L. & S. solution. Some of the plots whose seed was soaked with water containing wildfire germs did not come up so only Bordeaux mixture and Bordeaux dust were used. The experiment was started in the fall and five treatments were given in the seedbed, on Oct. 4, Oct. 10, Oct. 19, Oct. 26, and Nov. 6. After the last treatment, however, a few plants from each plot were transferred to small flats in the greenhouse and treatments continued there during the next nine weeks. Plot 1, Check, no treatment, seed sterilized with formalin. Plot 2, seed and soil sprayed with wildfire germs before planting; dusted well each time with Glidden's Bordeaux dust. Plot 3, seed and

soil sprayed with wildfire germs before planting; sprayed well each time with homemade, 4-4-50 Bordeaux. *Results:* No wildfire developed on any of the plants in the seedbeds or in the greenhouse. No evident injury resulted from spraying with Bordeaux mixture fourteen times. Soon after dusting began it was seen that these plants were yellowing and injured somewhat; they were more or less stunted by subsequent treatments and never grew as large as those sprayed.

Killing Plants with Formalin. This was tried only in two beds. Formalin at rate of 1 to 15 of water was liberally sprinkled with an ordinary sprinkling can on marked wildfire spots. The next day the plants were all dead; The photograph (Plate XXIX c) shown here was taken several days later. Care was used not to get the liquid outside the spots and the beds had the sash off at the time. No injury showed outside the sprayed spots. We have seen older beds where all the plants were sprayed and many leaves killed but the plants started to grow again. It is evidently harder to kill large than small plants, but in these cases less liquid or a weaker strength may have been used. See Plate XXIX d.

Field Experiments with Infected Seedlings. These were experiments with plants of different varieties selected from various infected beds and transplanted at New Haven and the Windsor tobacco farm, where they could be especially watched to see how the disease progressed later.

Windsor Experiments. The tobacco plants were set out June 7th at the Windsor tobacco farm with eight rows to a plot, except plot 5 which had six. The rows averaged about 150 plants. The Broadleaf, Havana and Round Tip plants in plots 1, 3 and 5 were obtained from seedbeds bad with wildfire, at least in spots, and infected seedlings were selected as far as possible. As check to these, plots 2, 4 and 6 were set with plants free, or nearly free from wildfire. Table IV shows the results of the examination of all the plants on June 28, before there was any appreciable spread of wildfire, but late enough for any masked seedbed infections to show. The check plots had only a few slightly infected leaves and these were all removed on this date, check plot 6 being the worst of these but still with less than 3% slightly infected plants as compared with 67% in the Havana wildfire plots. There was no check, wildfire-free, Broadleaf plot. After the July 4th spread the disease became general in the infected plots and even spread considerably into the check or free plots. In these it appeared most abundantly in the rows next the infected plots and by the end of the season had spread generally through the rows, but never so bad as in the wildfire plots. The west end of all the plots, both wildfire and check, never developed nearly as much wildfire as the east end which was more exposed and better fertilized.

TABLE IV. WILDFIRE PLANTS ON STATION FIELD, WINDSOR.

Plot.	Row.	Locality.	Variety.	Seedlings Condition.	Total Plants.	Inf. Plants.	% Infected.
1	1-8,	Rambow,	Broadleaf,	Bad,	1113	439	39.0
2	9-16,	Suffield,	Havana,	Free,	1375	1	.08
3	17-24,	Suffield,	Havana,	Very Bad,	1254	837	67.0
4	25-32,	Windsor,	Round Tip,	Trace,	1197	13	1.0
5	33-38,	Suffield,	Round Tip,	Bad,	777	386	50.0
6	39-46,	Windsor,	Round Tip,	Trace,	1006	32	3.0

While the examination of June 28 showed that the Havana wildfire Plot 3 had the highest infection, 67%, Round Tip Plot 5 next with 50%, and Broadleaf, Plot 1, the least with 39%, after the favorable weather ending July 4th it was seen that the spread was greatest in the Broadleaf, next in the Havana, and least in the Round Tip. This agrees with our experience elsewhere that these varieties are injured differently in the field. While no counts were made over the whole plots as on June 28th, counts on July 27 of a few of the unsprayed plants, given in Table VIII, at the least injured end of the field bring out this same variation in spread according to variety. For example, all 8 unsprayed Broadleaf plants taken as they came in the row were infected and had 55 infected leaves showing 1576 wildfire spots, as against 19 infected Havana plants similarly counted with only 71 infected leaves containing 602 spots and 16 out of 19 counted Round Tip plants with 48 infected leaves containing 204 spots. Figuring from this data the ratio of spots per plant in each variety, the difference would be still more marked since the Broadleaf plant would have 196 spots, the Havana 32, and the Round Tip only 11, despite the fact that the Havana seedlings were the worst and the Broadleaf the least infected to start with.

New Haven Experiments. At New Haven the plants from different sources were set out in small numbers in a garden plot so that they were all close together. There was no very evident development until July 5th, just at the end of the favorable moist weather for spreading already mentioned. Before this time in most cases the disease became less rather than more evident, as the infected leaves matured and disappeared. In one case (No. 1585) however, the disease became more evident soon after planting as it was masked in the seedlings when set out. The disease-free plants from New Milford remained practically free until July 5th, when they became more or less abundantly infected, largely from infected leaves previously buried under them, but partly by spread from the nearby infected plants. We shall speak of these later. The condition of all plants as regards wildfire on July 11, together with other data, is shown in Table V. An examination of these data shows that no varieties had any pronounced freedom from the disease when closely planted in small plots with others, with no topping, priming, etc., to limit the spread; in other words the Cuban tobacco became infected almost as badly as the Broadleaf.

TABLE V. WILDFIRE PLANTS IN STATION GARDEN, NEW HAVEN.

Exp. No.	Locality.	Variety.	Date of setting.	Seedling cond.	Plants set.	Plants lived.	Condition of Plants on July 11th. No. free. Little. Mod. Bad.
1569	E. Windsor Hill,	Havana,	May 26,	Consid.,	25	24	23 0 1 0
1570	E. Windsor Hill,	Broadl.,	May 26,	Bad,	50	32	13 15 2 4
1576	Windsor,	Havana,	May 28,	Consid.,	25	12	9 2 18 0
1577	E. Granby,	Havana,	May 28,	Consid.,	50	37	16 4 8 3
1579	Suffield,	Round Tip,	June 1,	Bad,	18	13	4 7 26 1
1582	W. Suffield,	Havana,	June 4,	Very bad,	55	48	7 2 5 15
1583	E. Granby,	Cuban,	June 4,	Consid.,	18	13	2 0 8 6
1584	Warehouse Point,	Havana,	June 9,	Bad,	17	17	0 0 8 9
1585	Glastonbury,	Broadl.,	June 9,	Very little,	114	109	30 1 65 13
1587	Ellington,	Broadl.,	June 11,	Bad,	26	24	8 0 14 2
1588	N. Milford,	Havana,	June 15,	Free,	38	38	13 1 17 7
1588a	N. Milford,	Havana,	June 15,	Free,	11	8	5 2 1 0

Infection from the Soil. Certain of the wildfire-free Havana plants (1588, Table V.) from New Milford had wildfire leaves buried in the soil under them on June 15th. After the first field outbreak, showing July 4th, these plants became abundantly infected. As they were near other wildfire plants the infection may have in part come from these, but we believe most of it came from the germs in the soil from the buried leaves, as the eight check plants (1588a) under which no leaves were buried, had only 13% with moderate and bad infections as compared with 63% in the others. These checks, too, were more exposed to the other infected plants nearby. The infections also showed more on the sides of the plants under which the leaves were buried. Later, soil from under the plants where the leaves were buried was sprayed with water onto plants in the greenhouse and a few infection spots appeared. These experiments seem to confirm our field observations that the spattering rains carry infection from the soil to the leaves.

Spread of Disease in Marked Fields. In order to determine the spread of wildfire under ordinary field conditions, six fields were selected that were set out by growers with plants from seedbeds having no, a little, and considerable wildfire. These included all four varieties of tobacco grown in Connecticut. On the first examination or two, up to July 4th before there was any field spread, these infected plants were marked by numbered labels stuck in the ground by them. After the spread, note was merely taken of total infected plants and severity of attack. It was thought that by marking the infected plants at first it could be seen whether or not subsequent infections clustered around these, but the spread when it did occur was usually so rapid and general that no special centers of distribution were noticed. Details of these fields and their inspections are given in the following paragraphs and Table VI.

Field 1, Windsor. This was Havana tobacco planted with seedlings obtained from Portland, where there was no wildfire in the seedbeds or anywhere near them. Care was used not to infect them in any way during transportation and planting. They were put out in a low, somewhat wet and isolated field that at least had never had any serious outbreak of wildfire. Inspection of Table VI shows that this field remained entirely free of infection until July 5th and that no general spread occurred later. Just after the first spread, examination showed on July 5th only seven infected plants in the field,—five of these had only a single spot on a leaf, and the other two had several spotted leaves. These latter appeared as if infected when set out and they might have served as the source of infection for the others. They were pulled up and all the other infected leaves were removed. The second examination on July 21 showed only five additional infected leaves,

four with two or three infected spots and one with ten. Most of these leaves were in the vicinity of the moderately infected plants previously pulled up. Priming was begun soon after so no further data were obtained but no injury resulted. This and Field 2 showed the value of setting with wildfire-free seedlings.

Field 2, Rainbow. This was a Round Tip field set with plants from a wildfire-free bed. No wildfire showed on the inspected plants at any of the four examinations made from June 20 to August 3d. As this field was near infected seedbeds that had been destroyed after it was planted, its freedom from wildfire indicates that the disease is not commonly carried any distance. The grower, however, was careful about the disease getting a start, as he did not use any of his own plants. In other rows in the same field with our plot and on Havana tobacco near-by, a few wildfire spots finally appeared.

Field 3, East Granby. In this case the infected Cuban plants were marked under a tent. These came from the grower's seedbeds that showed considerable wildfire, but care was used to avoid infected plants as much as possible. The few found on the 1st and 2d examinations, June 3 and 15, were all seedbed infections and averaged, on the last date, about $1\frac{1}{2}\%$ for the marked rows. The next examination was delayed until July 14, at which time the field was being primed the first time, so counts could not be made, but it was evident that the spread, while it may have included more plants, was so light on these that no very evident damage occurred, and the subsequent primings would keep ahead of the trouble. Injury to this field, apparently, was not over 1%.

Field 4, Windsor. Broadleaf was planted in this field from a seedbed that showed considerable wildfire. Inspections on June 3 and 20 were before any field spread, and showed on the last date about 6% seedbed infection. After the first spread in the field on July 6, this was over 12%. The grower after the second inspection removed all the infected leaves from the experimental plot, and this may have lessened the spread, for in two rows in which the leaves had not been removed counts on July 6 gave 51% infection. This field was not followed further so the final damage caused was not determined. The infection at the start, however, was abundant enough to cause serious injury judging from other similar fields.

Field 5, Windsor. The field was set with Havana plants mentioned under seedbed spraying test No. 4, so there was a moderate amount of infection to start with. The rows selected happened to have less than other parts of the field, and our first inspection of June 20 revealed no infection whatever. It was quite probable if these plants had been examined earlier, soon after they were set out, some infected leaves would have been found that later disappeared and so gave a false impression of freedom from

disease. After the first spread, counts on July 5 showed 10% of these plants infected. This was not nearly so high as in other parts of the field and the amount per plant was not so serious. The grower started in priming about the middle of July so no counts were made on the next inspections. For this particular part of the field the disease was kept in check by the priming and weather so that probably less than 5% injury resulted.

Field 6, Suffield. This Havana field certainly had a good chance for injury as it was set from the grower's badly diseased seedbeds with no particular care to avoid wildfire plants. As a result of our first count on June 3, we found that the average infection for the two marked plots was 36% and twelve days later, before any spread, this increased to 42% because of the masked seedbed infections developing. On July 8 after the first field spread, it had reached 90% and of course was very bad on some of the plants. One of the plots was protected from the wind by a barn and also happened to get fewer infected plants to start with, 31% as compared with 69%, so the final damage here was much less than in the other plot at the further side of the field. We estimated the total damage to the field to be about 20%, and if it had not been harvested early, just before the second infection period (the last of July), this would have been considerably greater. As it was, counts made on July 8th in the badly infected plot showed 23% of the plants badly injured, 41% moderately, 34% slightly, and only 2% free from wildfire.

TABLE VI. INFECTION IN MARKED FIELDS AT DIFFERENT DATES.

Field.	Locality.	Variety.	Condition Seedlings.	Total Plants Marked.	No. Inf. Plants on Examinations:			
					1st.	2d.	3d.	4th.
1	Windsor,	Havana,	Free,	4294	0	7	10	Priming;
					Je. 20	Je. 5	Je. 21	no injury.
2	Rainbow,	R. Tip,	Free,	2000	0	0	0	0
					Je. 20	Je. 28	Je. 5	Aug. 3
3	E. Granby,	Cuban,	Mod.,	6030	75	84	Priming;	Priming;
					Je. 3	Je. 15	Je. 14	no damage.
4	Windsor,	Broadl.,	Consid.,	1978	51	104	242	No later
					Je. 3	Je. 20	Je. 6	data.
5	Windsor,	Havana,	Mod.,	1733	0	183	Priming.	Plowed up.
					Je. 20	Je. 5	Je. 21	Aug. 3
6	Suffield,	Havana,	Bad,	733	265	310	656	Cut
					Je. 3	Je. 15	Je. 8	Je. 26

Removal of Infected Leaves. These plants, Jones' experimental plots with crosses, were set out June 4th at the Windsor tobacco farm. The plants came from a seedbed in which wildfire developed conspicuously, and the plants were kept moist in baskets for one or two days before planting; wildfire was very evident soon after they started to grow. There were four rows in each

plot. On June 20 the first counts were made and all infected leaves removed from rows 1-2 of each plot. On July 6 counts were again made and all infected leaves again removed from row 1 of each plot. Unfortunately counts were never made of infected plants and leaves in rows 3-4 and of rows 1-2 after July 6th. However, observations made at this date and later showed little difference in apparent infection between the plants in the rows in which the leaves were never removed and those that had been removed once and twice. In fact the first count showed infected plants (see Table VII) in row 1 of the different plots ranging from 15% to 81%, and yet on the second count the least infected rows had just as high a percent. of infection as the others, the range for all being only 97% to 100%. The first removal average from 1.8 to 5.2 leaves per infected plant for the different plots and the second from 4.1 to 5.4 leaves.

That the first removal had little result in stopping later infection is shown by the great number of leaves removed in each case at the second removal. No harm was done by the first removal, but the second one took off leaves of which 50% were of commercial value. This removal also showed in somewhat lessened growth of the plants subsequently. The second removal was made after the first spread of the disease in early July; if it had been made before this, say about June 27, less harm to the plants and more effect on the spread of the wildfire might have resulted. Again the plants with the leaves removed were so close to those that did not have the leaves removed, that re-infection from them was easy and so may have nullified the effect of their removal. As an experiment under the conditions which it was tried, it did not show any favorable result from the removal of the infected leaves.

TABLE VII. REMOVAL OF INFECTED LEAVES FROM FIELD TOBACCO.

Exp. No.	Plot.	Row.	Total plants.	1st removal.		2d removal.		% Inf. plants.		No. inf. leaves	
				Inf. pl.	Inf. lvs.	Inf. pl.	Inf. lvs.	1st tm.	2d tm.	1st tm.	2d tm.
2121	1	1	150	121	254	146	603	81	97	2.1	4.1
		2	...	109	191	...	...	...	...	1.8	...
2122	2	5	155	113	288	152	676	73	98	2.6	4.4
		6	...	90	260	...	...	...	...	2.9	...
2123	3	9	162	139	324	161	759	86	99	2.3	4.7
		10	...	95	253	...	...	...	...	2.8	...
3141	4	13	160	106	292	159	826	66	99	2.8	5.2
		14	...	122	325	...	...	...	...	2.7	...
3142	5	17	142	74	186	142	589	52	100	2.5	4.1
		18	...	...	197	...	...	...	...	2.1	...
3143	6	21	156	110	315	152	733	71	97	2.9	4.8
		22	...	95	290	...	...	...	...	3.1	...
4121	7	25	170	30	98	170	877	18	100	3.3	5.2
		26	...	48	145	...	...	...	...	3.0	...
4122	8	29	164	25	129	161	864	15	98	5.2	5.4
		30	...	38	155	...	...	...	...	4.1	...

Fertilizer Experiments. These rather simple fertilizer tests were made on the infected seedling plots 1-6 at the Station's Windsor tobacco farm. The field had already been given what growers would consider a rather moderate amount of fertilizer, consisting of one application of Olds & Whipple's tobacco manure at the rate of a ton per acre. It was decided to divide the field into three strips running crosswise of the plots. The first thirty-eight feet received nitrate of soda at the rate of 250 lbs. per acre; the second got sulphate of potash at the same rate; while the third and largest strip received no further fertilization. The plants at this time, July 12, had grown considerably. No counts were made as other factors entered into the problem; for example, the greater protection against wind, etc., of the plants at the further end of the field which received no further fertilization. However, it was evident that the first or nitrate of soda strip made the best growth, and had the most wildfire. The sulphate of potash strip also made a fair growth, somewhat less than the nitrate of soda, and had less wildfire. The check was the poorest in growth and had the least wildfire; this plot, however, would not have been considered sufficiently fertilized. Just how much was due to poor fertilization and consequent slow hardy growth of the tobacco, and how much to the greater wind protection, in the limiting of wildfire spread in the check, could not be determined.

Spraying Field Plants. These experiments were conducted on plants at the Station's Windsor tobacco farm. Plants in plots 1-6 already mentioned were used in part. The last ten plants in rows 2 to 46, making 450 plants in all, were sprayed five different times with homemade, 4-4-50, Bordeaux mixture, without lead arsenate, on the following dates: June 20, June 28, July 6, July 14, July 26. These plants had been set out on June 7, and included plants both badly diseased and practically free from wildfire. It happened that the end of the field sprayed was the end in which wildfire did not spread so rapidly or extensively as the opposite end, but this makes no difference between the sprayed and unsprayed plants compared here.

In order to determine the effect of the spraying, the sprayed plants in two rows of each plot (except plot 1 with one row) were compared on July 27 with the same number of unsprayed plants in the same rows and next to them. This count was just before the first priming and at a time when wildfire had completed its spread from the first infections of early July. The details are given in Table VIII. This shows that in every case the sprayed plots had fewer infected plants, leaves and spots than the corresponding unsprayed plots. There had, however, been much less spread in the sprayed and unsprayed wildfire-free or nearly free plants than on those that were badly infected when set out.

The average of the totals showed that the unsprayed had one

and a half times as many infected plants, two and a half times as many infected leaves and over eight times as many wildfire spots as the sprayed plants. A plant was called infected if only a single wildfire spot showed on it, so the true value of the control by spraying is shown by the number of spots. It must be remembered, too, that some infections on the sprayed plants were there before spraying began.

A second fact shown in the table is that most of the infections on the sprayed plants were on the end of the rows next to the infected unsprayed plants (see end of Table VIII), as the near end had 17 as compared to 15 infected plants at the further end, and almost twice as many infected leaves, and three times as many wildfire spots. This indicates that had the sprayed plants been entirely isolated there would have been even fewer infections. Where wildfire was bad on the plant to start with, the beneficial effect from the spraying was more marked than where there was little, for the unsprayed plants on the former developed over eight times as many spots as on the sprayed, while the latter only six times as many.

TABLE VIII. EFFECT ON WILDFIRE OF SPRAYING FIELD PLANTS WITH BORDEAUX MIXTURE.

Plot.	Rows.	Variety.	Condition of Seedlings.	Treatment.	Total Plants.	Infected Plants.	Infected Leaves.	Total leaf Spots.
1	2	Broadl.,	Wildfire bad,	Bordeaux,	8	8	31	209
1	2	Broadl.,	Wildfire bad,	Unsprayed,	8	8	55	1576
2	15-16	Havana,	No wildfire,	Bordeaux,	18	6	7	10
2	15-16	Havana,	No wildfire,	Unsprayed,	18	11	21	62
3	23-24	Havana,	Wildfire bad,	Bordeaux,	19	12	21	57
3	23-24	Havana,	Wildfire bad,	Unsprayed,	19	19	71	602
4	31-32	R. Tip,	Trace wildfire,	Bordeaux,	20	3	3	3
4	31-32	R. Tip,	Trace wildfire,	Unsprayed,	20	2	2	7
5	37-38	R. Tip,	Wildfire bad,	Bordeaux,	19	8	11	18
5	37-38	R. Tip,	Wildfire bad,	Unsprayed,	19	16	48	204
6	45-46	R. Tip,	Trace wildfire,	Bordeaux,	19	0	0	0
6	45-46	R. Tip,	Trace wildfire,	Unsprayed,	19	2	2	3
1-6	Totals	all vars.,	Little & much,	Bordeaux,	103	37	73	297
1-6	Totals	all vars.,	Little & much,	Unsprayed,	103	58	199	2454
First	4 Plants	all vars.,	All rows,	Bordeaux,	22	15	24	70
Last *	4 Plants	all vars.,	All rows,	Bordeaux,	22	17	42	215

* Next the unsprayed plants in same row, while the first four, of the ten sprayed plants, were away from them.

Laboratory Studies.

Cultures. Cultures of *Bacterium tabacum* are obtained fairly easily from the wildfire spots on tobacco leaves. The method finally used by us was to soak small pieces of the infected leaf tissue for about one minute in corrosive sublimate solution, 1 to 1,000. After washing these in sterilized water, they were crushed with a sterilized scalpel in a test tube containing about 5 c.c. sterilized beef broth. This was sometimes allowed to incubate for an hour or more, after which one to three drops were introduced into a test tube of melted beef-peptone agar, which, after thorough shaking, was poured into a Petri dish. From the resulting isolated colonies, pure cultures were eventually obtained. Practically all cultures were grown at room temperature without the use of an incubator. A variation of this method, used in the beginning, consisted of grinding the tissue with a few c.c. of water in a mortar with sand, all of which had been sterilized. About three drops of the liquid were smeared over the surface of hardened agar in a Petri dish. See Plate XXXII c-d.

Attempts to obtain cultures from old dried leaves and from seeds were tried in several cases, but it was difficult to isolate the germ, even when it was known to be present. Finally from one of the old dried leaf tissue nine months old, cultures were obtained, but not from the other leaves or seeds. This may have been due to over-sterilization or to faulty technique, since the same crushed unsterilized tissues when applied in moisture directly to pricked leaves often gave quite successful inoculations.

In general, no effort was made to distinguish between the dead center and the living yellow halo of the spots in obtaining cultures. However, to satisfy ourselves that bacteria were not confined either to the dead spots or to the yellow halo surrounding them, material was selected several times from each of these restricted areas and it was equally easy to obtain the germ from either region. No attempts were made to isolate the germ from seed-pods or ribs of the leaves. We have no doubt, however, that the germ can be isolated from either when infected.

Considerable variation existed in the virulence of the germ obtained in pure culture, depending upon the age of the same. In general, young, recently inoculated cultures were more virulent than those several months old that had been frequently renewed. An old culture received from Wolf also seemed to have lost its virulence. However, on Dec. 30th we made successful inoculations with a culture that had not been renewed since June 6th. In this particular case the culture had been kept at room temperature and had been dried out for some time, but before using it was soaked in water for several hours. The manner in which the inoculation is made is also an important factor of its success, a subject which will be discussed later.

The Organism. The germ is readily stained with gentian violet, fuchsin, etc., but these alone do not bring out the flagella. After trying several methods, our best results were with Moore's modification of Loeffler's stain. Our description of the bacteria are based chiefly on slides stained in this manner.

In common with most bacteria it is difficult to distinguish this species entirely by its morphology. Its pathogenicity to tobacco is its striking characteristic. There are, however, certain discrepancies in the characters assigned to it by Wolf and Foster (32.) and those observed by us. For this reason a brief discussion of it here is desirable.

The size of the organism, as stated by them, varies "from 2.4 to 5 by 0.9 to 1.5 μ , the most common size being 3.3 by 1.2 μ ." According to our measurements, we find it varying from 1.3 to 2.5 μ in length by 0.6 to 0.8 μ in width. Slagg (24, p. 25.) obtained measurements which agree very well with our own, since he gives the length as varying from 1.4 to 2.8 μ and the width from 0.5 to 0.75 μ . The largest size described by Wolf and Foster may have been due to measuring, as one, individuals which had not been completely divided. In our stained slides the bacteria are frequently seen in pairs in various stages of division, and in measuring these one is sometimes uncertain whether to consider them as a single or two germs. The measurements we have given here are limited to those of isolated individuals. In general, the germs are short rods with rounded ends, about two or three times as long as broad. See Plate XXXII a.

Wolf and Foster distinctly say that these bacteria have one polar flagellum. Slagg, on the other hand, states that the germ isolated by him from Kentucky and Connecticut had from three to six polar flagella. We have found from one to four flagella, with one or two doubtful cases where there may have been five. Most of the bacteria seen by us had one or two flagella. Counts of several hundred show about the following proportion: 40% with one flagellum, 45% with two flagella, 13% with three, and 2% with four. The number of flagella found, however, seems to us to depend somewhat upon the success that attended their staining. Where only one is found, one cannot be sure but that others may have been broken off, especially if a single flagellum comes off at an angle to the polar end. Very frequently one finds detached fragments of the flagella on the slide and the varying length of those attached indicates that portions have been broken off. On one of our slides the appearance of the rather stiff, coarse flagella, commonly one at a pole, suggested that they might have been accidentally coalesced in the manipulations. That this does occur is shown by frequent individuals, in certain slides, where a branching effect is produced by the flagella coalescing for a greater or less extent and then separating into two or more. A forked or pronged effect

is thus frequently given. In general, the flagella seem to be two or three times the length of the bacterium, though shorter ones were obtained which were probably broken off. See Plate XXXII b.

In this connection, it might be well to consider the characteristics of *Bacterium angulatum* as given by Fromme and Murray (Journ. Agr. Res. 16: 225.). In table form they mention five points that distinguish this germ from *Bacterium tabacum*. Three of these relate to the manner of liquifying gelatine, acid formation with saccharose, dextrose, etc., and growth in the closed arms of fermentation tubes. These seem to be chiefly differences of degree rather than of kind and so cannot be considered of as great importance as the other two which relate to size of the germ and number of flagella. They state that *Bacterium angulatum* varies from 2 to 2.5 μ in length and is 0.5 μ wide. Contrasted with Wolf and Foster's measurements of *Bacterium tabacum* these measurements are distinct but vary little from those found by Slagg and us for the latter germ. They give the number of flagella as varying from three to six. This also is quite different from the single flagellum mentioned by Wolf and Foster, but agrees fairly well with the number found by us, and exactly with the number given by Slagg for *Bacterium tabacum*.

From the preceding considerations it will be seen that the morphological differences between *Bacterium angulatum*, angular leaf spot, and *Bacterium tabacum*, wildfire, are not so marked as originally considered by Fromme and Murray. This may account for the confusion of the tobacco bacterial spot from Africa, mentioned by Klerck (19), where the spots are said to resemble those of wildfire while the germ agrees with the angular leaf spot organism. Undoubtedly a comparative study of the two germs and their effects on their host from different regions of the world is needed to bring out their real differences.

Methods of Inoculation. Altogether several hundred infection experiments were tried with the wildfire germ on tobacco. These were mostly under greenhouse conditions; some, however, were carried on outdoors under varying natural conditions. In the greenhouse, inoculations were made at all times of the year. According to the environmental conditions and the manner of inoculation, different results were obtained. The former we will consider later. The latter may be described briefly here as follows:

(1) The first method tried consisted merely of placing pure cultures of the germs, or the crushed tissues containing them, in a moderate amount of water and pouring it over the leaves to be infected. A variation of this method consisted in dropping with a medicine dropper the water containing the germs on the host. This method proved the least satisfactory of any of those tried. It was most successful when the conditions for natural infections outdoors were present. It was not so effective in the greenhouse unless

those conditions were simulated. However, it was very satisfactory when the tissues to be infected were injured so that the germs could gain entrance through the injured places. The injury was usually accomplished by pricking the tissues with a sterilized needle. Unless the environmental conditions were unusually favorable the infections almost always were limited to these pricked spots. This was especially true in our winter experiments. See Plate XXX b.

(2) The second method employed was to spray pure cultures of the germ in water on the plants by means of an atomizer. This was very successful outdoors when natural conditions were just right. In the greenhouse, it was most successful when accompanied by needle pricks in the tissues, as noted before. The disadvantages of this very successful method lies in the fact that the atomizer has to be thoroughly sterilized each time after a culture from a different source is used.

(3) This method consisted of pricking the tissues in definite places with a needle which, after being sterilized, had been introduced into a pure culture. The advantage of this method, which is also almost always successful, is due largely to infection taking place only at definitely marked points.

In any of these methods efforts were made to keep the plants under favorable moist conditions for a few hours after the inoculation. This was done in part by spraying with water, placing them under a bell jar or in a shady position, or by making the inoculations on a cloudy or moist day.

Relation to Environment. As has already been shown in this paper, environmental factors are very important in determining the spread of the disease in nature. The same holds true in relation to artificial infection, especially when no puncturing or injuring of the tissues is provided for entrance of the germ. The two factors of most importance are favorable moisture conditions and rapid growth of the host. In the greenhouse experiments, especially during the winter, these two factors did not always occur, and especially with the very slow growing plants infections were limited unless the tissues were punctured.

To secure more favorable conditions, the plants, some time previous to inoculation, were frequently placed under bell jars to facilitate the opening of the stomates, thus favoring the entrance of the germs. Likewise in the heat of early summer a cheese-cloth tent was built on the ground in the greenhouse to shade the plants and to retain a more moist atmosphere.

It might be stated here that the greenhouse conditions under which we worked were such that there was little or no accidental infection. Very little care was needed to keep the check plants isolated from the infected ones on this account, especially in the cooler months. This failure to spread will not hold true in nature where, under certain conditions, the disease spreads rapidly from

infected to free plants. These differences are well illustrated by the following experience. A number of small plants in the greenhouse were artificially inoculated without puncturing, only a few spots appearing on all of them. The plants were kept for some time under these conditions with no spread whatever of the infection, although they were frequently sprinkled. Later the plants were taken out of the crocks and transplanted in an isolated place outdoors. They began to grow more rapidly, and when a moist, favorable period arrived the wildfire spread suddenly and abundantly all over the newer leaves.

Relation to Host. Although in the greenhouse experiments we were most successful with those inoculations where the tissues were punctured, there is no doubt in our minds that in nature, where the disease suddenly spreads under favorable environment, the infections usually take place through the uninjured tissues. This undoubtedly occurs by the passage of the motile germs through the open stomates. Examination of the tobacco leaves shows that the stomates are abundant on both the upper and lower surfaces, although somewhat more numerous on the lower. Under favorable environmental conditions for the opening of the stomates, both outdoors and in the greenhouse, we were able to produce abundant infections on the uninjured tissues by applying the germs alone either to the upper or lower surface of the mature or nearly mature leaves. However, when they were sprayed over the immature leaves rarely did infection occur. Similar freedom from infection of young leaves is seen in nature and indicates that entrance takes place through the stomates, which in these leaves are not so fully developed or liable to be open. Furthermore, that it was a question of open stomates and not of the age of the tissues, is shown by the fact that young leaves are very easily infected after puncturing.

This last statement leads us to a consideration of the age of the tissues in reference to their susceptibility to artificial infection. In several cases we tried comparative tests in inoculating over-ripe and somewhat yellowing leaves, with those in their prime and the young or immature leaves, all on the same plant. Where the puncturing method was used we found that the young leaves apparently show the most successful infections, especially by sharper contrast of the halo spots with the normal tissues, and possibly by their larger size. This contrast was nearly as evident on the leaves in their prime, but much less so on the older over-ripe leaves. On the latter, especially when yellowed, the infections were frequently not very evident, and as the general yellowing progressed they become entirely obscured. To our minds, this is explained by the fact that young leaves have more food for growth, and as the chlorophyll granules are the parts more directly attacked, leaves in their prime furnish a more favorable environment than do the old yellowing leaves.

Tissues Invaded. When we employed the puncturing method of inoculation we found it equally easy to secure infections in the leaf parenchyma, ribs, or the stems of growing greenhouse plants. No attempts were made to inoculate the floral parts or seed-pods. Certain differences showed in the results of infection at these three different points of inoculation. For example, in the leaf blades, round yellow halo spots that eventually reached a diameter of one-half inch or so were the common result. In time, as the spots reached their maximum size, dead centers of more or less extent appeared, but these were not so common or quick to develop as with natural infections outdoors.

If these inoculations were made on the veins, nearly similar results were obtained. When, however, the inoculations were made on the midrib, yellowing was more extended in a linear direction up and down either side of the same and less definitely marked off from the surrounding healthy green tissues. Likewise some of the yellowing extended out along the lateral divergent ribs. Soon dead spots appeared in the tissues parallel to the midrib, and frequently smaller ones along the lateral ribs. This indicates more of an up and down spread, as if the germ or its toxin followed the course of the veins. It made little difference whether the midrib was inoculated near its apex or its base, as the disease seems to spread as readily downward as upward. Plate XXX c.

Where the young stems were inoculated below, but away from the base of the leaf, an elongated blackening of the tissues occurred in the vicinity of the puncture. In time the leaf immediately above showed yellowing and spotting, somewhat similar to that described for the inoculations of the midrib. In some cases upper leaves away from the point of inoculation showed a slight yellowing of the leaf blade in the vicinity of the midrib. Whether this yellowing had anything to do with the immediate presence of the germs, or was merely a secondary result, we did not determine. A single attempt to inoculate plants with such leaves was unsuccessful. Neither did we try to determine, by inoculation tests or staining, the presence of the germs widespread in stems or the midribs. In the parenchyma, however, both in the dead centers and yellow halo spots, the presence of the germs was demonstrated both by staining and by inoculations with tissues from these restricted regions.

Methods of Survival. Cotton Seed Meal. We have already mentioned our failure to secure infection of tobacco plants by means of cotton seed meal. In these tests eighty-one samples of cotton seed meal, recently collected over the State by the Station's sampling agent, were used on greenhouse plants in the spring of 1921. A small amount of each fertilizer was soaked for a short time in water and then sprinkled over a small tobacco plant in a

crook. It is to be regretted that no punctures were made in the leaves of the plants to secure more certain infection if the germs were present. However, other plants similarly sprinkled with germs in water at the same time of year were successfully inoculated. These results seem to indicate that this fertilizer is not a means by which the germs are carried over from one year to another. This is the only fertilizer, except tobacco stems, in which it is at all likely that the germs could be carried from the south.

Tobacco Stems. Similar experiments were tried in a few cases with commercial tobacco stems, such as are used in field fertilization, but of unknown origin, and of leaves and stems of wildfire tobacco overwintered in a barn. No results were obtained from any of these. The barn-cured wildfire tobacco when first used was about a year old and the inoculated plants were unpunctured. This may account for our failure to secure successful infection from it, since we later secured successful infection from dried herbarium wildfire leaves equally old when the puncturing method was used. This barn wildfire tobacco was used again on punctured leaves, when it was a year and a half old, but no successful inoculations resulted. We believe, however, with this method we could secure successful inoculations with barn-cured wildfire tobacco that is not over a year old.

Dried Herbarium Leaves. In the winter of 1922 we attempted to isolate the germ from dried, herbarium, wildfire, tobacco leaves of varying ages. We were unsuccessful in all of these except two. Both were from seedling tobacco leaves from the same source collected early in May, 1921, and the cultures were isolated in February, 1922, over nine months later. Successful inoculations were made with the isolated germ. Failure to isolate this germ from the other sources was not due to death, but rather to the presence of other germs and lack of sufficient attempts to secure it. This was proved by the later successful inoculation of pricked leaves with these crushed herbarium leaves soaked in water. By this method infections were obtained from this dried material in twenty out of twenty-seven attempts. The leaves were from thirteen different sources, eight of which were tried successfully from one to three times, and one tried successfully twice and unsuccessfully once, while four were tried unsuccessfully one or two times. Four other inoculations were made with a mixture of tissues from two to four of these sources, but each limited to the dampening off, the halo or the dead center stage, all of which were successful.

The material used was obtained from both seedbed and field plants of several varieties of 1921 tobacco. All but two were from material collected in the State, one from Vermont and the other from Florida. We secured infections with the Vermont, but not with the Florida material. Only one attempt, however, was made with the latter. The leaves in the various experiments had

been dried from 198 to 298 days when used for inoculation. Success was had with the oldest, as well as with the youngest. There was considerable variation in the vigor of development of the infection spots, even on the same plant. Material from different sources also seemed to show variation in vigor. These experiments prove that the germs can retain their viability, at least for a considerable period, in dried material that has not been exposed to the elements. There is no question, therefore, that refuse from barn-cured wildfire tobacco is a menace if used on land planted with tobacco the following year.

A single one of these experiments will suffice to illustrate the average results obtained, using Infection Numbers 2042 and 3003: The leaves were gathered from a wildfire field at Somers, Conn., Aug. 26, 1921, and separate inoculations were made Mar. 7 and Mar. 17, 1922. Both were successful. In the first, three leaves on each plant were pricked with a needle about eight times before the water containing the crushed infected tissues was poured over them. Inoculation 2042 was made on three plants and about a week later showed five, nine and sixteen fair to good infection spots at the punctured places. One infection spot appeared at an unpunctured place, which was very unusual in these experiments. Inoculation 3003 was made on a single plant with an indefinite number of pricks in the three leaves. An examination ten days later showed seven good and eight fair infection spots on two of the leaves and none on the third.

Later similar infection experiments were tried with older dried herbarium wildfire leaves collected in 1920. These experiments were made in late April, 1922. The leaves had been dried in these cases from 573 to 651 days when crushed and placed in water on the plants. They were from twelve different fields in Connecticut. In none of these did any of the inoculations take. This seems to indicate that the germs can not retain their vitality much over a year in the old dried leaves.

Seed. We were unsuccessful in six attempts to isolate the wildfire germ from supposedly infected 1920 Round Tip tobacco seed, these being made one or two years after it was gathered. We also failed to secure infection from water in which the same seed had been soaked several hours. Several months previously the same seed planted in the greenhouse had given one infected seedling and we have reason for believing that it was the source of infection in several seedbeds in 1921.

We artificially infected unsterilized tobacco seed with the wildfire germ but in the one or two attempts to re-isolate it we also failed because of the presence of other bacteria. However, one month after the seed was inoculated infections were secured when it was soaked in water and this was applied to punctured plants. The same seed several days after inoculation was placed outdoors,

protected from the rain but exposed to the cold, from Feb. 14 to April 18. On the latter date part of it was soaked in water several days and then applied to punctured plants which later showed a few infections. About two weeks later the experiment was repeated with even better results. These experiments, while not entirely satisfactory, indicated on the whole that the germ may retain its viability on tobacco seed for some months.

Overwintered Refuse. We have tried several times to infect punctured greenhouse plants with infected refuse from tobacco plants that had overwintered in the field. Badly disintegrated leaves, from the Station garden plot already mentioned, were gathered at different times. These were ground up further and soaked from one hour to several days in water. This water with some fragments of the tissue was poured over needle-punctured plants. Altogether twenty-seven plants were thus inoculated and on these we succeeded in securing three poor and three fair to good infection spots. These experiments indicate that the germs, to a certain extent, can be wintered over in infected leaves left outdoors in the field and undoubtedly under favorable conditions are the source of occasional infections the succeeding year. From our experience this is not a great menace in the field, but should be a warning to the grower not to leave tobacco refuse in the seedbeds after the plants have been pulled. This overwintering is also shown somewhat by the following experiment. On Feb. 1st artificially infected plants were changed from a warm to a cold greenhouse and on March 1st placed outdoors. They were thus exposed for some time to freezing weather. The soaked crushed infected tissues from these gave vigorous infections on punctured greenhouse plants late in April.

Soil. We have already mentioned the experiment where infected leaves were buried in the soil under disease free plants which later became infected, and the successful inoculations made with the same soil a month or two later after the leaves had become entirely disintegrated. This showed that the germs could be carried in the soil for a short period.

We have further data that indicate that they may be carried over the winter in this manner at least to a limited extent. Samples of soil on different occasions in March and April were taken from the Station garden plot which the previous year had grown wildfire plants that had been allowed to rot in place. After sifting off the coarse particles of soil the fine particles were soaked in water for several hours and applied to pricked tobacco plants in the greenhouse. The first experiment with six plants produced no results. In the second experiment with three plants, each produced a single fair to good infection spot. Of course these germs may have come from the very finely disintegrated tobacco tissues rather than from germs entirely free in the soil, but the general statement that they carry over in the soil is approximately correct.

since it is difficult to distinguish between the mineral part and the fine humus of the soil.

In a tobacco seedbed, however, on which pure cultures of the wildfire germ were sprayed in the fall, we failed to secure infection of plants the next spring by spraying on pricked leaves water in which this soil was soaked.

Infection of Sprayed Plants. Our field experiments showed that seedlings and field plants sprayed with Bordeaux mixture were partially or entirely protected from infection according to the number and efficiency of the treatments. This was also tested out with artificial infections in the greenhouse and similar results were obtained. On several occasions pricked plants were inoculated by atomizing with the germ as follows: 1, Check plants inoculated but no other treatment; 2, Plants sprayed with Bordeaux mixture immediately before inoculation; 3, Plants sprayed with Bordeaux mixture immediately after inoculation; 4, Plants sprayed with Bordeaux mixture immediately before and after inoculation. In the latter case infection never took place unless the puncture was at a point poorly protected by the spray. Where the plants were sprayed either before or after inoculation there was only an occasional infection. On the unsprayed plants infection took place at practically all the punctured spots.

Infection with African Material. We were very successful in making infections with wildfire tobacco leaves received from Miss Doidge, collected in Rustenburg, Transvaal, Jan. 2, 1922. These inoculations were made in both April and May, 1922, and were equally successful in both cases, infection appearing at most of the many pricked places on which the water containing the crushed infected tissues was applied. These infections were typical and fully as virulent as inoculation from our own cultures made at the same time.

Infection of Other Hosts. In nature we have never seen wildfire on any of the weeds or cultivated plants in or adjoining the seedbeds or tobacco fields. Our experiments to infect other hosts at first were limited to the tomato and a cultivated species of flowering tobacco. In neither were the leaves pricked before inoculating and this may account for the failure in both cases. Later inoculations on pricked leaves of young plants of tomato, pepper, eggplant, jimson weed and pokeweed were tried. Three plants were used in each case and each had from thirty to fifty pricked places. Apparently all of these failed of infection, except possibly the pepper and the eggplant. On the former three or four and on the latter one slight faint yellowish spots appeared at punctured places. These possible infections, however, were quite indefinite as compared with those that appeared in the tobacco plants similarly inoculated at the same time.

Wolf and Foster (32, p. 452.) originally claimed to have inocu-

lated tobacco with wildfire obtained from cowpeas. In a later publication, however, Wolf and Moss (33, p. 32.) state that "all efforts to prove that the wildfire organism is parasitic in plants other than tobacco have thus far failed." These inoculated plants included potatoes, tomatoes, peppers, eggplants, jimson weed and horse nettle, all of which are related to tobacco. Chapman and Anderson (2, p. 74.) succeeded in inoculating "petunia, eggplant and pokeweed (*Phytolacca decandra*) by spraying with suspensions of bacteria in water in the same way in which tobacco plants were usually inoculated. Some of the leaves in each case were wounded by puncture with a sterile needle." They also isolated the germ from spots on tomatoes growing in an infected tobacco seedbed.

Recommendations for Control.

Seedbeds. (1) If wildfire developed at all in the beds the previous year, either make beds on new land away from all possible sources of infection, or sterilize the old beds and paths with steam heat. Heat the soil for 20 to 30 minutes at a pressure of at least 100 lbs. Boards, sash and cloth used on beds or fields previously infected should be thoroughly sprinkled all over with formalin, 1 to 25 parts of water, and piled in a dry place to slowly dry off; or the cloth can be heated in boiling water for one hour.

(2) Use seed known to have come from a wildfire-free field and which has been protected at all times from subsequent contamination. If in doubt place seed in a cheesecloth bag in a jar and soak for 10 to 15 minutes in a corrosive sublimate solution, rate of 1 part of corrosive sublimate [Poison!] to 1,000 parts water. Then wash thoroughly with pure water and dry immediately.

(3) Use as little water on plants as is consistent with good growth and apply at such times as it will most quickly dry off the leaves without sun-scorch injury. Air the beds when feasible both day and night, and especially in moist weather, in the best possible ways to prevent water of transpiration settling on the leaves.

(4) No matter what the previous treatment, as a final precaution spray the plants with Bordeaux mixture; if homemade use the 4-4-50, or if commercial as recommended on package. Begin treatment on the very young seedlings soon after roots start and largest leaves are the size of a finger-nail, and repeat spraying each week until the season for pulling is over. Clean up seedbeds at end of setting and plant beds with a different crop if desired.

Fields. (1) In setting out the fields use only plants known to come from the wildfire-free seedbeds. If impossible to get these, select only the plants apparently free of the disease and from parts of the beds least infected. Plant as soon as pulled and keep water off the leaves while in the baskets.

(2) About a week after setting out plants go over the field and remove diseased plants, and if possible make a second similar

inspection about a week or ten days later. Take plants pulled up off the field. Reset with healthy plants.

(3) In case these inspections show the field badly infected, plow it up and reset with healthy plants, providing this can be done in time to insure the newly set field properly maturing before danger from frosts.

(4) In some cases, especially where the tobacco is primed, it may be preferable, instead of resetting or doing nothing, to go over the field once or twice and remove the infected and non-commercial lower leaves. These also should be taken off the field, instead of being thrown on the ground. The first removal should be made about a week after planting and the second after the plants have started to grow.

LITERATURE.

Most of the following papers have been referred to in the preceding discussions. They include practically all of the literature relating to wildfire. Some of them are merely brief notes on the presence of the disease in certain localities.

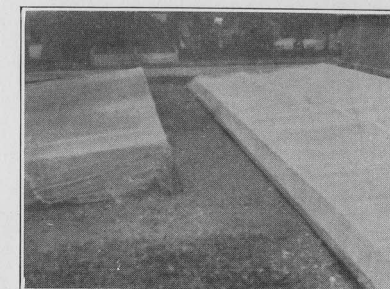
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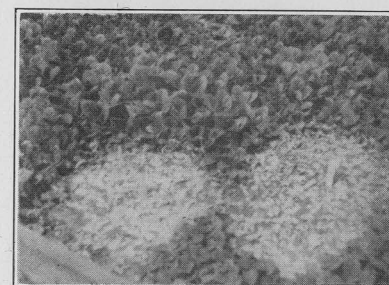


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b. Cloth Covers, p. 383.

WILDFIRE PLANTS KILLED WITH FORMALIN.

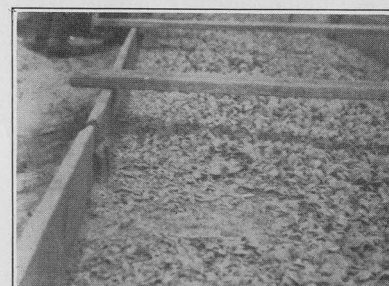


c. Isolated Spots, p. 401.

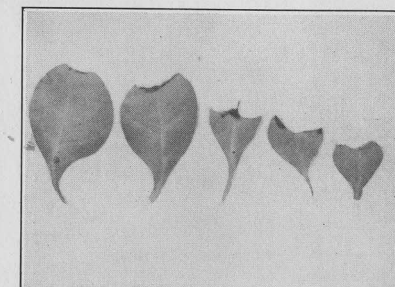


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WILDFIRE IN SEEDBEDS.

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a. Leaves from Seedbed, p. 381.

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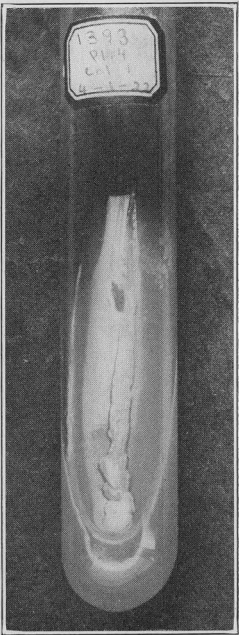


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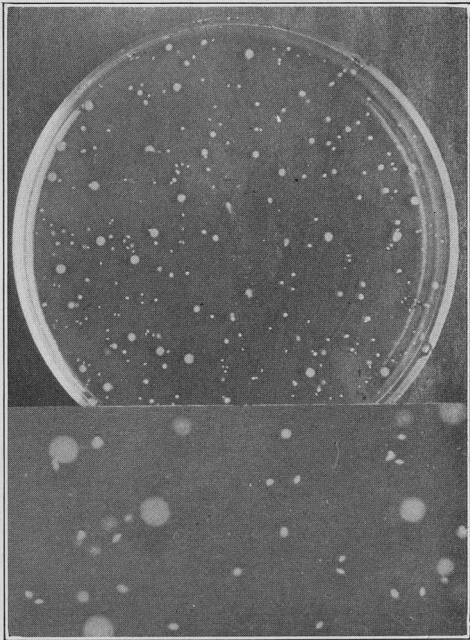


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