Found. The weights of 25 tablets ranged from 646.3 to 647.8, average, 647.0 mgms. On drying the sample showed a loss of 1.87 per cent. The dried material was titrated with silver nitrate. The U. S. P. IX requires that "each gram of sodium bromid, previously dried, corresponds to not less than 95.7 mils (cc) nor more than 98.3 mils (cc) of tenth. normal silver nitrate." In this sample 1 gm. of material corresponded to 98.35 cc of tenth-normal silver nitrate, very slightly above the U. S. P. maximum limit, indicating only a small amount of chlorid present. The minimum U. S. P. value, 95.7, is equivalent to 98.5 per cent of sodium bromid, the U. S. P. standard of purity for that drug.

Tablets satisfactory.

Sodium Salicylate Tablets.

11407. *Sodium Salicylate Tablets,* made by Yates Drug and Chem. Co.; stock of Dr. J. F. Harrison, Stamford.

Claimed per tablet. Sodium salicylate 5 grs.

Found. The weights of 20 tablets ranged from 415.4 to 480.2, average, 449.2 mgms. They contained 71.56 per cent of sodium salicylate, or from 4.59 to 5.30, average, 4.96 grs. per tablet.

Tablets satisfactory.

11434. *Sodium Salicylate Tablets,* made by Yates Drug and Chem. Co.; stock of Dr. E. K. Roberts, New Haven.

Claimed per tablet. Sodium salicylate 5 grs.

Found. The weights of 21 tablets ranged from 769.1 to 837.7, average, 804.7 mgms. Their analysis showed loss at 100°C. 1.22, ash 17.80 and sodium salicylate 39.21 per cent, so that they contained from 4.65 to 5.07, average, 4.75 grs. of sodium salicylate per tablet.

Tablets satisfactory.

Strychin Sulphate Tablets.

11428. *Strychnin Sulphate Tablets,* made by Bristol Myers Co.; stock of Dr. C. H. Robbins, New Haven.

Claimed per tablet. Strychnin sulphate 1/60 gr.

Found. The weights of 25 tablets ranged from 68.6 to 78.4, average, 74.0 mgms. They contained 1.44 per cent of strychnin sulphate, or from 0.0153 to 0.0174, average, 0.0164 gr. per tablet.

Tablets satisfactory.

SOLUTIONS.

Sol. Peptonized Iron and Manganese.

11565. *Sol. Peptonized Iron and Manganese,* made by Bristol Myers Co.; stock of Dr. G. E. Bradford, New London.

Claimed. B. and M. formula: Average alcohol 16 per cent; contains iron peptonate and manganese peptonate corresponding to 0.6 per cent of iron and 0.1 per cent of manganese.

Found. The sample contained

Alcohol by volume	16.25
Ash	1.40
Iron oxid	1.15
= Iron	0.80
Manganese oxid	0.17
= Manganese	0.12

Liquor Ferri Peptonati et Mangani, N. F., according to analyses of the American Medical Association, should contain from 0.99 to 1.05 per cent of ash, from 0.58 to 0.64 per cent of iron and from 0.13 to 0.19 per cent of manganese. This preparation agrees satisfactorily with these requirements and contains somewhat more of both iron and manganese than is claimed on the label.

11584. *Aromatic Cordial of Iron and Manganese Peptonates,* made by Buffington Pharmacy Co.; stock of Dr. F. E. Wilson, Willimantic.

Claimed. Alcohol 15 per cent maximum. The physician claimed he bought this for the U. S. P. preparation, but there is no such preparation cited by that authority. There is, however, in the N. F., a *Liquor Ferri Peptonati et Mangani* to which he may have had reference (See No. **11565**).

Found. The sample contained

Alcohol by volume	17.50	Iron oxid	0.15
Ash	0.36	= Iron	0.10
Sodium oxid	0.13	Manganese oxid	0.03
		= Manganese	0.02

The preparation, therefore, contained only 17.2 per cent of the minimum iron and 15.4 per cent of the minimum manganese of the N. F. preparation.

Sample below requirements of N. F. preparation.

11442. *Elixir Iron and Manganese Peptonates,* made by Independent Pharmaceutical Co.; stock of Dr. G. F. Converse, New Haven.

Claimed. Each fl. dram contains about 2.5 grs. of neutral organic salts of iron and manganese. This claim is rather indefinite as the particular organic salts of iron and manganese are not stated. However, if the preparation corresponds to *Liquor Ferri Peptonati et Mangani, N. F.* 2.5 grs. per fl. dram of neutral organic salts would equal 20 grs. per fl. oz.; or 1.296 gms. per fl. oz.; or 1.296 gms. per 30.59 gms. of the solution (sp. gr. 1.0197), equal to 4.24 per cent. If the N. F. organic salts are used, the source of the iron would be iron peptonate (containing 25 per cent of iron), and the source of the manganese manganese citrate (containing 22.4 per cent of manganese). The ash of such a preparation would be about 1.57 per cent, calculated as oxids of iron and manganese, not taking into account alkali bases, the N. F. formula showing sodium citrate and sodium hydroxid. For the composition of the N. F. preparation see No. **11565.**

Found. The sample contained the following

Alcohol by volume	7.00	Iron oxid	0.20
Ash	0.62	= Iron	0.14
Sodium oxid	0.25	Manganese oxid	0.13
Chlorin	trace	= Manganese	0.09

The preparation, therefore, contained only 34.5 per cent of the minimum iron and 69.3 per cent of the minimum manganese of the N. F. preparation. It also contained only 46.7 per cent of the alcohol claimed on the label.

Sample below requirements of the N. F. preparation.

Elixir of Iron, Quinin and Strychnin.

11413. *Elixir of Iron, Quinin and Strychnin.* (Sphinx Pharmaceuticals), made by Tailby-Nason Co.; stock of Dr. J. A. Clarke, Greenwich.

Claimed. Each fl. oz. contains alcohol about 20 per cent; tinct. iron citrochlorid 24 min.; quinin muriate 2 grs.; strychnin 8/60 gr. (This is equivalent to 0.1145 gm. of total anhydrous alkaloids per fl. oz.)

Found. The composition of the sample was as follows:

Spec. grav. at 15.6° C.	1.2223	
Alcohol by volume	19.03	per cent
Total alkaloids (anhydrous)	0.4192	gm. per 100 cc.
Iron	0.2552	" " "
Quinin (anhydrous)	0.3724	" " "
= Quinin hydrochlorid	0.4557	" " "
Strychnin (anhydrous)	0.0402	" " "

The N. F. elixir should contain 0.155 gm. of iron, 0.2625 gm. of quinin hydrochlorid and 0.0021 gm. of strychnin per fl. oz. This sample contained 0.0766 gm. of iron, 0.1348 gm. of quinin hydrochlorid and 0.0119 gm. of strychnin per fl. oz. It contained, therefore, about half of the iron and quinin of the N. F. formula and about five times the strychnin. By the method used with this sample the results for quinin are slightly low and those for strychnin slightly high.

Preparation is substandard.

11427. *Elixir of Phosphates of Iron, Quinin and Strychnin,* made by The Tilden Co.; stock of Dr. G. F. Converse, New Haven.

11443. The same brand from stock of Dr. W. H. Donaldson, Fairfield.

Claimed. Alcohol 10 per cent; each fl. oz. contains ferric phosphate 8 grs.; quinin phosphate 4 grs.; strychnin phosphate 8/60 gr.

Found. The composition of the elixirs was as follows:

	11427	11443
Spec. grav. at 15.6° C.	1.1186	1.1388
Alcohol by volume	11.30	12.20
Total alkaloids (gms. per 100 cc.)	0.840	0.847
Strychnin " " "	0.0275	0.025
Quinin " " "	0.813	0.822
Iron " " "	0.38	0.36
Phosphoric acid " " "	0.32	0.44

The *Elixir of the Phosphates of Iron, Quinin and Strychnin, U. S. P. VIII* contains 0.21 gm. of iron, 0.875 gm. of quinin and 0.0275 gm. of strychnin per 100 cc. The above analyses agree quite well with these requirements. It is impossible to calculate the alkaloids in terms of their phosphates as there are several theoretical phosphates. The iron present is equivalent

to 14.7 grs. of ferric phosphate per fl. oz. in **11427** and 13.9 grs. in **11443.**

Preparations satisfactory.

Elixir of Lactated Pepsin.

11426. *Elixir Pepsin Lactated No. 2,* made by The National Drug Co.; stock of Dr. G. F. Converse, New Haven.

Claimed. Alcohol 14 per cent; each fl. oz. contains pepsin lactated (The N. D. Co's) 50 grs.; composed of pepsin, pancreatin, maltose, diastase, lactic and hydrochloric acids. (The fact that we have no knowledge of the strength of The N. D. Co.'s lactated pepsin makes the above claim very indefinite.)

Found. The following analytical details were secured:

Spec. grav. at 15.6° C.	1.1136
Alcohol by volume	13.70
Amylase	none detected
Tryptic digestion	none detected
Peptic digestion	active pepsin present

The elixir in our tests showed no power of digesting starch or casein. Its action on egg albumin showed about one-thirteenth of the digesting power of U. S. P. pepsin.

The cause of the low digestive powers above noted may possibly be explained by the paralyzing effect of alcohol on enzyme action (*see Euler, p. 120*), or by the fact that the N. D. Co's lactated pepsin may contain less than the 10 per cent of pepsin of the standard, or by the fact that the pepsin used was not of U. S. P. strength, as has been the case with many samples of commercial pepsin which we have examined.

To test the retarding action of alcohol the following experiment was made: 0.972 gm. of starch paste + 0.0324 gm. of pancreatin + 0.0032 gm. of diastase + 4.3 cc of water + 0.7 cc of alcohol (equal to 14 per cent by volume) were digested at 40° C. for thirty minutes. Digestion was found to be complete by the iodin test as in similar checks made without alcohol. Although the effect of alcohol was negative in this trial, it is still possible that prolonged contact of the enzymes and alcohol (as is the case in the sample) might result in paralysis of the ferments.

Preparation of low digestive power.

Fowler's Solution

11421. *Fowler's Solution,* made by The National Drug Co.; stock of Dr. S. L. Katzoff, Bridgeport.

Claimed. Solution Potassium Arsenite. The U. S. P. IX preparation should contain not less than 0.975 nor more than 1.025 per cent of arsenious oxid.

Found. The solution contained 1.014 per cent of arsenious oxid.

Preparation satisfactory.

Spirits of Nitre.

11556. *Spirits Nitre,* made by Walker and Gibson; stock of Dr. B. A. Bryon, Ridgefield.

Claimed. Spirits Nitre, U. S. P. Alcohol 92 per cent, ethyl nitrite 4 per cent.

Found. The sample contained 90.7 per cent of alcohol by volume and 2.51 per cent of ethyl nitrite. This amount of ethyl nitrite corresponds to 71.7 per cent of minimum U. S. P. strength and to 62.8 per cent of the amount claimed on the label.

Preparation deficient in ethyl nitrite.

Syrup of Codein Compound.

11550. *Syrup of Codein Compound,* made by Tailby-Nason Co.; stock of Dr. C. K. Heady, Milford.

Claimed. Each fl. oz. contains alcohol about 2 per cent, codein phosphate 1 gr. and virtues of wild cherry, ipecac and white pine.

Found. The preparation contained 2.83 per cent of alcohol by volume and 0.921 gr. of codein phosphate per fl. oz. No tests were made for the other ingredients claimed.

Preparation satisfactory.

Syrup of Iodid of Iron.

11555. *Syrup of Iodid of Iron,* made by The Tilden Co.; stock of Dr. B. A. Bryon, Ridgefield.

Claimed. Syr. Iodid Iron.

Found. The following analytical data were obtained:

Spec. grav. at 15.6° C.	1.2793	Free iodin	none
Ferrous iodid	2.69	Color	brown

The U. S. P. IX requires that this preparation shall contain not less than 4.75 nor more than 5.25 per cent of ferrous iodid. The sample, therefore, was below standard as it contained only 2.69 per cent or 56.6 per cent of the minimum requirement.

Preparation below standard.

Tincture of Iodin.

11419. *Tincture of Iodin,* made by C. P. Cippola, Bridgeport; sample taken from his stock.

Claimed. Tinct. Iodin.

Found. The sample contained 6.11 gms. of iodin, and 4.58 gms. of potassium iodid per 100 cc, and 88.50 per cent of alcohol. Tincture of iodin, U. S. P. should contain not less than 6.5 gms. nor more than 7.5 gms. of iodin, and not less than 4.5 nor more than 5.5 gms. of potassium iodid per 100 cc. The tincture also should contain 83 per cent of alcohol, but the U. S. P. tolerates a variation of 10 per cent above or below this figure.

Preparation deficient in iodin.

SUMMARY.

Fourteen of the 53 samples failed to contain the amounts of drugs claimed (allowing a variation of 10 per cent), or were below the standard of the corresponding U. S. P. or N. F. preparation. The names of these with their manufacturers were as follows:

Buffington Pharm. Co.
  Sol. Pept. Iron and Manganese.
C. P. Cippola.
  Tinct. Iodin.
Daggett & Miller Co.
  Phenolphthalein.
G. F. Harvey Co.
  Digestive Aromatic Tablets.
Independent Pharm. Co.
  Elix. Iron and Manganese Pept.
The National Drug Co.
  Calomel.
  Elix. Pepsin Lactated No. 2.
Tailby-Nason Co.
  Elix. Iron, Quinin and Strychnin.
The Tilden Co.
  Syr. Iodid of Iron.
The Tracy Co.
  Migrain No. 7.
  Corrosive Sublimate.
Walker & Gibson.
  Spirits Nitre.
Yates Drug & Chem. Co.
  Calomel and Soda.
Manufacturer unknown.
  Acetphenetidin.

Of 41 samples of tablets 8, or 20 per cent, were deficient, while of 12 samples of solutions 7, or 60 per cent, were unsatisfactory.

The most serious discrepancies arose from substitutions, intentional or otherwise. In one sample acetanilid was substituted in part for acetphenetidin; and in another terpin hydrate was present instead of acetphenetidin as claimed.

VARIATIONS IN THE WEIGHTS OF TABLETS.

A claim frequently heard in favor of the use of tablets is that they afford "uniform dosage and medication." It is therefore important to determine the degree of uniformity secured by the manufacturers both as regards the weight of the tablets and the amount of medicament they contain. Kebler has pointed out (*The Tablet Industry, 1914, p. 42*) that the chief defects causing variations in the weights of tablets are (1) improper feeding to the machines, (2) worn machinery, punches or dies, (3) loosening of adjustments, and (4) careless weighing of the finished tablets. It is almost universally conceded that a variation in weight of 5 per cent above and below the average is generous especially for the larger tablets. In the smaller tablets a somewhat greater variation would be expected.

The present examination afforded an opportunity to add to the data on this subject collected by Kebler (loc. cit). In the forty-one samples of tablets examined individual weighings were made of 836 tablets, ranging from 10 to 80 tablets per sample. The maximum, minimum and average weights of the tablets are shown in Table XVI, together with the percentage variation above and below the average.

While in some cases remarkable uniformity in weight is shown, in others the variations are very great. In the case of only two manufacturers are all the total variations less than 10 per cent, while in the others they range from 13.2 to 19.4, 3.1 to 22.5, 3.9 to 14.9, 6.1 to 20.0, 5.4 to 13.7, 5.4 to 18.0, and from 7.5 to 23.4, respectively. In other words, in over half of our samples carelessness in the preparation of the tablets is shown.

Although Kebler examined 231 lots of tablets and our present inspection covers only 41, the results of the two investigations are strikingly similar, as is shown in the following tabulation:

	Kebler. Per cent.	Conn. Per cent.
Showing variation less than 10%	43	45
" " more " 10%	57	55
" " " " 12%	44	42
" " " " 15%	28	28
" " " " 20%	9	10

TABLE XVI:—VARIATIONS IN THE WEIGHT OF MEDICINAL TABLETS.

Station No.	Name of Tablet.	Weight per tablet.			Maximum variation.		
		Maximum. mgms.	Minimum. mgms.	Average. mgms.	Above average. Per cent.	Below average. Per cent.	Total. Per cent.
	Antiseptic (Corrosive sublimate).						
11433	Bristol Myers Co. (1.75 grs.)	187.2	154.9	166.9	12.2	7.2	19.4
11423	The Norwich Co. (7.3 grs.)	1061.2	1004.8	1026.1	3.4	2.1	5.5
11417	The Tracy Co. (7.3 grs.)	1157.6	1072.8	1124.6	2.9	4.6	7.5
11439	The Tracy Co. (1.75 grs.)	166.2	133.6	145.3	14.4	8.1	22.5
	Acetanilid.						
11415	G. F. Harvey Co. (2⅛ grs.)	269.2	230.3	261.4	3.0	11.9	14.9
11410	G. F. Harvey Co. (2 grs.)	249.8	240.2	246.8	1.2	2.7	3.9
11403	Tailby-Nason Co. (3 grs.)	470.8	441.4	460.1	2.3	4.1	6.4
11411	Yates Drug & Chem. Co. (2½ grs.)	359.9	338.5	350.1	2.8	3.3	6.1
11405	Yates Drug & Chem. Co. (2 grs.)..	260.8	245.2	253.4	2.9	3.2	6.1
	Acetphenetidin.						
11446	The Tracy Co. (2½ grs.)	317.9	260.0	304.0	4.6	14.5	19.1
11404	(3 grs.)	243.8	195.2	220.9	10.4	11.6	22.0
	Aspirin.						
11416	Tailby-Nason Co. (5 grs.)	365.9	332.9	352.2	3.9	5.5	9.4
	Blaud's Compound.						
11412	G. F. Harvey Co.	562.6	520.8	538.8	4.4	3.3	7.7
	Calomel.						
11438	The National Drug Co. (¼ gr.)..	88.2	77.5	83.7	5.4	7.4	12.8
11406	The National Drug Co. (1/10 gr.)	35.0	30.5	32.7	7.0	6.7	13.7
11418	The Tracy Co. (2 grs.)	454.1	420.9	441.9	2.8	4.8	7.6
11409	Yates Drug & Chem. Co. (1/10 gr.)	34.9	30.9	33.7	3.6	8.3	11.9
	Calomel and Phenolphthalein.						
11437	Daggett & Miller Co. (1/10 gr.) ...	77.9	70.2	75.0	3.9	6.4	10.3
	Calomel and Soda.						
11451	The Drug Products Co. (1/10 gr.)	88.4	78.9	83.6	5.7	5.6	11.3
11425	The Harvey Co. (¼ gr.)	178.4	165.5	172.6	3.4	4.1	7.5
11402	Yates Drug & Chem. Co. (1 gr.)..	175.9	147.2	161.5	8.9	8.8	17.7
	Digestive Tablets.						
11414	G. F. Harvey Co.	351.0	313.6	335.8	4.5	6.6	11.1
	Hexamethylene tetramine.						
11404	Daggett & Miller Co. (5 grs.)	329.6	312.4	320.3	2.9	2.5	5.4
11424	Daggett & Miller Co. (5 grs.)	331.6	310.0	323.5	2.5	4.2	6.7
11430	The National Drug Co. (5 grs.) ...	332.8	315.4	324.3	2.6	2.8	5.4
11429	Norwich Pharmacal Co. (5 grs.) ..	335.8	321.8	328.8	2.1	2.1	4.2
	Neurosal.						
11422	The Tracy Co.	399.8	357.8	370.9	7.8	3.5	11.3
	Nitroglycerin.						
11448	The Harvey Co. (1/100 gr.)	47.8	40.6	44.0	8.6	7.7	16.3
11551	The Harvey Co. (1/100 gr.)	49.2	41.8	46.1	6.7	9.3	16.0
* 11553	The Harvey Co. (1/100 gr.)	107.5	84.9	96.8	11.1	12.3	23.4
11554	Yates Drug and Chem. Co. (1/100 gr.)	106.2	86.8	97.1	9.4	10.6	20.0
	Paregoric.						
11435	The Harvey Co. (20 min.)	107.2	90.0	95.0	12.8	5.3	18.1
	Phenolphthalein.						
11436	Daggett & Miller Co. (1½ grs.) ...	377.8	312.9	356.9	5.9	12.3	18.2
	Quinin Sulphate.						
11432	Tailby-Nason Co. (2 grs.)	271.5	248.6	263.7	3.0	5.7	8.7
11400	The Tracy Co. (2 grs.)	269.5	250.6	260.2	3.6	3.7	7.3
	Sedative (Bromids).						
11420	The Tracy Co. (7.5 grs.)	540.4	523.5	531.2	1.7	1.4	3.1
	Sodium Bromid.						
11401	Yates Drug & Chem. Co. (10 grs.)	688.5	603.9	647.8	6.3	6.8	13.1
	Sodium Salicylate.						
11434	Yates Drug & Chem Co. (5 grs.)..	837.7	769.1	804.7	4.1	4.4	8.5
11407	Yates Drug & Chem. Co. (5 grs.)..	480.2	415.4	449.2	6.9	7.4	14.3
	Strychnin Sulphate.						
11428	Bristol Myers Co. (1/60 gr.)	78.4	68.6	74.0	5.9	7.3	13.2

Four of our samples show total variations in weight of 20 per cent or over. The fact that these particular samples contained such potent drugs as corrosive sublimate, nitroglycerin and acetphenetidin makes the discrepancy a matter of considerable gravity, and if the oft-repeated claim of uniformity in weight and dosage is to be substantiated certain manufacturers at least must reform their methods in preparing their tablets.

VARIATIONS IN AMOUNT OF MEDICAMENT IN TABLETS.

It is of even greater importance, however, to ascertain how closely the composition of the tablets conforms with that claimed for them on the label. In securing these data it has been necessary to assume that the tablets are of uniform composition, and that the manufacturer has carefully prepared his mix before passing it through the machines. The small quantity of medicament in certain tablets, for instance, nitroglycerin and strychnin tablets, makes the analysis of individual tablets of such drugs almost an impossibility. In the table which follows, therefore, it has been assumed that all the tablets in any one lot were chemically the same and the amounts of medicament recorded for the heaviest and lightest tablets have been calculated directly from the data obtained from the analysis of a composite of 10, 25 or more tablets.

Considering the variations both above and below the claimed amounts, we find a wide range, from 30 per cent above to 64.6 per cent below. The following is a summary of these variations in both directions:

	Number.	Per cent of total determinations.
Variations less than 5%	68	58
" from 5.00-9.99%	24	21
" " 10.00-14.99%	10	8
" " 15.00-19.99%	5	4
" " 20.00-29.99%	5	4
" " 30.00-50.00%	3	3
" over 50%	2	2

That is, 21 per cent of all the drugs determined varied from the claimed amount by more than 10 per cent, and 13 per cent by more than 15 per cent. These results while far from satisfactory show a considerable improvement over the tablets exam-

TABLE XVII:—VARIATIONS IN MEDICAMENT IN TABLETS.

Station No.	Name of Tablet.	Amount declared. grs.	Amount found. Maximum. grs.	Amount found. Minimum. grs.	Amount found. Average. grs.	Maximum Variation from Claim. Above.	Maximum Variation from Claim. Below.
						%	%
11433	Antiseptic Tablets.						
	Corrosive sublimate	1.75	1.88	1.56	1.68	7.4	10.9
11423	Corrosive Sublimate Tablets.						
	Corrosive sublimate	7.30	7.82	7.40	7.56	7.1	0
11417	Antiseptic Tablets No. 1.						
	Corrosive sublimate	7.30	7.87	7.30	7.65	7.8	0
11439	Corrosive Sublimate Tablets.						
	Corrosive sublimate	1.75	1.54	1.24	1.35	0	29.1
11408	Antiseptic Tablets.						
	Corrosive sublimate	7.00	7.57	0.00	7.57	8.1	0
11416	Aspirin Tablets.						
	Aspirin	5.00	5.12	4.66	4.93	2.4	6.8
11412	Blaud's Compound No. 9.						
	Iron carbonate	1.00	0.96	0.89	0.92	0	11.0
	Corrosive sublimate	0.0125	0.0113	0.0105	0.0108	0	16.0
	Arsenious oxid	0.0200	0.0200	0.0185	0.0191	0	7.5
	Strychnin sulphate	0.0167	0.0182	0.0169	0.0175	9.0	0
11438	Calomel Tablets.						
	Calomel	0.25	0.236	0.208	0.223	0	16.8
11406	Calomel Tablet Triturates.						
	Calomel	0.10	0.101	0.088	0.093	1.0	12.0
11418	Hepatic Tablets No. 2.						
	Calomel	2.00	1.94	1.79	1.89	0	10.5
11409	Calomel Tablets.						
	Calomel	0.10	0.101	0.090	0.097	1.0	10.0
11437	Calomel and Phenolphthalein Tablets.						
	Calomel	0.10	0.103	0.093	0.099	3.0	7.0
	Phenolphthalein	0.10	0.106	0.095	0.101	6.0	5.0
11451	Calomel and Soda Tablets No. 1.						
	Calomel	0.10	0.106	0.095	0.100	6.0	5.0
	Sodium bicarbonate	1.00	1.06	0.95	1.00	6.0	5.0
11425	Calomel and Soda Tablets No. 5.						
	Calomel	0.25	0.28	0.26	0.27	12.0	0
	Sodium bicarbonate	2.00	2.10	1.95	2.04	5.0	2.5
11402	Calomel and Soda Tablets No. 4.						
	Calomel	1.00	0.94	0.79	0.86	0	21.0
	Sodium bicarbonate	1.00	1.08	0.90	0.99	8.0	10.0
11415	Headache Pills.						
	Acetanilid	2.125	2.13	1.82	2.07	2.4	14.4
	Caffein	0.375	0.37	0.32	0.36	0	14.7
	Sodium bicarbonate	0.250	0.24	0.21	0.24	0	16.0
			(?)	(?)	(?)		
	Strychnin sulphate	0.004	0.006	0.005	0.006	..	..
11410	Migrain Citrated Tablets No. 2.						
	Acetanilid	2.00	1.99	1.81	1.97	0	9.5
	Caffein citrate	0.50	0.52	0.50	0.51	4.0	0
11403	Tab Salparettes.						
	Acetanilid	3.00	3.06	2.87	2.99	2.0	4.3
	Strontium salicylate	0.50	0.65	0.61	0.63	30.0	0
	Sodium bicarbonate	0.50	0.64	0.60	0.62	28.0	0

TABLE XVII:—VARIATIONS IN MEDICAMENT IN TABLETS.—*Cont.*

Station No.	Name of Tablet.	Amount declared. grs.	Amount found. Maximum. grs.	Amount found. Minimum. grs.	Amount found. Average. grs.	Maximum Variation from Claim. Above.	Maximum Variation from Claim. Below.
11431	Migrain Tablets No. 7.						
	Phenacetin	2.50	1.09	0.89	1.04	0	64.6
	Acetanilid	0.00	1.22	0.99	1.16	..	..
	Caffein citrate	0.50	0.43	0.35	0.41	0	30.0
	Sodium bicarbonate	1.00	0.56	0.46	0.53	0	54.0
11411	Headache Tablets.						
	Acetanilid	2.50	2.54	2.39	2.47	1.6	4.4
	Caffein	0.50	0.52	0.49	0.51	4.0	2.0
	Sodium bicarbonate	1.00	1.04	0.97	1.01	4.0	3.0
11405	Migrain Tablets.						
	Acetanilid	2.00	2.12	1.91	1.98	6.0	4.5
	Caffein citrate	0.50	0.58	0.55	0.57	16.0	0
11404	Formin Tablets.						
	Hexamethylene tetramine	5.00	5.09	4.82	4.94	1.8	3.6
11424	Formin Tablets.						
	Hexamethylene tetramine	5.00	5.12	4.78	4.99	2.4	4.4
11430	Hexamethylene Tetramine Tablets.						
	Hexamethylene tetramine	5.00	5.14	4.87	5.00	2.8	2.6
11429	Formin Tablets.						
	Hexamethylene tetramine	5.00	5.17	4.96	5.06	3.4	0.8
11422	Neurosal Tablets.						
	Acetanilid	2.50	2.47	2.21	2.29	0	11.6
	Sodium salicylate	1.00	1.06	0.95	0.99	6.0	5.0
11448	Nitroglycerin Pills.						
	Nitroglycerin	0.01	0.0105	0.0089	0.0096	5.0	11.0
11551	Nitroglycerin Pills.						
	Nitroglycerin	0.01	0.0100	0.0085	0.0094	0	15.0
11553	Nitroglycerin Tablets.						
	Nitroglycerin	0.01	0.0129	0.0102	0.0117	29.0	0
11554	Nitroglycerin Tablets.						
	Nitroglycerin	0.01	0.0121	0.0099	0.0111	21.0	1.0
11436	Phenolphthalein Tablets.						
	Phenolphthalein	1.50	1.26	1.04	1.19	0	30.7
11432	Quinin Sulphate Tablets.						
	Quinin sulphate	2.00	2.00	1.84	1.95	0	8.0
11400	Quinin Sulphate Tablets.						
	Quinin sulphate	2.00	2.02	1.87	1.95	1.0	6.5
11420	Sedative Tablets.						
	Sodium bromid	2.50	2.66	2.58	2.61	6.4	0
	Potassium bromid	2.50	2.49	2.41	2.45	0	3.6
	Ammonium bromid	2.50	2.51	2.43	2.47	0.4	2.8
11401	Sodium Bromid Tablets.						
	Sodium bromid	10.00	10.00	9.97	9.98	0	0.3
11407	Sodium Salicylate Tablets.						
	Sodium salicylate	5.00	5.30	4.59	4.96	6.0	8.2
11434	Sodium Salicylate Tablets.						
	Sodium salicylate	5.00	5.07	4.65	4.75	1.4	7.0
11428	Strychnin Sulphate Tablets.						
	Strychnin sulphate	0.0167	0.0174	0.0153	0.0164	4.2	8.4

ined by Kebler, who found over one-third exceeding a variation of 10 per cent.

In the smaller tablets a slight variation causes a relatively large percentage variation, and possibly a comparison based on grains of active drug present is more illuminating. On this basis the following variations from claim are shown:

Drug.	Claimed. grs.	Found. Max. grs.	Found. Min. grs.	Maximum Variation from Claim. grs.	Maximum Variation from Claim. Per cent.
Acetanilid	2.00	2.12	1.81	— 0.19	— 9.5
"	2.125	2.13	2.82	— 0.305	—14.4
"	2.50	2.54	2.21	— 0.29	—11.6
"	3.00	3.06	2.87	— 0.13	— 4.3
Acetphenetidin	2.50	1.09	0.89	— 1.61	—64.6
Ammonium bromid	2.50	2.51	2.43	— 0.07	— 2.8
Arsenious oxid	0.02	0.0200	0.0185	— 0.0015	— 7.5
Aspirin	5.00	5.12	4.66	— 0.34	— 6.8
Caffein	0.375	0.37	0.32	— 0.055	—14.7
"	0.50	0.52	0.49	+ 0.02	+ 4.0
Caffein citrate	0.50	0.58	0.35	— 0.15	—30.0
Calomel	0.10	0.103	0.088	— 0.012	—12.0
"	0.25	0.280	0.208	— 0.042	—16.8
"	1.00	1.06	0.79	— 0.21	—21.0
"	2.00	1.94	1.79	— 0.21	—10.5
Corrosive sublimate	0.0125	0.0113	0.0105	— 0.002	—16.0
" "	1.75	1.88	1.24	— 0.51	—29.1
" "	7.30	7.87	7.37	+ 0.57	+ 7.8
Hexamethylene tetramine	5.00	5.17	4.78	— 0.22	— 4.4
Iron carbonate	1.00	0.96	0.89	— 0.11	—11.0
Nitroglycerin	0.01	0.0129	0.0085	+ 0.0029	+29.0
Phenolphthalein	0.10	0.106	0.095	+ 0.006	+ 6.0
"	1.50	1.26	1.04	— 0.46	—30.7
Potassium bromid	2.50	2.49	2.41	— 0.09	— 3.6
Quinin sulphate	2.00	2.02	1.84	— 0.16	— 8.0
Sodium bicarbonate	0.25	0.24	0.21	— 0.04	—16.0
" "	0.50	0.64	0.60	+ 0.14	+28.0
" "	1.00	1.08	0.46	— 0.54	—54.0
Sodium bromid	2.50	2.66	2.58	+ 0.16	+ 6.4
" "	10.00	10.00	9.97	— 0.03	— 0.3
Sodium salicylate	1.00	1.06	0.95	+ 0.06	+ 6.0
" "	5.00	5.30	4.59	— 0.41	— 8.2
Strontium salicylate	0.50	0.65	0.61	+ 0.15	+30.0
Strychnin sulphate	0.0167	0.0182	0.0153	+ 0.0015	+ 9.0

While the average composition of the tablets agrees as a rule very satisfactorily with that claimed, the above table shows that the individual variations from the claim are far too wide. Moreover, the maximum variation is more often below than above the amount claimed, only 10 of the 35 kinds of drugs showing a maximum above the claim. These variations may be summarized as follows:

	Number.	Per cent.
Variation less than 5%	7	20
" " " 10%	18	51
" " " 15%	23	66
" " " 20%	26	74
" " " 30%	32	91
" " " 50%	33	94
" more " 50%	2	6

In other words, in nearly half of the determinations the variation from the claim amounts to over 10 per cent, in one-third over 15 per cent, in one-fourth over 25 per cent, while in the case of two drugs the maximum variation amounted to 54.0 and 64.6 per cent. These last two wide variations occurred in the same tablets, in which there was a deficiency in all of the drugs claimed, and an unclaimed drug, acetanilid, was present. These variations are far too wide and are by no means favorable to the claim of uniform dosage previously referred to.

MAGNESIUM SULPHATE.

(*Epsom Salt.*)

The 37 samples analyzed showed a high degree of purity, ranging from 48.60 to 49.30, average, 49.10, per cent of anhydrous magnesium sulphate. The U. S. P. sets limits of 48.59 and 53.45 per cent for this ingredient. All the samples reacted neutral to litmus; no heavy metals were present in any case; and in only four samples was there a trace of arsenic, the amount in each instance being considerably less than one part in 100,000.

In purchasing these samples the agent asked for four ounces of material. In seven cases considerably less than this amount was delivered. The deficient samples were as follows:

No.		oz.	Deficiency Per cent.
7949.	Notkin's Pharmacy, New Haven	3.2	20
7965.	S. J. Rickman, Hartford	3.6	10
7968.	Front Pharmacy, Hartford	2.3	42
7969.	J. J. Seinsoth, Hartford	3.2	20
7981.	M. A. McCarthy, Waterbury	3.0	25
8054.	City Drug Store, New Britain	3.5	12
8057.	Lincoln's Drug Store, Middletown	3.0	25

The usual price was 5 cents per 4 oz.; although in three samples 10 cents was charged for this quantity.

SODIUM PHOSPHATE.

(*Sodii Phosphas.*)

Eleven samples of this drug were analyzed. The U. S. P. VIII requires that

"it should contain, in an uneffloresced condition, not less than 99 per cent of pure Di-sodium-ortho-phosphate, and should be kept in well-stoppered bottles, in a cool place."

The U. S. P. IX has changed the requirements to read

"It contains not less than 39.25 per cent, nor more than 44.00 per cent of anhydrous sodium phosphate (di-sodium-ortho-phosphate), corresponding to not less than 99 per cent of the crystallized salt."

No impurities were found in any of the samples, the arsenic, when present, being in all cases considerably less than one part per 100,000. The content of anhydrous sodium phosphate is shown in the following tabulation:

		Per cent.
7962.	The Gladding Drug Co., Hartford	45.88
8030.	Louis K. Liggett Co., New York	40.92
7964.	Mallinckrodt Chem. Works, St. Louis	42.15
7963.	Merck and Co.	41.29
7942.	" " "	41.76
7918.	In bulk	53.47
7919.	" "	42.62
7920.	" "	44.85
7961.	" "	53.51
7984.	" "	54.11
8064.	" "	45.72

While no adulteration was found in any of the samples, it is evident that in certain cases there was carelessness in storage, resulting in a partial efflorescence of the salt, and consequently a loss of water of hydration. The phosphate bought in cartons showed as a rule less change than the bulk samples. The latter were bottled immediately on receipt in the laboratory, and the dehydration observed took place before the samples reached our hands. Only five of the eleven samples fully met the U. S. P. requirements.

7964, Mallinckrodt Chem. Works, claimed one pound net weight, but contained only 14.7 oz. **7961**, sold in bulk by A. Laschever, Hartford, for 4 oz. contained only 3.5 oz.

The prices ranged from 15 to 25 cents for pound packages, and from 5 to 15 cents for 4 oz. portions.

EFFERVESCENT SODIUM PHOSPHATE.

(*Sodii Phosphas Effervescens.*)

Three samples of this product were examined, all of which were delivered on a request for Sodium Phosphate. The U. S. P. formula for this substance is 200 gms. exsiccated sodium phosphate, 477 gms. sodium bicarbonate, 252 gms. tartaric acid and 162 gms. citric acid, the whole to make 100 gms. of the finished product.

The analyses of the samples were as follows:

		Loss @ 100° C.	Phosphoric acid.	Equal to exsiccated sod. phos.	Soda.	Carbonic acid.
7944.	Am. Drug. Synd., New York	1.67	10.23	20.41	26.48	17.75
7941.	McKesson & Robbins, N. Y.	2.30	9.38	18.70	31.02	28.79
7917.	Henry Thayer & Co., Boston	10.04	11.58	23.09	28.92	7.41

Tartaric and citric acids were present in all the samples. Less than one part of arsenic per 100,000 was present in any sample.

While the samples contained not far from the theoretical amount of exsiccated sodium phosphate, they all showed a deficiency in carbonate. The percentages of sodium bicarbonate, calculated from the sodium oxid in excess of that required for the sodium phosphate, called for 25.04, 32.42 and 26.79 per cent of carbon dioxid, while only 17.75, 28.79 and 7.41 per cent, respectively, was present, showing that a decomposition had taken place, probably due to exposure to damp air.

PROPRIETARY MEDICINES.

The work of the past few years in connection with proprietary remedies has been continued this year, and the analyses of 38 additional preparations are herewith reported. Most of these represent remedies extensively advertised in the newspapers of the state. A number of additional phenolphthalein preparations were also examined.

Partly because of the nature of the remedies examined, and partly because there has been an actual improvement in the ingredients used in such remedies during the past few years, only a few dangerous drugs (other than alcohol) were found in the medicines. These included pyrogallol and corrosive sublimate each once, and strychnin three times.

The remedies examined this year, however, include some outrageously fraudulent preparations. Remedies for female disorders depending chiefly upon their alcoholic content, a "hair curler" composed of washing soda and gum, dangerous kidney remedies (dangerous because of their ingredients and because they encourage self-medication for such serious ailments), constipation remedies abounding in cathartics (whose presence is often disclaimed), "cure-alls" (whose chief medicament is a mixture of simple, well-known laxatives), fake flesh producers, nerve remedies, germ destroyers, and vitality restorers, are found in the list.

Most of these remedies depend for their sale upon the advertising given them in our newspapers. The speciousness and falsity of their claims are apparent to any one who gives them the slightest consideration, and yet the advertising managers of most of our papers open their columns to them, apparently without the slightest compunctions of conscience. Certain druggists too in order to gain a little free advertising are willing to allow their names to be used in the exploitation of remedies which from their very experience and training they must know to be fraudulent.

The leaven, however, is working and gradually the decent newspapers of the country are taking the stand that their advertising columns shall be as clean and honest and respectable as the news part of their papers. When the newspapers quite generally take this stand the "patent medicine" problem will in great measure be solved, as publicity is the chief stock in trade of these nostrums, and especially as under the Sherley amendment the manufacturers no longer dare to lie on their labels or in the circular matter accompanying the medicines.

A classified list of the brands examined in 1916 follows:

Female Disorders.

McElree's Wine of Cardui.
Pinkham's Vegetable Compound.

Hair and Scalp.

Brownatone.
Eureka Hair Tonic.
Harfina.
Liquid Silmerine.
Mason's Old English Hair Tonic.

Kidneys and Liver.

Cystogen.
Fulton's Renal Compound.
Pierce's Anuric Tablets.
Uricol.
Warner's Safe Remedy.

Skin and Complexion.

Creme Tokalon.
Rexall Tan and Freckle Lotion.

Stomach and Bowels.

A-Lax Tablets.
Analax.
Auto-Laks Chocolates.
Bisuroids.
Bonalax.
Casca Beans.
Ex-Lax.
Lax-A-Tone.
Laxol.
Limestone Phosphate.
Stuart's Calcium Wafers.
Tanlac.
Tanlac Laxative Tablets.

Tonics.

Mark Tonic Bitters.
Nuxated Iron.
Paine's Celery Compound.
Rexall Celery and Iron Tonic.
Rexall Wine of Peruvian Bark.

Miscellaneous.

Comfort Powder.
Kellogg's Sanitone Wafers.
Parmint.
Protone.
Pyorrhocide.
Quaker Herb Extract.

Physicians' Drugs.

Brown's Sedative Tablets.
Formin.
Hawley's Headache Tablets.
Neurosal, Tracy.
Saratoga Goldens.
Tailby-Nason's Tabs. Salparettes.
Tracy's Hepatic Tablets.
Videns Phenolphthalein Tablets.

During the past eight years about 400 proprietary remedies have been analyzed in this laboratory. Below will be found a summary of those remedies containing habit-forming, dangerous, or poisonous drugs. The list of alcoholic medicines includes only those intended for internal use and containing over 10 per cent of alcohol.

Acetanilid.

Aceton.
A. D. S. Headache Wafers.
Antikamnia Tablets.
Bristol Headache Cure.
Broderick and Curtin's Headache Konseals.
Bromo-Lithia.
Callahan's Headache Powder.
Conway's Headache Konseals.
Coughlin's Sure Remedy Head. Powd.
Davis' Anti-Headache.
Duggan's Headache Konseals.
El-Ce-Dee Headache Wafers.
Goodwin's Headache Remedy.
Goulden's Headache Wafers.
Halloran's Headache Powder.
Hawley's Headache Tablets.
Hill's Cascara-Bromide-Quinine.
Hobson's Headache Wafers.
Hoffman's Harmless Headache Powders.
Ingram's Celero-Caffeine Headache Wafers.
Instant Headache Remedy.

Instant Headache Wafers.
James' Miniature Headache Powders.
Jamieson's Headache Konseals.
Jamieson's Improved Headache Powd.
Jones' Grip and Cold Tablets.
Kelly's Headache Konseals.
Lee's Headache Powders.
Linde's Headache Wafers.
Matchless Headache Cure.
McCarthy's Headache Wafers.
Migrain Tablets.
Mohegan Headache Wafers.
Murphy's Instantaneous Headache Remedy.
Narco Headache Remedy.
Neurosal, Tracy.
Notkin's Headache Cure.
Nugent's Headache Wafers.
Nyal's Headache Wafers.
Old B's Headache Tablets.
Orangeine Powder.
Parker's Headache Cure.
Pelton's Headache Powder.
Phenyo-Caffein.
Quick Relief Headache Powder.
Reliable Headache Wafers.
Salparettes Tablets.
Saratoga Goldens.
Shac (Stearns' Headache Cure).
Simon's Headache Pills.
Smith's Headache Tablets.
Stanley Headache Powder.
Superior Headache Powder.
Tanner's Headache Powder.
Taylor's Headache Wafers.
Wheeler's Headache Wafers.
Wilson's Headache Wafers.
Wolff and Fitch's Headache Konseals.
Woodward's Headache Powder.

Acetanilid and Acetphenetidin.

Nicholson's Headache Powder.
Radon's Headache Wafers.

Acetphenetidin (Phenacetin).

Antikamnia Tablets.
Budd's Headache Wafers.
Emerson's Bromo-Seltzer.
Grove's Laxative-Bromo-Quinine.
Halloran's Headache Wafers.
Howard's Headache Powder.
Hufeland's Sure Headache Cure.
Kohler's Antidote for Headache, etc.
Nolan's Headache Powder.
Poyer's Headache Powder.
Rapport's Headache Powder.
Rex Headache Powder.
Rexall Headache Powder.
Shoop's 20 Minute Headache Tablets.
Smith's Headache Wafers.
Toucey's Headache Wafers.
Tracy's Headache Wafers.
Wood's Improved Headache Powder.

Alcohol, ethyl.

%	
42.56	Boker's Stomach Bitters.
30.65	Porter's Medicated Stomach Bitt.
27.68	Sayle's Sarsaparilla.
24.82	Hostetter's Cel. Stomach Bitters.
24.80	Purogen.
24.48	Severa's Stomach Bitters.
23.86	Callahan's Sarsaparilla.
23.36	Rexall Celery and Iron Tonic.
22.52	Rexall Sarsaparilla Tonic.
22.39	Kaufmann's Sulphur Bitters.
21.46	Lash's Kidney and Liver Bitt.
21.42	Rexall Wine of Peruvian Bark.
21.20	Phytoline.
20.75	Wampole's Kola Wine.
20.68	Tona Vita.
19.76	McElree's Wine of Cardui.
19.61	Wincarnis.
19.48	Claflin's Coca Wine.
19.39	Harris' Beef Tonic.

19.28	Burdock's Blood Bitters.
19.13	Bucklen's Electric Bitters.
19.10	Wadewitz's Vegetable Worm Syrup.
18.85	Cuticura Resolvent.
18.94	Mark Tonic Bitters.
18.70	Cardiol Essence.
18.69	Vinol.
18.49	Bowe's Turf Club Bitters.
18.48	Paine's Celery Compound.
18.39	Beef, Iron and Wine (ave.).
18.32	Nyal's Iron Tonic Bitters.
18.00	Pinex.
17.95	Tanlac.
17.89	A. D. S. Iron Tonic Bitters.
17.83	Satoin.
17.37	Peruna.
17.35	Manola.
17.27	Greene's Nervura.
17.20	Rheumatogen.
17.17	Irondequoit Wine of Pomelo.
16.92	Quaker Herb Extract.
16.59	Wampole's Tasteless Prep. C. L. Oil.
16.32	Pinkham's Vegetable Compound.
16.25	Vin Mariani.
15.84	Hopkin's Cel. Union Stomach Bitters.
15.69	Hood's Sarsaparilla.
15.56	Metcalf's Coca Wine.
15.35	Carnrick's Coca Muscatel.
15.20	Neutrone Prescription 99.
15.20	Warner's Safe Remedy.
15.00	Kargon Compound.
14.98	Fowler's Asthma Cure.
14.80	Thompson's Lax. Appetizing Bitters.
14.55	A. D. S. Premium Peptonized Wine.
14.44	Eckman's Alterative.
13.87	Hale's Honey of Horehound and Tar.
13.62	Var-ne-sis.
13.55	Atwood's Veg. Phys. Jaundice Bitt.
13.10	Parmint.
12.43	Maltine with Coca Wine.
12.13	Heckler Palatable Prep. C. L. Oil.
11.25	Waterbury's Compound.
10.90	Manhattan Worm Syrup.
10.20	Hand's Worm Elixir.

Alcohol, methyl (wood).

Carnation Hair Tonic.
Frost's Superior Bay Rum.
Hanford's Balsam of Myrrh.
Jarden's French Bouquet Toilet Water.
Johnson's Bouquet Toilet Water.
Stephan's Clescalp.

Ammoniated mercury (white precipitate).

Kintho Beauty Cream.
Mercolized Wax.
Othine.

Bromids.

Brown's Sedative Tablets.
Kosine.
Mile's Restorative Nervine.

Chloral hydrate.

D. D. D. Prescription.

Cocain.

Anglo-American Catarrhal Powder.
Birney's Catarrh Powder.
Carnrick's Coca Muscatel.
Cole's Catarrh Cure.
Gray's Catarrh Powder (old formula).
Maltine with Coca Wine.
Metcalf's Coca Wine.

Corrosive sublimate.

Hill's Freckle Lotion.
Kingsbery's Freckle Lotion.
McCorrison's Famous Diamond Lotion.
Perry's Moth and Freckle Lotion.
Rexall Tan and Freckle Lotion.
Ruppert's World Renowned Face Bleach.

Fusel Oil.
En-Ar Co Oil.

Lead acetate.
Allen's World's Hair Color Restorer.
Barbo Compound.
Hay's Hair Health.
Parker's Hair Balsam.
Perry's Moth and Freckle Lotion.
Q-Ban Hair Color Restorer.
Wyeth's Sage and Sulphur Hair Remedy.

Opium or morphin.
Cubanos.
Kopp's Baby's Friend.

Paraphenylene diamine.
Potter's Walnut Tint Hair Stain.

Potassium acetate.
Kargon Compound.

Pyrogallol.
Brownatone.

Silver nitrate.
Farr's Gray Hair Restorer.
Goldman's Gray Hair Color Restorer.

Thyroid Gland.
Marmola.
Phy-thy-rin.

REMEDIES FOR FEMALE DISORDERS.

McElree's Wine of Cardui.

5501. *McElree's Wine of Cardui, or Woman's Relief,* for Menstrual Disturbances of Women, Chattanooga Medical Co.; Chattonooga, Tenn. "Alcohol 20 per cent." Price one dollar for 9 fl. oz.

Solids	3.08	gms. per 100 cc.
Glycerin	0.50	" " "
Ash	0.86	" " "
Invert sugar	0.42	" " "
Vegetable extractives	1.30	" " "
Potash	0.282	" " "
Nitrogen, total	0.074	" " "
" nitric	0.026	" " "
Chlorin	0.056	" " "
Spec. grav. at 15.6° C.	0.9910	
Alcohol by volume	19.76	
Phosphates, sulphates, Fe, Ca, Mg	traces	
Black haw, blessed thistle	present	
Bitter principle	present	
Iodids, bromids, emodin, alkaloids	none	
Reaction	neutral	

This remedy contained 19.76 per cent of alcohol by volume, and 3.08 gms. of solids per 100 cc. The latter contained 0.50 per cent of glycerin, 0.86 per cent of ash, 0.42 per cent of invert sugar and 1.30 per cent of vegetable extractives. While the tests for identity were rather inconclusive, the vegetable extractives appeared to be derived from blessed thistle (*Carduus benedictus*) and blackhaw (*Viburnum prunifolium*). No potent drugs, such as iodids, bromids, alkaloids, or emodin were present. Wine also was absent.

The manufacturers of this remedy in their literature recommended it for practically all of woman's ills. Blessed thistle is not recognized in the U. S. P. and the therapeutic value of blackhaw has long been a controversial question. The amounts of these drugs present in the preparation are so small as to indicate little probable beneficial effect on the user, and the fact (recently testified to in the American Medical Association suit) that in the South the women frequently take this remedy direct from the bottle, shows the medicament present is not sufficient to prevent its use as a beverage. Its popularity, especially in prohibition areas, would seem to rest upon its 20 per cent of alcohol (two-fifths the strength of whiskey) rather than on its small amount of medicament. In many derangements of the female system the amount of alcohol in the daily dosage would have a distinctly prejudicial effect.

Pinkham's Vegetable Compound.

5502. *Lydia E. Pinkham's Vegetable Compound,* The Lydia E. Pinkham Medicine Co., Lynn, Mass. "Alcohol 18 per cent." "Recommended for the treatment of non-surgical cases of Weaknesses and Disorders of the Female Generative Organs, Catarrhal Leucorrhoea and Irritation." Price one dollar for 13.8 fl. oz.

Solids	3.12	gms. per 100 cc.
Glycerin	0.56	" " "
Ash	0.34	" " "
Sucrose	0.29	" " "
Invert sugar	0.47	" " "
Total nitrogen	0.07	" " "
Vegetable extractives	1.02	" " "
Chlorin	0.08	" " "
Spec. grav. at 15.6° C.	0.9917	
Alcohol by volume	16.32	
Phosphates, sulphates, Fe, Ca, Mg	traces	
Lovage or angelica	present	
Aloes, or aloin	(?)	
Tansy	(?)	
Emodin, alkaloids, bromids, iodids	none	
Reaction	acid	

This much-advertised remedy contains 16.32 per cent of alcohol by volume with 3.12 gms. of solids per 100 cc. All but a trifle over one per cent of these solids consist of glycerin, sugars and mineral matter. In the vegetable extract lovage (or angelica), and possibly aloes (or aloin) and tansy were identified. No alkaloids, iodids or bromids were present.

As in the case of *Wine of Cardui,* the chief therapeutic effect of the *Compound* rests in its content of alcohol. Like many other proprietary medicines the composition of this remedy is not constant, an analysis of the British Medical Association made in 1912 showing 19.3 per cent of alcohol and only 0.60 per cent of solids and 0.06 per cent of ash.

The persistent advertising of this familiar preparation must mean an extensive sale, which is difficult to explain on any other ground than that the exhilaration afforded by its use brings to the woman temporary forgetfulness of the ills to which her flesh is heir.

HAIR AND SCALP REMEDIES.

Brownatone.

6723. *Brownatone, Dark Brown to Black,* The Kenton Pharmacal Co., Covington, Ky. "Alcohol 10 per cent." "An Ideal Hair Stain. Free from lead, sulphur, silver, mercury, zinc, peroxide, aniline coal-tar products or their derivatives." Price 21 cents for 0.6 fl. oz.

Solids	5.88	gms.	per	100 cc.
Ash	0.74	"	"	"
Iron (Fe)	0.67	"	"	"
Copper (Cu)	0.52	"	"	"
Alcohol	present			
Pyrogallol	present			
Chlorids	present			
Free hydrochloric acid	present			
Acidity (cc. N/10 NaOH per 2 cc.)	16.			
Lead, silver, mercury, arsenic, zinc	none			
Sulphur, peroxids, paraphenylene diamine, diamidophenol	none			

This appears to be a solution of iron and copper chlorids with pyrogallol, having a strongly acid reaction. This pyrogallol preparation is quite similar in composition and properties to *Seeger's Hair Dye* and *Shadeine,* well-known English nostrums. Pyrogallol has a strong affinity for oxygen and rapidly reduces metallic oxids and because of this property is used in photography. It is an active irritant substance, and is sometimes used in certain skin diseases, "but even for this purpose the remedy is not devoid of danger, as at least two deaths are on record from its external application." *U. S. Dispens. 19th ed., p. 1030.*

Eureka Hair Tonic.

5581. *Eureka Hair Tonic,* G. M. Duncan, Springfield, Mass. A brown, slightly turbid liquid.

Spec. grav. at 15.6° C.	1.0068			
Alcohol	none			
Non-volatile solids	1.30	gms.	per	100 cc.
Ash	0.86	"	"	"
Boric acid	1.53	"	"	"
Soda	0.11	"	"	"
Volatile oils (bergamot (?))	present			
Heavy metals, arsenic, ammonia, glycerin, sulphur, capsicum, cantharidin, alkaloids, phenols	none			
Reaction	acid			

The material appears to be simply a perfumed, dilute aqueous solution of boric acid with a very small amount of unidentified vegetable extractive.

Harfina.

6731. *Harfina,* Philo Hay Specialties Co., Newark, N. J.: "A Delightful Tonic for the Hair." Price 45 cents for 3.8 fl. oz.

Solids	2.30	gms.	per	100 cc.
Ash	0.38	"	"	"
Glycerin	1.35	"	"	"
Fatty acids (from soap)	0.66	"	"	"
Quinin	0.073	"	"	"
Spec. grav. at 15.6° C.	0.9838			
Alcohol by volume	18.10			
Wood alcohol	none			
Capsicum, soap, resorcin	present			
Cantharidin, pilocarpin, boric acid	none			
Salicylates	(?)			
Soda, carbonates, sulphates	present in ash			
Reaction	alkaline			
Perfume	present			

This preparation contains only 2.30 gms. of non-volatile solids per 100 cc, consisting chiefly of glycerin and soap, with small amounts of quinin, resorcin, capsicum, perfume, and possibly a small amount of salicylic acid. The claims made for it are not unreasonable and its ingredients are harmless for the purposes recommended. The 18 per cent of alcohol, however, is not declared on the label.

Liquid Silmerine.

6726. *Liquid Silmerine,* Parker, Belmont and Co., Chicago. Price one dollar for 4.4 fl. oz.

Solids	2.16	gms. per 100 cc.
Ash	1.34	" " "
Prec. by alcohol (gum)	1.65	" " "
Boric acid	1.35	" " "
Soda, lime, carbonates	present	
Spec. grav. at 15.6° C.	1.0132	
Alcohol	none	
Sulphates, phosphates, chlorids	traces	
Benzoic acid	trace(?)	
Salicylic acid, phenols, alkaloids	none	

The preparation is a very dilute solution (2.16 per cent) of sodium carbonate, boric acid and a gum, with a possible trace of benzoic acid.

Silmerine is recommended as a means of making hair curl. Any such power which it may possess could be secured just as well by the use of a little gum and washing soda. In either case the effect would be but temporary. A bottle of *Silmerine* costs one dollar, and the ingredients are worth only about 0.8 of a cent.

Mason's Old English Hair Tonic.

6725. *Mrs. Mason's Old English Hair Tonic,* The Paxton Toilet Co., Boston. "Alcohol 25 per cent." Price 89 cents for 5.7 fl. oz.

Spec. grav. at 15.6° C.	0.9722	
Alcohol by volume	26.00	
Wood alcohol	none	
Solids	0.98	gm. per 100 cc.
Ash (mostly sod. phos.)	0.33	" " "
Glycerin	0.61	" " "
Phosphorus or hypophosphorous acid	present	

Ether extract	0.0075
Quinin	trace(?)
Benzaldehyde, benzoic acid	present
Heavy metals, arsenic, capsicum, cantharidin	none

This tonic contains only 0.98 gm. of non-volatile solids per 100 cc, 0.61 gm. of which is glycerin. The remainder probably consists chiefly of a phosphorized oil, with benzaldehyde, benzoic acid and possibly a trace of quinin.

REMEDIES FOR KIDNEYS AND LIVER

Cystogen.

6722. *Cystogen,* Uri-Solvent, Genito-urinary Germicide, Cystogen Chemical Co., St. Louis. Price 39 cents per box of 25 tablets, weighing 124.5 grs.

The material corresponds to the U. S. P. tests for hexamethylene tetramine, and contains 39.80 per cent of nitrogen against a theoretical percentage of 40.

Hexamethylene tetramine is a drug of established value, whose usefulness is in no wise enhanced by the fanciful and therapeutically suggestive name here used. Furthermore 5 gr. tablets of the drug itself were quoted at the time of purchase of our sample of *Cystogen* at the rate of 30 for 15 cents, less than one-third the cost of the proprietary article. This useful drug is also sold under other proprietary names, such as *Urisep-tin, Formin, Urotropin, Ammoform, Cystamine, Hexamine,* etc.

Fulton's Renal Compound.

6732. *Fulton's Renal Compound for Bright's Disease,* John J. Fulton Co., Oakland, Cal. "Alcohol 5 per cent." "The first known specific for Bright's Disease." Price one dollar for 16.3 fl. oz.

A brown, turbid liquid, with much sediment, and with the odor and taste of oil of wintergreen followed by a bitter flavor.

Solids	5.61	gms. per 100 cc.
Ash	0.95	" " "
Boric acid	0.38	" " "
Nitric nitrogen	0.061	" " "
Potash	0.37	" " "
Phosphoric acid	0.17	" " "

Sucrose	2.57	gms. per 100 cc.
Invert sugar	1.19	" " "
Vegetable extractives	0.90	" " "
Resin	present	
Alkaloids	very slight trace	
Methyl salicylate	present	
Licorice	present (?)	
Spec. grav. at 15.6° C.	1.0183	
Alcohol by volume	4.58	
Heavy metals, bromids, iodids, arsenic, glycerin, acetates, antipyrin, acetanilid, acetphenetidin, caffein, emodin	none	
Citrates, lime, magnesia, soda, sulphates	none	

The *Compound* contains about 4.5 per cent of alcohol and 5.61 gms. of solids per 100 cc. 3.76 gms. of the latter are sugars, 0.38 gm. boric acid, with 0.90 gm. of vegetable extractives and an undetermined potassium salt equivalent to 0.37 gm. of potash. Oil of wintergreen (methyl salicylate) is present, and probably licorice.

The analysis indicates the presence of only an extremely small amount of medicament, certainly not sufficient to warrant the remedy's claim of being "the first known specific for Bright's Disease," for which disease of course there is no specific.

The following excerpts from the Company's literature illustrate the extravagance of its claims and its effort to frighten the ignorant into a belief that they are the victims of kidney disease.

"It is the first and only thing we know of that reduces inflammation and stops degeneration in the kidney tissue."

"While Fulton's Compounds have a proven efficiency of about 85 per cent in Bright's Disease and Diabetes, it is to be impressed on patients that what nature does slowly she undoes slowly and that in chronic cases very little is to be expected from the first three or four bottles; in fact, it commonly takes from four to six to begin to make a showing, and it often takes dozens to effect a cure."

"Loomis, of Bellevue Hospital, is on record as saying that from autopsies at Bellevue he believed that nine-tenths of men and women over forty have Bright's Disease in some form."

Among the dietary prohibitions properly recommended by the Company are included malt and spirituous liquors, in spite of the fact that the *Compound* is of about the same alcoholic strength as ordinary beer and ale.

Pierce's Anuric Tablets.

6721. *Dr. Pierce's Anuric Tablets for Kidneys and Backache,* World's Dispensary Medical Association, Buffalo, N. Y. Price 50 cents for 51 tablets, weighing on the average 7.79 grs.

Pink tablets of kidney form, with a bitter saline taste, and with a slight odor of aloes.

Loss at 100° C.	4.00
Ash	35.58
Reducing sugars, as dextrose	42.00
Citric acid	5.44
Iodin	0.70
Total nitrogen	1.52
Free ammonia	0.10
Alkaloids, chiefly cinchonin	2.30
Salicylic acid, about	1.00
Potassium oxid	16.54
Sodium oxid	0.40
Calcium oxid	3.74
Sulphuric anhydrid	0.56
Carbonates, potassium iodid, potassium bicarbonate, potassium citrate	present
Magnesia, phosphates, chlorids	traces
Hexamethylene tetramine	present
Oxymethylanthraquinons	present
Aloin	present
Quinin, cinchonidin	very slight
Acetates, tartrates, nitrates, acetanilid, acetphenetidin, antipyrin	none

These tablets consist essentially of potassium citrate, potassium bicarbonate, potassium iodid, calcium carbonate, hexamethylene tetramine, aloin, cinchonin (probably as sulphate), salicylic acid (probably as sodium salicylate), and sugar. The free ammonia reported is due to the decomposition of hexamethylene tetramine. The source of the salicylic acid is somewhat uncertain; salol (phenyl salicylate) could not be isolated; and the alcoholic extract had a slight odor of methyl salicylate.

In the pamphlet accompanying the remedy the manufacturer notes 78 symptoms of diseases of the kidneys. It is somewhat comforting, however, to be assured that "in no case are all these symptoms felt at one time," but the symptoms are so comprehensive as to lead almost any impressionable person to believe that he is the victim of kidney disease of some sort. Many of

these symptoms are commonly experienced by persons not suffering from any form of kidney disease. "Occasionally colicky abdominal pains," "low spirits," "worry," "nervous dyspepsia," "constipation," "headache," "vomiting," "short of breath," "fever," "itching," "redness of face," "loud breathing," "recurring attacks of bronchitis," "the arteries gradually become stiff," "ringing of ears," "sick feeling," and "poor appetite" are no certain symptoms of kidney disease, although they may at times accompany that malady. The publication of this staggering array of symptoms can have but one purpose, the scaring of the reader into the belief that he is seriously sick.

In referring to Bright's Disease the pamphlet states that "it is not to be expected that these tablets are a cure for all serious kidney diseases, when present in chronic form, but we have found them a great help, giving relief and comfort," but a later paragraph in the same section tells us that "the advantages we possess, and which are enjoyed by few doctors, have resulted in our perfecting methods of treatment and elaborating remedies, which are veritable specifics in this dangerous disease." In other words the tablets are not a "cure" but a "veritable specific," certainly contradictory statements.

In spite of the dangers of self-medication, especially in such a serious ailment as kidney disease, the manufacturer emphasizes the fact that the tablets can be purchased at any drug store, "or sent by mail anywhere," so that "every one who is afflicted with any form of urinary disease has at command reliable remedies which are sure to be of material service. No one will go astray by using them at least until consulting us, or until the necessity for other treatment is unmistakable." This last clause is a wonderfully clear exposition of the danger in using nostrums recommended for the treatment of serious diseases. Many diseases, taken in their earlier stages and treated intelligently, may be checked or even cured, whereas even a short delay caused by self-medication may be fatal and may reveal all too late the distressing fact that "the necessity for other treatment is unmistakable."

Uricol.

27569. *Uricol (Benoit's)*, The Uricol Co., New Haven, Conn. "An Eliminative Solvent for Uric Acid." Price 50 cents for 4.6 oz.

A dry, white powder with a saline taste.

Loss at 100° C.	3.58	K	trace
Na	25.20	Citric acid	45.16
SO_4	5.76	Carbon dioxid	3.48
PO_4	4.86	Ash	62.00
Cl	0.98	Salicylates, acetates, tartrates, nitrogen	none
Li	0.48		

From the above data the following hypothetical composition of *Uricol* may be calculated:

Loss at 100° C.	3.58	Sodium carbonate	8.17
Sodium phosphate	8.49	Sodium citrate	59.42
Disodium phosphate	7.11	Lithium citrate	1.40
Sodium chlorid	1.61	Water of hydration (by diff.)	10.22

Warner's Safe Remedy.

5497. *Warner's Safe Remedy for Kidneys and Liver and Bright's Disease,* Warner's Safe Remedies Co., Rochester, N. Y. "Alcohol 15.5 per cent." Price 50 cents for 7.7 fl. oz.

Spec. grav. at 15.6° C.	1.0236	
Alcohol by volume	15.20	
Solids	13.39	gms. per 100 cc.
Glycerin	9.56	" " "
Ash	1.31	" " "
Invert sugar	0.76	" " "
Vegetable extractives	1.76	" " "
Nitric nitrogen	0.144	" " "
= Potassium nitrate	1.04	" " "
Potash	0.78	
Phosphates, Cl, Fe, Ca, Mg	traces	
Tannin, horehound	present	
Bitter principle	present	
Taraxacum	(?)	
Emodin	none	
Alkaloids, bromids, iodids	none	
Reaction	acid	

The remedy contains 15.20 per cent of alcohol by volume, with 13.39 gms. of solids per 100 cc, 10.32 gms. of which are glycerin and sugar. Potassium nitrate, 1.04 per cent, is present as well as bitter principles and 1.76 gms. of vegetable extractives, among which hoarhound, tannin, and possibly taraxacum were identified.

This remedy, until quite recently exploited as a "cure" for

Bright's disease and other kidney and liver troubles, contains as its most essential ingredients alcohol and potassium nitrate, both contraindicated in kidney diseases because of their irritant properties. The manufacturer in referring to the importance of diet in Bright's disease advises the patient that all stimulating drink should be avoided and yet he supplies to the patient a preparation by taking which according to directions the sufferer will receive the equivalent of 1.25 oz. of whiskey per day.

The advertising of this Company, formerly blatant in its disregard for truth, to-day is more conservative, especially in the literature accompanying the medicine, and yet its effort to scare people into believing they are suffering from kidney affections is continued by such statements as the following:

"Consumption, pneumonia, typhoid fever, appendicitis and heart failure are physical and organic troubles, justly and rightly to be dreaded, but the annual mortality of all put together, we believe, does not equal that of kidney disease."

REMEDIES FOR SKIN AND COMPLEXION.

Creme Tokalon.

6730. *Creme Tokalon, Non-Greasy,* Tokalon, Paris. Price 50 cents.

A white cream with the odor of oil of rose geranium.

Solids	37.60
Ash	0.95
Glycerin	16.91
Fatty acids (stearic and palmitic)	19.90
Boric acid	0.89
Sodium	present
Heavy metals, nitrogen	none
Solubility in 95% alcohol	practically complete

The cream consists of about 79 per cent water and glycerin, 20 per cent stearic and palmitic acids, and 1 per cent of boric acid. The manufacturer claims that it contains predigested dairy cream and olive oil, while an American authority found Irish moss present. If any of the latter is present the amount must be extremely small as the material is practically completely soluble in 95 per cent alcohol. No attempt was made to identify the source of the fatty acids. The absence of nitrogen shows that *Tokalon* is not a casein cream.

Rexall Tan and Freckle Lotion.

6724. *Rexall Tan and Freckle Lotion,* United Drug Co., Boston. "For External Use Only, Poison." Price 25 cents for 1.68 fl. oz.

Spec. grav. at 15.6° C.	1.0344	
Solids	7.32	gms. per 100 cc.
Ash	2.78	" " "
Mercury	0.10	" " "
Boric acid	1.42	" " "
Glycerin	2.01	" " "
Alcohol	none	
Sulphites, or hyposulphites	present	
Chlorids, sodium	present	
Heavy metals, arsenic	none	
Gum, possibly	a trace	

The *Lotion* is a slightly perfumed aqueous-glycerin solution of mercuric chlorid (corrosive sublimate) with borax and an alkaline sulphite.

Corrosive sublimate is a dangerous poison, and while it will remove the freckles it will have the same effect on the skin itself.

REMEDIES FOR STOMACH AND BOWELS.

A-Lax Tablets.

6735. *A-Lax Tablets,* Raymond Chemical Co., Albany, N. Y. Price 25 cents per box of 27 tablets, each weighing on the average 3.38 grs.

Brown, chocolate-covered tablets, with a persistent bitter taste, and on grinding the odor of aloes.

Loss at 100° C.	6.00	Sulphuric anhydrid	6.40
Ash	31.61	Carbonates	present
Ash, insol. in acid	1.89	Manganese	trace
Sucrose	25.44	Strychnin, brucin	present
Invert sugar	trace	Belladonna alkaloids	(?)
Insoluble in 95% alcohol	69.79	Anthraquinons	present
Alkaloids	0.28	Aloin, resins	present
Iron oxid	4.64	Drug plant tissues	very slight
Calcium oxid	11.85	Starch	trace
Magnesium oxid	4.08	Phenolphthalein, capsicum	none

The tablets contain nux vomica, probably belladonna, aloin and possibly other vegetable cathartics, with an iron salt, calcium carbonate and magnesium sulphate.

The remarkable action of the tablets is shown by the following:

"They search every corner of the system, and will help fill you with new rich red blood, life and vigor, impart the glow of health to your cheeks, clear that sallow complexion and relieve that tired feeling; your steps become light and your eyes clear. They aid the stomach in digesting the food and strengthening the nerves. These tablets act as a tonic and blood purifier and must not be classed as a cathartic pill."

It is difficult not to class "as a cathartic pill" a preparation containing aloin and Epsom salt.

Analax.

6718. *Analax,* McKesson and Robbins, New York. "A Delicious Fruity Laxative." "Prepared from a vegetable base containing a high percentage of fruit acids and other vegetable products which have a decided aperient and regulating effect." Price 10 cents for 9 pastilles, weighing on the average 22.3 grs.

Pastilles covered with crystals of sugar, with a sweet, slightly acid taste, and with a strawberry-like flavor.

Loss at 100° C.	11.72	Organic acids (cc. N/10 NaOH per gm.)	1.15
Phenolphthalein	9.25	Citric and tartaric acids	present
Sucrose	45.19	Esters	present
Invert sugar	23.90	Starch	slight trace
Ash	0.26	Nitrogen	none
Gum tragacanth	2.24		

The pastilles each contain 2.17 grs. of phenolphthalein, 16.24 grs. of sugars, with gum tragacanth, citric and tartaric acids, and strawberry flavor.

The claims of the manufacturers are somewhat misleading as undue stress is placed on the presence of fruit acids, whereas the primary effect of *Analax* in relieving constipation is due to the familiar drug phenolphthalein.

Auto-Laks Chocolates.

6716. *Auto-Laks Chocolates,* Auto-Laks Mfg. Co., New York. Price 10 cents for 8 tablets, weighing on the average 21.8 grs.

Loss at 100° C.	1.26	Ash	2.03
Phenolphthalein	13.65	Ether extract	31.27
Sucrose	39.85	Starch	6.11
Invert sugar	trace	Chocolate	present

These are chocolate tablets containing 2.98 grs. of phenolphthalein, 8.69 grs. of sucrose and 1.33 grs. of starch per tablet.

This is one of the many phenolphthalein preparations now on the market. While phenolphthalein is a useful drug and in most cases a harmless remedy, the statement that *Auto-Laks* "is the only laxative known that will not cause any harm if taken habitually" is untrue, as the claim is equally applicable to most phenolpthalein and mineral oil preparations.

Bisuroids.

6733. *Bisuroids,* International Druggists and Chemists Laboratories, New York. Price 17 cents for 31 tablets, weighing on the average 3.04 grs.

Loss at 100° C.	3.24	Heavy metals	none
Phenolphthalein	67.44	Bismuth	none
Starch	25.27	Emodin	none
Ash	2.31	Alkaloids	none
Ash, insol. in acid	2.10		

A simple mixture of about two-thirds phenolphthalein and one-third starch and talc.

The name of the remedy shows a close resemblance to *Bisurated Magnesia* exploited by the same company, but unlike that preparation contains no bismuth. The manufacturers advise the purchaser that "it was found possible to incorporate all the valuable properties of the remedy in the form of a convenient small tablet," surely an illustration of consummate pharmaceutical skill.

Bonalax.

6734. *Bonalax (Roberts),* Practitioners Pharmacal Co., New York. Price 38 cents for 51 tablets, weighing on the average 6.67 grs.

Yellow, sugar-coated tablets with a sweet, licorice-ginger taste.

Loss at 100° C.	4.02	Magnesium oxid	3.80
Phenolphthalein	13.22	Sodium oxid	1.54
Sucrose	35.92	Potassium oxid	0.28
Invert sugar	trace	Carbonates, chlorids	present
Ash	14.21	Sulphates, phosphates, iron	traces
Ash insol. in acid	1.61	Licorice, ginger, starch	present
Insol. in 95% alcohol	44.02	Bile acids	present
Calcium oxid	3.52	Emodin, aloin, alkaloids	none

The tablets contain 0.99 gm. of phenolphthalein and 2.40 grs. of sugar per tablet, with bile acids, licorice, ginger and excipients.

Casca Beans.

4694. *Casca Beans,* P. J. Kellogg Co., Battle Creek, Mich. These tablets accompanied the sample of *Kellogg's Sanitone Wafers.* (See page 285.)

The sample consisted of 10 bean-shaped, chocolate-coated tablets, weighing on the average about 5 grs. per tablet.

Ash	16.87	Rhubarb, aloes, cascara	present
Ash insol. in acid	2.37	Licorice	probably present
Iron oxid	5.17	Capsicum	present
Manganese oxid	0.65	*Alkaloids	very slight amount
Calcium oxid	4.67	Calomel, arsenic	none
Insoluble carbonates	present		

The tablets consist of rhubarb, aloes, cascara, capsicum, and probably licorice, with iron carbonate, manganese oxid and calcium carbonate; a very small amount of an unidentified alkaloid is present.

The manufacturer lays great stress on the "damage done by cathartics" and calls attention to the fact that "there is a raft of stuff sold as laxatives and cathartics that are a positive curse to the human body. Among these cruel bowel-paralyzers are calomel, blue moss, aloes, croton oil, jalap, gamboge and some others." It is, therefore, somewhat disturbing to find of these "cruel bowel-paralyzers," aloes, present in *Casca Beans.* The manufacturer again lays stress on the presence of the "Sacred Bark," a popular name for *Cascara sagrada.* Cascara is present in the remedy, but its newness as a laxative drug is much overstressed.

Ex-Lax.

6717. *Ex-Lax,* Ex-Lax Mfg. Co., New York. "A Chocolate Laxative." Price 19 cents per box of 18 tablets, weighing on the average 23.9 grs.

Loss at 100° C.	1.03	Invert sugar	trace
Phenolphthalein	9.67	Starch	2.90
Ash	1.12	Ether extract	34.92
Sucrose	44.03	Chocolate	present

* Could obtain no reaction for quinin, strychnin or belladonna alkaloids.

Tablets of sweet chocolate containing 2.31 grs. of phenolphthalein, 10.52 grs. of sucrose and 0.69 gr. of starch per tablet.

Ex-Lax is simply phenolphthalein incorporated with sweet chocolate, and whatever virtues it may possess are shared equally by that important drug.

Lax-A-Tone.

7182. *M. J. Kraus' Herbal Lax-A-Tone,* T. G. Walton and Co., Chicago. "A purely Herbal Extract carefully prepared from a proper selection of the Herbs, Roots, Barks, Leaves and Blossoms that cleanse and strengthen the human system." Price one dollar for 6.6 fl. oz.

A brown turbid liquid with an alcoholic, senna-like odor, and with a bitter taste.

Spec. grav. at 15.6° C.	1.0735	
Alcohol by volume	9.74	
Solids	21.51	gms. per 100 cc.
Cane sugar	7.21	" " "
Invert sugar	5.75	" " "
Ash	1.54	" " "
Calcium oxid	0.40	" " "
Carbonates	present	
Rhubarb	present	
Cascara, senna, aloes	prob. present	
Phenolphthalein	none	
Alkaloid, unidentified	trace	
Bitter principles	present	
Other vegetable extractives	present	
Glycerin	none	

Lax-A-Tone is simply an alcoholic, sweetened infusion of vegetable drugs among which rhubarb seems to predominate; cascara, senna and aloes, as well as other unidentified vegetable drugs are probably present. The total vegetable extractives amount to about 7 gms. per 100 cc.

This remedy has been widely advertised in the local newspapers during the past year and wonderful testimonials have been offered attesting its efficacy. As long as constipation continues to be the popular American ailment, various mixtures of well-known cathartics, whether they be named *Lax-A-Tone* or some other fanciful name, will doubtless find a ready sale, even if the misguided user is obliged to pay $5.00 a quart, a cham-

pagne price, for them. Moreover, the habitual user of cathartic drugs should remember that he is simply laying up trouble for himself in the future.

Laxol.

6720. *Laxol,* A. J. White, New York. "99 per cent Cold Pressed Castor Oil made Palatable by the addition of 1 per cent of sweetening and flavoring." Price 25 cents for 3.2 fl. oz.

Spec. grav. at 15.6° C.	0.9630	Castor oil	present
Iodin No.	87.8	Oil of peppermint	present
Refractive index at 25° C.	1.4758	Saccharin	present
Alcohol solubility	complete	Color	pale yellow

The preparation consists of castor oil sweetened with saccharin and flavored with oil of peppermint. The claims made for *Laxol* are conservative.

Limestone Phosphate.

6719. *Limestone (Brand) Phosphate,* Limestone Phosphate Co., New York. Price 35 cents for 4.1 oz.

A fine, dry, white powder, showing a strong effervescence on the addition of water with evolution of carbonic acid gas.

Sodium (Na)	23.84	Lime, if any	very slight trace
Phosphoric acid (PO_4)	56.69	Chlorids, sulphates	traces
Carbon dioxid	12.42	Organic acids	none
Insoluble in water	0.02	Nitrates, potassium	none

This preparation is a mixture of monosodium phosphate and sodium bicarbonate, with possibly a small amount of disodium phosphate. It contains no organic acids and not more than a very slight trace of lime.

The use of the word "Limestone" in connection with this preparation is totally unwarranted, and is most misleading in spite of the word "brand" which appears on the package in small letters.

The reaction between monosodium phosphate and sodium bicarbonate in the presence of water is a simple one, carbonic acid being evolved and disodium phosphate and water remaining. Disodium phosphate has been used by physicians as a mild purgative for over a century. The only possible advantage we can see

in the use of *Limestone Phosphate* is the securing the effect of the disodium phosphate, the U. S. P. drug, without the use of organic acids. *Limestone Phosphate* will have the same effect in preventing auto-intoxication as Sodium Phosphate, U. S. P., no more, no less.

Stuart's Calcium Wafers.

4695. *Stuart's Calcium Wafers Compound,* F. A. Stuart Co., Marshall, Mich. Price 50 cents for 125 wafers weighing 157.4 grs.

Brown wafers with a fetid odor after grinding.

Loss at 100° C.	2.62	Reducing sugars, as dextrose	48.72
Ash	25.15	Alcohol extract	24.50
Ash insol. in acid	0.36	Total alkaloids	0.62
Iron and aluminum oxids	1.36	Strychnin	present
Calcium oxid	15.20	Aloes, or aloin	present
Total sulphur as SO_3	17.12	Carbonates	present
Sulphate sulphur as SO_3	4.29	Starch	present
Magnesium oxid	0.51	Chlorids, phosphates	none

The wafers consist essentially of calcium sulphid, aloes (or aloin), a strychnin preparation, and excipients.

Calcium sulphid some years ago had vogue among certain physicians as an alleged "blood-purifier." The U. S. P. does not consider the drug of sufficient importance to deserve recognition, and whatever virtues the wafers may possess are doubtless due to the cathartic action of the aloes and the stimulating effect of strychnin.

Tanlac.

8003. *Tanlac,* The Cooper Medicine Co., Dayton, Ohio. "18 per cent alcohol by volume." Price one dollar for 8.3 fl. oz.

A brown, vinous liquid with the bitter taste of gentian.

Spec. grav. at 15.6° C.	1.0231	
Alcohol by volume	17.95	
Solids	10.74	gms. per 100 cc.
Ash	0.32	" " "
Sucrose	8.00	" " "
*Alkaloids	0.168	" " "

* This residue was apparently from a berberin-like alkaloid; no reactions for quinin or strychnin were given.

Tartaric acid	0.37	gms. per 100 cc.
Glycerin	small amount	
Rhubarb, gentian	present	
Licorice, cascara	prob. present	
Phenolphthalein	none	

Tanlac, therefore, is apparently simply a sweetened wine, containing rhubarb, gentian and probably licorice and cascara, with a small amount of an alkaloid of the berberin type.

For many months a vigorous advertising campaign has been waged for this remedy in our newspapers. Fabulous cures have been recorded and, if the carefully edited testimonials were to be believed, in *Tanlac* long-suffering humanity is given a panacea for all its ills. The analysis, however, unfortunately solves the *Tanlac* mystery, and shows it to be a simple wine containing laxatives and bitter principles.

Tanlac Laxative Tablets.

8003. *Tanlac Laxative Tablets,* The Cooper Medicine Co., Dayton, Ohio.

These accompanied the sample of *Tanlac* and are supposed to be taken in connection with it. The sample was too small for quantitative determinations, as it consisted of only four brown, coated tablets, weighing on the average 6.56 grs. The presence of the following substances was indicated: cascara, resin, sugar, carbonates, iron, licorice and possibly aloes; phenolphthalein, capsicum, ginger and alkaloids were not present.

It would seem that the manufacturer has so little confidence in the laxative properties of the wine that it is necessary to supplement it with these cathartic tablets.

TONICS.

Mark Tonic Bitters.

6785. *Mark Tonic Bitters,* Henry Thayer and Co., Cambridge, Mass. "Alcohol 18 per cent." "Contains gentian root, cardamon, nutmeg, allspice, bitter orange, quassia, kola nut, cascara bark, sweet flag." Price 50 cents for 7.8 fl. oz.

Spec. grav. at 15.6° C.	1.0417	
Solids	17.86	gms. per 100 cc.
Glycerin	1.61	" " "
Ash	0.54	" " "
Sucrose	1.25	" " "
Invert sugar	10.07	" " "
Total nitrogen	0.042	" " "
Vegetable extractives	4.13	" " "
Iron (Fe)	0.004	" " "
Phosphoric acid	0.048	" " "
Alcohol by volume	18.84	
Chlorids, sulphates, lime, magnesia	traces	
Allspice, cardamon, cloves, bitter orange, oil of bay	present	
Bitter principles	present	
Oxymethylanthraquinons	none	
Alkaloids	none	
Bromids, iodids	none	
Reaction	acid	

These bitters contain 18.84 per cent of alcohol by volume, with 17.86 gms. of solids per 100 cc, of which 10.93 gms. are sugars and glycerin and 4.13 gms. vegetable extractives. Among the latter were identified allspice, cardamom, cloves, bitter orange and other bitter principles. A trace of iron was present, but no alkaloids.

Nuxated Iron.

6728. *Nuxated Iron,* Dae Health Laboratories, Detroit. "Organic iron in the form of ferrum peptonate in combination with nux vomica, phospho-glycerate de chaux and other valuable ingredients." Price one dollar for 60 tablets weighing on the average 4.65 grs.

Brown tablets with the odor of cinnamon and with an intensely bitter taste.

Loss at 100° C.	4.58	Cinnamon, or cassia	present
Ash	38.08	Carbonates	present
Ash insol. in acid	2.08	Cascara	present
Iron oxid	0.80	Calcium glycerophosphate	present
Calcium oxid	8.16	Resin	present
Phosphoric acid	9.20	Vegetable tissue	slight
Alkaloids (nux vomica)	0.155	Starch, Mg, K, Cl, Na, SO_3	traces
Nitrogen	2.34	Sugar, capsicum, aloin, phenolphthalein	none
Strychnin, brucin	present		
Peptonates	present		

The composition claimed for this remedy, as far as ingredients are concerned, is substantially confirmed by our analysis. The impressiveness of "phospho-glycerate de chaux," however, is lost to a considerable degree when translated into its English equivalent, calcium glycerophosphate.

The tablets consist essentially of calcium glycerophosphate, iron peptonate, a nux vomica preparation and cascara. The therapeutically important ingredients present are the iron and nux vomica. We find, however, only 1/40 gr. of iron and 1/140 gr. of nux vomica alkaloids per tablet, almost negligible amounts, especially of the latter. The whole box of 60 tablets, costing one dollar, contains only about 1.5 grs. of iron. One of the best known official iron preparations is *Blaud's Pills,* and these can be purchased at any drug store for from 50 to 75 cents per 100, and they will supply 48 grs. of iron.

"The exploiters of 'Nuxated Iron' would have the public believe that iron is the one thing that most ailing people need. Nothing could be much further from the truth. Iron is a useful and valuable drug in selected cases, but the conditions for which it may be used are limited. The indiscriminate use of iron is illogical and unwise. The claim that 'Nuxated Iron' possesses great advantages over other forms of iron is the sheerest advertising buncombe." *Jour. Amer. Med. Assoc., Oct. 21, 1916, p. 1244.*

The newspaper exploitation of this remedy is mendacious in the extreme. Were one to believe the statements made in these advertisements, it would be necessary to attribute Ty Cobb's success as a baseball artist and Jess Willard's prowess in his contests with Frank Moran and Jack Johnson, solely to these little tablets with their 1/40th grain of iron and their trace of nux vomica alkaloids.

Paine's Celery Compound.

5492. *Paine's Celery Compound,* Wells, Richardson Co., Burlington, Vt. "Alcohol 19.85 per cent." "Contains celery seed, calisaya bark, cascara sagrada, senna leaves, prickly ash bark, sarsaparilla root, hops, ginger root, dandelion root, mandrake root, blackhaw, gentian root, chamomile flowers, black cohosh root, yellow dock root, potassium nitrate, glycerin, sugar and water." Price one dollar for 15.2 fl. oz.

Solids	13.71	gms. per 100 cc.
Glycerin	5.96	" " "
Ash	0.82	" " "
Sucrose	4.01	" " "
Invert sugar	1.45	" " "
Potash	0.47	" " "
Nitric nitrogen	0.114	" " "
= Potassium nitrate	0.79	" " "
Vegetable extractives	1.47	" " "
Cl, Fe, SO_3, Ca, Mg, P_2O_5	traces	
Senna, ginger, celery, sarsaparilla, blackhaw	present	
Bitter principles	present	
Alkaloid (unidentified)	present	
Iodids, bromids	none	
Reaction	acid	
Spec. grav. at 15.6° C.	1.0248	
Alcohol by volume	18.48	

This remedy contains 18.48 per cent of alcohol by volume with 13.71 gms. of solids per 100 cc, of which 11.42 gms. are glycerin and sugars. It also contains 0.79 per cent of potassium nitrate and 1.47 gms. of vegetable extractives, among the latter senna, ginger, celery, sarsaparilla and blackhaw being identified. Bitter principles and a small amount of an unidentified alkaloid are also present.

The list of fifteen vegetable drugs of more or less efficacy given on the label loses much of its impressiveness when it is seen that the total amount of vegetable extractives is less than 1.5 per cent. The manufacturers lay great stress upon the use of celery in cases of nervous prostration, general debility and kindred diseases, but it is somewhat disturbing to note that celery is not included among the official drugs of the U. S. P.; in spite of the worthlessness of many there recognized. Aside from the bitter principles supplied and their consequent tonic effect, it is difficult to see how the small amounts of vegetable extractives, the alleged product of fifteen different drugs, can have any very distinct value. The presence of 18.5 per cent of alcohol is more impressive than the traces of vegetable drugs present.

In spite of its long existence on the market, the manufacturers tell us that

"after much experimenting and research we are able to say to our friends that such a revised formula has been adopted by us and we feel free to

say that for real medicinal merit it stands at the head of remedies of its kind."

This last clause of course means little, but the earlier part of the statement again illustrates the changing formulas of proprietary medicines and the impossibility of depending upon any constancy in their composition.

Rexall Celery and Iron Tonic.

5491. *Rexall Celery and Iron Tonic,* United Drug Co., Boston. "Alcohol 25 per cent." "A General Blood Tonic in Conditions of Debility." Price 75 cents for 15.5 fl. oz.

Spec. grav. at 15.6° C.	1.0176	
Alcohol by volume	23.36	
Solids	12.24	gms. per 100 cc.
Glycerin	1.92	" " "
Ash	0.38	" " "
Sucrose	3.66	" " "
Invert sugar	4.39	" " "
Nitrogen, 0.04 = protein	0.25	" " "
Vegetable extractives	1.64	" " "
Fe, P_2O_5, Cl, SO_3, Ca, Mg	traces	
Capsaicin (or piperin), celery, cardamon	present	
Alkaloid (unidentified)	present	
Bitter principle	present	
Oxymethylanthraquinons	present	
Salicylates, iodids, bromids	none	
Reaction	acid	

This tonic contains 23.36 per cent of alcohol by volume with 12.24 gms. of solids per 100 cc, 9.97 gms. of which consist of sugars and glycerin. Capsaicin (or piperin), celery, cardamom, a cathartic drug, a bitter principle, and possibly other vegetable extractives are present; a small amount of an unidentified alkaloid is also indicated; only a trace of iron (0.008 gm. per 100 cc) is present. Whatever value this tonic possesses must rest upon other drugs than those which are given prominence in its name.

Rexall Wine of Peruvian Bark.

6786. *Rexall Wine of Peruvian Bark,* United Drug Co., Boston. "Alcohol 22 per cent." Price one dollar for 15.3 fl. oz.

Spec. grav. at 15.6° C.	1.0225	
Alcohol by volume	21.42	
Solids	12.82	gms. per 100 cc.
Glycerin	1.05	" " "
Ash	0.32	" " "
Invert sugar	9.40	" " "
Total nitrogen	0.044	" " "
Vegetable extractives	1.77	" " "
Quinin	present	
P_2O_5, Cl, SO_3, Ca, Mg	traces	
Emodin	none	
Iodids, bromids	none	
Reaction	acid	

The preparation contains 21.42 per cent of alcohol with 12.82 gms. of solids per 100 cc, of which 10.45 gms. are sugar and glycerin and 1.77 gms. vegetable extractives, probably derived chiefly from Peruvian bark; quinin alkaloids are present.

It is a fortified wine containing quinin as a tonic.

MISCELLANEOUS REMEDIES.

Kellogg's Sanitone Wafers.

4694. *Kellogg's Sanitone Wafers,* F. J. Kellogg Co., Battle Creek, Mich. "One of the Greatest Nerve Vitalizers Ever Known. Unequalled Strengthener For Mind and Body." Price one dollar for 21 tablets weighing on the average 12.8 grs. per tablet. The package also contained ten *Casca Beans* (see page 276).

Orange colored, sugar-coated tablets.

Total ash	28.93	Sucrose	32.00
Ash insol. in acid	18.20	Phenolphthalein	1.44
Chromium oxid (Cr_2O_3)	16.72	Carbonates in original	present
= Chromium	11.44	Carbonates in ash	trace
Calcium oxid	4.08	Emodin	none
Iron oxid	0.86	Capsicum	none
Total sulphate by $BaCl_2$	17.29	*Alkaloid	slight
Total sulphate by fusion	20.47	Loss at 100° C.	7.98
Sulphate in ash	6.18		

The tablets contain chromium as a sulphate, phenolphthalein, and a trace of an alkaloid-bearing constituent, with calcium car-

*No reaction obtained for quinin or strychnin.

bonate and sugar as excipients. The small amount of iron found is probably present as an impurity in the chromium sulphate, and the undetermined matter is probably simply water of hydration.

Authorities on therapeutics are strangely silent on the virtues of chromium sulphate, which the manufacturer hails in these enthusiastic words:

"The success of this new discovery, contained in Kellogg's Sanitone Wafers, has been determined by its results on a dilapidated array of nervous wrecks; some in the first stages of nervous prostration; some trembling like leaves;—some with punctured ambitions;—some with nerves like limp spaghetti, with memory gone, clear-thinking gone;—some victims of alcohol, and some in the final stages of ruin, locomotor ataxia."

"What have we to say about its effect on a man who had for ten years locomotor ataxia, the worst possible condition into which the nerves may lapse, and by the aid of this great discovery was able in a comparatively short time to walk without assistance,—a circumstance which has compelled the attention of scientists and physicians in many parts of this country and other countries?"

Among the ailments for which the Wafers are especially recommended are lack of energy, lack of ambition, lack of self-confidence, weakness of old age, nervous prostration "even in its most serious and hopeless stage," and paresis. One would almost think that an aphrodaisiac were being recommended.

"In all forms of nervous afflictions—Kellogg's Sanitone Wafers stand out as the most powerful, lasting, striking, curative nerve-strengthener now known. Of this there is no question. There has been no form of treatment known heretofore as a remedy for locomotor ataxia—absolutely none. But this new discovery contained in Kellogg's Sanitone Wafers is the only known treatment so far known to science which has been able to produce striking changes in this disease."

According to the manufacturer these Wafers are not only indispensable for the sick, but also for those who are well, "for you and every grown member of your family."

"Even on healthy nerves, the curative effect of Kellogg's Sanitone Wafers should prove their almost unbelievable power. Neither you nor any grown member of your family will ever be able to fully realize the exquisite sensation of high nerve-power and all the brightness, bounding force and supreme happiness which they should bring in every detail of life, until after using Sanitone Wafers for a time."

The language is somewhat guarded but again the aphrodaisaical suggestion.

The value (?) of this remedy is best shown by the methods used in its exploitation.

"The reader is advised that a 'fifty cent trial package' will be sent free to anyone who applies for it. Those who write for the free samples receive a small box in which are a few orange-colored tablets, and by the same mail a larger box containing a 'complete thirty days' treatment' for which $5 is asked. If no further notice is taken of the Kellogg concern, the unwilling recipient of the $5 'treatment' is bombarded with a series of fellow-up letters each succeeding letter being more insistent than its predecessor in urging that the money be sent for the treatment. Like all mail-order medical fakers, Kellogg has a sliding scale of prices. The first two letters ask $5 for the 'treatment' that was sent unasked; the third and fourth letters offer to accept $3.50 while the fifth and sixth letters inform the prospective victim that a mere $2.50 will square the account. The sixth letter ends with the statement 'This is final,' and, apparently it is, for no further reduction in the price of the treatment is made and neither is the postage sent for the return of the $5 treatment. As it only takes four cents to send the $5 treatment by mail, and as, apparently, the Kellogg company would lose money by sending the four cents for the return of the treatment that was sent unasked, the evident value of this $5 package of pills is less than four cents." *Nostr. and Quack., 1912, p. 385.*

PARMINT.

6727. *Parmint, Double Strength,* International Laboratories, Binghamton, N. Y. "Alcohol 12 2/3 per cent, chloroform 8 min. per fl. oz." Price 75 cents per fl. oz.

A reddish liquid with a strong odor of anise, and with a burning, sweet taste.

Solids	46.00	gms. per 100 cc.
Glycerin	16.68	" " "
Sucrose	20.63	" " "
Ash	0.11	" " "
Chloroform	0.65	" " "
Spec. grav. at 15.6° C.	1.1353	
Alcohol by volume	13.10	
Oil of anise	present	
Other volatile oils (camphor, eucalyptol (?))	present	
Alkaloid, unidentified	trace	
Cochineal	present	

Parmint appears to be an alcoholic solution containing sugar, glycerin, a small amount of chloroform, and a mixture of volatile

oils with oil of anise predominating. Certainly the analysis fails to reveal "the secret of the great success of Parmint."

The solicitude of the manufacturer for the sufferer from catarrh is indeed touching:

"To rid the system of Catarrhal poison and heal all affected parts, and to cleanse and purify the blood, generally requires from 4 to 12 weeks' time. The treatment must be taken without interruption. Not a dose should be skipped and you positively must not allow any lapse of time when you have finished one bottle before starting another.—A break of this kind in leaving off the treatment means a loss of much of the good already done by the medicine, and allows a setback that is unnecessary and useless.—When you start to drive this loathsome disease, Catarrh, from your system, don't stop until you feel sure you have succeeded. Your feelings will be the best guide and will tell you when you are cured."

The above words simply state in another way, what we have often said in connection with other nostrums, if the remedy does not cure you it is your fault, not the medicine's.

Protone.

4707. *Protone,* The Protone Co., Detroit, Mich. "The New Flesh Builder." Price one dollar for 25 tablets and 21 gelatin globules. The average weight of the tablets was 9.91 grs., that of the globules 9.52 grs.

Analysis of Tablets.

Loss at 100° C.	2.80	Sucrose	50.84
Ash	18.89	Invert sugar	4.92
Ash insol. in acid	7.74	Ether extract	16.91
Phosphoric acid, total	4.81	Total nitrogen	0.52
Phosphoric acid, in ether extr.	0.48	= Protein	3.25
Phosphoric acid, water-sol.	0.52	Sulphates, chlorids, carbonates	slight
Calcium oxid	4.64	Hypophosphites	none
Sodium oxid	1.08		
Potassium oxid	0.30		

The percentage of phosphoric acid is rather high, and we find 0.48 per cent of this in the ether extract, indicating the probable presence of a phosphatid of the lecithin type, or a soluble glycerophosphate; there is also 0.52 per cent of water-soluble phosphoric acid. The ash is chiefly calcium phosphate, which again may be derived from calcium glycero phosphate.

Analysis of globules.

These contained a bark brown oil, with the odor of oil of wintergreen, and a black tablet suspended therein. Six capsules yielded about 1.6 cc of this oil. The tablets had a persistent, bitter, distinctly ferruginous taste. Freed from oil they averaged 0.115 gm. in weight.

The oil on heating at 100° C. lost 1.82 per cent, oil of wintergreen being given off. At least 98 per cent was a fixed oil having the characters of castor oil. The oil also contained a cinchona alkaloid, probably cinchonin.

The tablets in the oil contained 41.60 per cent of ash, 6.41 of ash insoluble in acid, 16.83 of iron oxid and 7.91 of calcium oxid; sulphates and carbonates were present as well as iron in the metallic state. The tablets contained reduced iron, iron sulphate, calcium carbonate, and a cinchona alkaloid, probably cinchonin.

Protone is offered to the public as a means for increasing one's weight.

"Protone, remarkable as the fact may appear, contains the main constituent of the cell tissues of the body, scientifically prepared so that it can be taken internally like any ordinary treatment. This is the reason why it can produce such prompt results—it enters almost immediately into the blood circulation and induces from the very beginning of the treatment an increase in weight and a strengthening of the whole nervous system."

The above doubtless refers to the phosphoric acid, probably in the form of a glycerophosphate. The excessive claims made for the glycerophosphates have become very familiar, due to the wide advertising of *Sanatogen* and similar nostrums.

"Protone should be taken alone. Nothing else is needed but Protone, and no diet is necessary."

"Protone is calculated to affect every case of leanness, and it needs but a faithful adherence to the treatment to bring about a successful result."

"Massages, developers, creams, cosmetics, and similar treatments produce but a superficial stimulation, and necessarily cannot *produce* flesh. Internal treatments, such as cod liver oil, milk, emulsions of various kinds, do not serve to distribute over the body the tissue material that *is* formed from digestion."

The daily dosage of *Protone* is 3 of the globules and 4 of the tablets, a total of 69 grs. or about one-eighth of an ounce. The

preparation undoubtedly contains certain tonic principles and may stimulate the appetite, but that the daily use of one-eighth of an ounce of its ingredients will produce the wonderful increases in weight claimed certainly strains our powers of credulity. "Nothing else is necessary" is claimed for *Protone* over and over again in its literature.

The following excellent advice given by the manufacturer probably indicates the reason for any favorable effect from its use:

"Try to cultivate a cheerful disposition, go about your work as usual, avoid intoxicants as much as possible, keep away from the scales except once a week, and you should then without fail begin to notice a distinct improvement in your general condition, your nerves should grow more steady, your mind quicker, your complexion clearer, your carriage become more erect, your self-confidence become stronger, and with it all pound by pound should be gradually added to your weight, your cheeks begin to fill out, wrinkles to disappear, shoulders and chest to develop, the whole body to round out with firm, solid flesh, and your health become firmly established."

And yet heretics tell us "The age of miracles is past."

According to *Nostrums and Quackery, 1912, p. 387,* the Protone Co. is owned by Frank J. Kellogg, whose *Sanitone Wafers* have been discussed on another page. The method of selling the two preparations by mail are very similar. On asking for a free fifty cent package, as advertised, the inquirer also receives a "six weeks' treatment," for which $5 is asked. This price is gradually scaled down from $5 for six boxes to $3 for six boxes, then $1.66 for three boxes and finally twelve boxes are offered for $2.50. Such a method of doing business clearly indicates the true nature of the preparation.

Pyorrhocide.

6729. *Pyorrhocide,* The Dentinol and Pyorrhocide Co., New York. "A Powerful Antiseptic, Deodorant and Prophylactic Tooth Powder. Universally prescribed by The Dental Profession in the treatment and prevention of Pyorrhea alveolaris." Price one dollar for 3.14 oz.

A fine, reddish-brown powder with the odor of sassafras and wintergreen.

Loss at 100° C.	6.16	Fatty acids and resin	6.79
Ash	65.93	Ground vegetable drugs (approx.)	22.76
Ash, insol. in acid	5.73	Alkaloids	0.394
Calcium oxid	30.50	Carbon dioxid	much
Magnesium oxid	3.08	Cinchona alkaloids	present
Sodium oxid	2.30	Ipecac alkaloids	present
Potassium oxid	0.25	Oil of sassafras	present
Boron, as boric acid	4.59	Oil of wintergreen	present
Ether extract	3.19	Soap	present
95% alcohol extract	9.71		

Insoluble ash. This was of the nature of quartz-like grit, probably existing as an impurity of the ground vegetable drugs.

Ether extract. This was chiefly oils of sassafras and wintergreen. On saponification with alcoholic potassium hydroxid and extracting with ether, unsaponified oil identified as oil of sassafras was found. The alkaline solution was then acidified and shaken out with ether, the ethereal residue giving reactions for salicylic acid, present as methyl salicylate (oil of wintergreen).

95 per cent alcohol extract. This was a brown residue, with the odor of sassafras and also with a peculiar nauseous odor. It was of a soap-like character, producing a foam when shaken with water, and on the addition of dilute acid free fatty acids contaminated with resinous matter were separated.

Alkaloids. The acid-soluble portion of the 95 per cent alcohol extract was made alkaline with ammonia and extracted with chloroform. On evaporating the chloroform an impure brown, non-crystalline alkaloidal residue was obtained, which gave reactions indicating the presence of alkaloids from ipecac and cinchona.

Vegetable drugs. Microscopical examination showed powdered sassafras, ipecac and red cinchona, with quartz grains.

From the above data *Pyorrhocide* appears to be a mixture of chalk, borax, soap, and ground cinchona, ipecac and sassafras (containing considerable mineral impurity), flavored with methyl salicylate.

In recent years emetin (as hydrochlorid), an alkaloid contained in ipecac, has had much vogue as a remedy for pyorrhea alveolaris (Riggs' disease). Quinin is also recognized as a highly efficient amoebacide. *Pyorrhocide* contains both cinchona and ipecac in the form of the ground drugs, but whether their

alkaloids would be as effective in this condition we are not prepared to say.

The manufacturers of this product take a refreshingly enlightened attitude, as is evidenced by the following statement:

"Notwithstanding the fact that Pyorrhocide is singularly efficacious in pyorrhea alvéolaris, if used in due time with proper regularity, it should be borne in mind that the services of a competent dentist are of great importance in every instance."

Quaker Herb Extract.

6787. *Quaker Herb Extract,* The Quaker Herb Co., Cincinnati, Ohio. "Alcohol 18 per cent." "The Great Quaker System Purifier and Worm and Germ Destroyer." Price one dollar for 12.2 fl. oz.

Solids	8.29	gms. per 100 cc.
Glycerin	0.88	" " "
Ash	2.89	" " "
Magnesium oxid	0.48	" " "
Sodium oxid	0.84	" " "
Potassium oxid	0.17	" " "
Sulphuric anhydrid	1.35	" " "
Sucrose	0.29	" " "
Invert sugar	1.60	" " "
Total nitrogen	0.062	" " "
Vegetable extractives	2.24	" " "
Spec. grav. at 15.6° C.	1.0258	
Alcohol by volume	16.92	
P_2O_5, Cl, Fe_2O_3, CaO	traces	
Licorice (much)	present	
Rhubarb (much)	present	
Tannin	present	
Bitter principle	present	
Aloes, or aloin	probably	
Santonin, salicylates	none	
Reaction	neutral	

A vigorous advertising campaign in connection with this remedy has recently been conducted through the local newspapers, and tapeworms of fabulous size have been displayed in the windows of one of our drug stores as testimonials of its wonderful efficacy. It is strongly alcoholic, containing nearly 17 per

cent, and contains 8.29 gms. of solids per 100 cc. These solids are made up of sugars and glycerine, mineral matter, and vegetable extractives in nearly equal proportions. The extractives contained much licorice and rhubarb with tannin; and a bitter principle, and probably aloes (or aloin). The ash shows considerable amounts of magnesia, soda potash and sulphates, but we are unable to determine the manner in which these were combined, although the presence of some magnesium sulphate (Epsom salt) was strongly indicated. No santonin or salicylate was detected.

The analysis shows the presence of no remarkable therapeutic agents. Licorice has value as a demulcent, while rhubarb is useful as a tonic, laxative and astringent and the cathartic properties of aloin are well-known. The extractives from these three drugs, however, present in the remedy amount to only about two per cent. Just what gives the medicine its wonderful power as a "Germ Destroyer" our analysis fails to disclose. Great emphasis is placed on the purely vegetable character of the Quaker remedies, yet in this preparation we find over one-third of the total solids to be in the mineral form, with a strong suspicion that Epsom salt is one of its ingredients.

Quaker Herb Extract is recommended for a very long list of ailments, including catarrh, liver, kidney and bladder complaints, rheumatism, neuralgia, malaria, constipation, general debility, falling of the womb, leucorrhoea, change of life, worms, and, inferentially, for pneumonia, bronchitis and consumption. Perhaps licorice, rhubarb and aloes will effect cures of these diseases, but our doubts on this subject are great indeed.

FOOD AND DRUG PRODUCTS EXAMINED FOR THE DAIRY AND FOOD COMMISSIONER.

Eight hundred and eighty-six samples were examined for the Dairy and Food Commissioner. Of the total number examined, 533 were not found to be adulterated, 42 were legally labeled compounds, and 311 were adulterated, misbranded or below standard.

Butter and Butter Substitutes. Of 349 samples examined 247 were genuine butter, 83 renovated butter and 19 oleomargarine.

Cider. The single sample examined contained no chemical preservative.

Clams. Eleven samples were examined for added water, including 7 samples of long clams and 4 of round clams. The Maine authorities hold that clams, presumably long clams, should contain at least 18 per cent of solids with not more than 12 per cent of free liquor. No standards for round clams are given, but apparently much more free liquor is to expected with this kind of clams. According to the Maine standard only one of the seven samples of long clams was satisfactory both as regards solids and free liquor. **11009** carried only a small amount of free liquor but the solids were suspiciously low; with **11029** the reverse was true. **11008** and **11029** were the only samples showing a high content of salt in the liquor. **11015** and **11022** are especially worthy of attention as they contained only 12.1 and 9.8 per cent of solids with 35.0 and 35.1 per cent of free liquor, respectively; they both gave decided evidence of watering.

The round clams showed more uniformity in composition. **11025**, however, was badly decomposed when received in the laboratory.

No.	Drained Clams. gms.	Liquor. gms.	Per Cent Liquor.	In Clams. Solids. %	Ash. %	Salt. %	In Liquor. Salt. %	Loss on Boiling. %
Long clams.								
11008	440	25	5.4	22.2	1.82	0.19	1.25	68.5
11009	404	27	6.3	15.1	1.14	0.05	0.23	64.3
11015	285	169	35.0	12.1	1.02	0.07	0.29	61.0
11022	303	164	35.1	9.8	0.80	0.20	0.55	70.1
11023	404	61	13.1	17.8	1.24	0.21	0.54	60.2
11028	417	41	8.9	16.3	1.26	0.24	0.68	62.2
11029	355	122	25.6	20.7	2.46	0.79	2.17	46.1
Round clams.								
11010	189	278	59.5	20.7	2.19	1.14	2.53	46.2
11014	165	288	63.6	20.9	2.25	1.09	2.58	49.8
11018	161	267	62.4	18.6	2.43	1.29	2.61	52.8
11025*	194	294	60.4	20.9	3.30	1.23	2.50	57.2

Coffee. Eighteen brands of ground coffee were examined, all of which were free from adulteration. These brands were as follows:

Arbuckle's Yuban.
Beatsall.
Brownie.
Famous Royal Scarlet.
Frazier's Mascot.
Gold Coin.
Gate's Pioneer.
Grand Union Turkish Style.
Kar-A-Van El Perco.
Kay-Bee.
Lincoln's Capitol Mills.
Lincoln's Union Club.
Lipton's Perfection Blend.
Moody's Morning Glory.
Relicco.
Van Dyk's Duchess.
Weir's Skyline.
Weir's White Squadron.

Cordial Chocolates. Four samples were examined, which contained in the liquor 0.51, 0.79, 1.07 and 0.86 per cent of alcohol by weight. Under the law all of these were therefore adulterated.

Eggs. One sample of eight eggs was examined with the following results:

No.	Air Space.	Break.	Gain or Loss on Boiling. gm.
1	Prominent	.....	—0.08
2	Large	White watery, yolk settled	0
3	Large	Yolk flattened	...
4	Prominent	" "	...
5	Large	" "	...
6	?	" "	—0.09
7	Large	White watery, yolk settled	0
8	Prominent	.....	...

These eggs were sold as "Fresh York State Eggs." From the data given above it is evident that they were not fresh eggs, although it cannot be stated definitely that they were storage eggs.

Ketchup. Eighteen samples were examined, 14 of which claimed the use of no chemical preservative, the other 4 admitting the use of benzoate of soda. The claims were found to be correct, except that one brand contained more benzoate than claimed.

The following brands contained no benzoates, salicylates, borates or saccharin:

10951. Austin, Nichols & Co. Scottish Chief.
10788. Booth Packing Co. Booth's Pure.
10988. Cudahy Packing Co. Rex.
10799. John T. Doyle Co. Country Club.
10969. John T. Doyle Co. Country Club.
10981. John H. Fitch Co. Onward.

* Rotten when received.

10997. Frazier Packing Co. Royal Red.
10990. Frazier Packing Co. Frazier's.
10954. Great Atl. and Pac. Tea Co. A. and P.
10795. Harbauer Co. Harbauer's.
10791. Burt Olney Canning Co. Burt Olney's.
10967. T. A. Snider Conserve Co. Snider's.
10961. Stoddard, Gilbert & Co. Polo.
10957. R. C. Williams & Co. Robin Hood.

The following brands contained benzoate of soda in the amounts stated, 0.10 per cent being uniformly claimed:

11020. Curtice Bros. Blue Label (0.10).
11027. Empire Bottling Works. Just Right (0.10)
11021. Humphrey-Cornell Co. Best Yet (0.14).
11024. E. Pritchard. Pride of the Farm (0.10).

Nine samples were examined bacteriologically according to the methods outlined in *Circular 68* of the Bureau of Chemistry with the following results:

No	Bacteria per cc.	Yeasts and Spores per 1/60 cc.	Moulds Per cent of Fields.
11024	119,300,000	22	4
10981	92,400,000	133	7
11021	175,200,000	28	18
11027	188,400,000	48	25
10997	183,600,000	25	11
10961	136,800,000	19	28
11020	160,800,000	22	21
10951	219,600,000	63	28
10957	153,600,000	25	16
Bur. of Chem. max. standard	25,000,000	25	25

All of the samples exceeded the maximum of the Bureau of Chemistry standard for bacteria; four exceeded, two equalled and three were below the maximum for yeast and spores; while two exceeded the maximum for moulds.

Lard. Eight samples sold as "Compound" or "Compound Lard" were examined. These samples consisted largely of cotton seed oil and oleo stearin, with some beef stearin in a few cases. The sale as "Compound Lard" of a material containing no lard whatever is certainly contrary to the spirit of the law.

Milk. Three hundred and eight samples were analyzed. Of these 164 conformed to the legal standards, while 49 were deficient only in solids-not-fat. Eighty-nine were below standard

in solids, 51 in fat and 133 in solids-not-fat, 144 samples failing to meet the legal requirements in one or more particulars. Forty-seven samples were watered, 8 were skimmed and 1 was both skimmed and watered.

The skimmed milks were taken in Bozrah, Easton, Salem and Stonington; the watered milks in Ansonia, Bloomfield, Brookfield, Cheshire, Easton, Guilford, Manchester, Marlboro, Meriden, Middlebury, Naugatuck, New London, Newtown, Orange, Oxford, Preston, Rocky Hill, Somers, Southington, Stonington, Torrington and Wethersfield; the sample of skimmed and watered milk in Middlebury.

Molasses. Twenty-two samples were examined for sulphurous acid, which was declared in each instance. Nineteen samples contained from 51 to 296 mgms. of sulphurous anhydrid per kilo, with an average of 131 mgms. The remaining three samples contained 669, 884 and 500 mgms., respectively, far in excess of the amount permitted by the Federal Government.

Oysters. Sixteen samples were tested for added water. Shucked oysters shipped in commerce should contain but very little free liquor, certainly not more than 10 per cent. Oysters sold with their own juice, however, may carry as much as 35 per cent of liquor. Too close conclusions will not be drawn, therefore, in this respect from the date given in the following table. Nevertheless, **10982** and **10995** probably, and **10994** certainly, carried an excess of liquor.

Oysters which have not been adulterated with water, either by floating or soaking, by direct addition of water, or by the melting of ice packed with them, should not contain less than 16 per cent of solids or less than 0.25 per cent of salt in the oysters, or lose more than 50 per cent of their weight on boiling.

According to these criteria only **10974, 10975, 10976, 10994,** and **10996** show no evidence of added water. In the other samples in some cases there is evidence of the oysters having been "soaked," while in others water has been added directly. **10982** was reported by us to the retailer as being "soaked" oysters and as containing too much free liquor. The retailer claimed that the oysters were in the same condition as when received from the wholesaler except for the addition of oyster liquor supplied by said wholesaler at the time of purchase. Accordingly a sample, **11006,** was taken from the wholesaler and the

analyses of the oysters in the two samples proved to be quite similar, the wholesaler's containing somewhat more ash and salt. The amounts of free liquor, however, are very different. **11007** represents the oyster liquor claimed to have been supplied by the wholesaler with **10982.** The analysis of this liquor shows it to be a true oyster liquor, as distinguished from a brine, containing 1.26 per cent of organic matter. It shows, however, no resemblance whatever to the liquor drained off from **10982.**

To summarize concerning these two samples, the oysters in **11006** had been soaked by the wholesaler, the oysters in **10982,** already soaked when received, had been further soaked by the retailer, and water added to them.

No.	Beds.	Drained Oysters. gms.	Liquor. gms.	Per cent Liquor.	In Oysters. Solids. %	Ash. %	Salt. %	In Liquor. Salt. %	Loss on Boiling. %
	Oysters.								
10974.	Greenport, L. I..	409	70	14.6	19.5	1.49	0.32	1.09	40.2
10975.	Rockaway, N. Y.	408	91	18.2	22.6	2.07	0.47	1.38	36.0
10976.	Orange	424	45	9.6	18.5	1.58	0.39	1.27	42.4
10978.	Narragansett ..	394	92	18.9	17.1	1.22	0.22	0.76	51.8
10979.	? ..	429	40	8.5	16.2	1.05	0.08	0.37	48.8
10982.	*Stony Creek ..	286	196	40.7	13.0	0.63	0.02	0.20	58.4
11006.	†Stony Creek ..	396	63	13.7	13.3	0.81	0.10	0.18	51.9
10983.	Branford	331	162	32.9	16.0	1.21	0.17	0.70	48.9
10984.	Cristfield, Md...	361	114	24.0	16.3	0.73	0.04	0.18	54.6
10986.	Narragansett ..	282	179	38.8	14.3	0.99	0.12	0.39	52.0
10987.	Stony Creek ...	345	121	26.0	14.2	0.94	0.05	0.20	52.4
10994.	Sound Beach ...	188	284	60.2	18.5	1.86	0.69	1.59	43.0
10995.	Darien	380	101	21.0	17.6	1.28	0.21	0.71	40.6
10996.	Setauket, L. I...	288	194	40.2	16.2	1.44	0.38	1.07	45.7
11019.	? ..	334	157	32.0	14.9	2.01	1.21	2.03	53.8
	Oyster liquor.				*In liquor.*				
11007.	.....	...	...	....	3.42	2.16	1.74	....	....

Sausage. The two samples contained 0.29 and 1.20 per cent of starch.

Vinegar. Two samples were examined, which had been complained of because they blackened on standing after opening. One represented the partly used consumer's sample, the other an unopened sample purchased by our agent. Their analysis was as follows:

* Retailer. † Wholesaler.

	11289	11290
Acidity	4.70	4.72
Solids	1.88	1.90
Ash	0.29	0.29
Iron (gms. per 100 cc.)	0.0073	0.0074

On evaporation the coloring matter came down as a very fine black precipitate. On boiling the blackened vinegar became appreciably lighter in color but on exposure to the air became brown and after 36 hours black. After keeping the samples for a month, tightly stoppered, they both became clear and free from the black precipitate. While the presence of iron may have had some influence in the darkening of the vinegar, it seems more likely that the latter was due to the presence of an oxidase.

Bay Rum. Bay Rum according to the National Formulary should contain 58 per cent of ethyl alcohol. Various products are offered on our markets under this name but claiming much lower percentages of alcohol, one brand actually claiming to be non-alcoholic. It is apparent that such products are not true bay rums and there is considerable question as to the legality of their sale even when their substandard character is indicated on the label. Fifteen such samples were examined and are listed below:

Brand.	Spec. gr.	Alcohol Claimed.	Alcohol Found.
Marvo (Wm. H. Loveland Co.)	0.9777	20	18.44
Marvo (Wm. H. Loveland Co.)	0.9770	20	19.05
(United Toilet Goods Co.)	0.9883	15	9.00
Favorite (C. H. Seleck)	0.9737	20	22.33
Favorite (C. H. Seleck)	0.9747	20	21.37
Moorac (Holman)	0.9848	12	11.58
Royale (Ed. Gerarde)	0.9770	20	19.11
(Joubet & Co.)	0.9825	15	13.75
(Joubet & Co.)	0.9810	15	15.14
Eden	0.9800	..	16.68
(Chas. M. Rich)	0.9817	15	14.51
(Calavecchio & Co.)	0.9492	..	42.54
(Star Perfumery Works)	0.9801	15	16.02
(Queen Perfume Co.)	0.9764	33⅓	19.73
French's Improved	1.0025	0	0

Two brands made no specific claim as regards alcohol and must therefore be assumed to be sold as standard bay rum. These contained only 16.68 and 42.54 per cent of alcohol, respectively. Another brand claiming 15 per cent contained but 9

per cent, while another claiming 33 1/3 per cent contained only 19.73 per cent.

Hair Tonic. A sample of *Carnation Hair Tonic,* made by Eugene Warshaw and Co., Hartford, contained 38.16 per cent of methyl (wood) alcohol by volume.

Hydrogen peroxid. A sample of the product of the Busy Bee Chemical Co., New York, contained only 1.25 per cent of absolute hydrogen peroxid, and showed an acidity equivalent to 3 cc of tenth-normal alkali per 25 cc of the solution.

Physicians' Drugs. Fifty-three samples of drugs were taken from the stocks of dispensing physicians. These are discussed on pages 229 to 248.

Rum. The sample was deficient in alcohol, containing only 35.80 per cent by volume; no wood alcohol was present.

Toilet Waters. A sample of *Bouquet Toilet Water,* made by C. A. Johnson, New Haven, contained 49.25 per cent of methyl (wood) alcohol by volume. A sample of *Jarden's French Bouquet Toilet Water,* made by Eugene Warshaw and Co., Hartford, contained 16.20 per cent of ethyl alcohol and 24.49 per cent of methyl (wood) alcohol, both by weight.

Turpentine. Forty-four samples were examined, 39 of which showed no adulteration other than possible small amounts of mineral oil. Five samples were adulterated with mineral oil in amounts equal to 9.6, 16.4, 22.4, 12.0 and 13.6 per cent, respectively.

Whiskey. A sample of *Sherwood* whiskey contained 43.19 per cent of ethyl alcohol by volume; no wood alcohol was present.

Wine. A sample of California wine showed the following analysis:

Spec. grav. at 15.6° C.	0.9971	Color	natural
Alcohol by volume	14.60	Preservatives	none
Ash	0.37	Wood Alcohol	none

MISCELLANEOUS MATERIALS SENT BY PRIVATE INDIVIDUALS.

Baking Powder. The sample analyzed was not adulterated.

Buckwheat Flour. The sample analyzed was not adulterated.

Butter. Of the 7 samples tested 4 were genuine butter, 2 were renovated butter and 1 was oleomargarine.

Candy. A sample of Eatums, made by the Crescent Candy Co., was suspected of having caused sickness in children. The candy was a "taffy-on-the-stick" with a peanut butter center. It contained 8.30 per cent of fat, mostly peanut oil, 1.45 per cent of ash, only a trace of acid-insoluble ash, and no alkaloids or heavy metals. There were no abnormal features as regards taste, odor, appearance, etc. The yellow paper covering the candy was colored with turmeric, a harmless vegetable color.

Cider. The sample tested contained 5.43 per cent of alcohol by volume, placing it in the "hard" cider class.

Cream. The three samples tested contained from 21.50 to 30 per cent of butter fat.

Gluten Bread. The sample was quite stale when received, and contained in this state 10.50 per cent of protein and 50.32 per cent of starch, showing the material to be by no means a desirable "gluten" bread.

Maple Syrup. The sample analyzed was not adulterated.

Milk. All of the 9 samples analyzed were of standard quality.

Near Beer. A sample of Pabst Pablo contained 0.17 per cent of alcohol by volume.

Roman Punch Flavor. This material, made by the Daggett Chocolate Co., Boston, contained 48.41 per cent of ethyl alcohol by volume.

Vinegar. Twenty-eight samples were analyzed, chiefly for farmers intending to sell their product to local dealers. The state's minimum standard for cider vinegar is 4 per cent of acetic acid and 1.6 per cent of solids. Fourteen samples satisfied this standard, while 6 were low in acidity and 8 were low both in acidity and solids. Such abnormal values as 10.76 per cent of acid and 6.01 per cent of solids were shown by two of the samples.

Wine. Five samples were analyzed. Two were examined for alcohol only, containing 6.37 and 12.65 per cent of ethyl alcohol by volume, respectively. The other samples, all California wines and purchased for sacramental purposes, had the following composition:

	1	2	3
Spec. grav. at 15.6° C.	0.9984	1.0237	0.9967
Alcohol by volume	12.13	17.90	20.23
Extract	3.67	11.78	5.38
Acidity as tartaric (gm. per 100 cc.) ...	0.51	0.66	0.45

Animals Suspected of Poisoning. Eight animals, or portions of same, suspected of having been poisoned, were examined. The contents of the stomachs of three heifers, which died suddenly, were found to contain arsenic. The contents of the stomach of a horse, which likewise died under suspicious circumstances, showed no poisons of an alkaloidal or mineral nature; the stomach contents showed several rat faeces and many larvae of the horse fly were found attached to the walls of the stomach. Two chickens and two pigeons were also examined for poisons, in all cases with negative results. In one of the chickens the crop was gorged and of abnormal weight, the bird apparently having died from suffocation. The organs of the other chicken were in good condition except the liver which bore greenish patches.

Antikamnia. A sample of this much-advertised remedy was suspected of containing acetanilid on account of the symptoms shown by the person using it. No acetanilid was found, but 4.97 grs. of acetphenetidin (phenacetin) per tablet was present.

Disinfecting Fluid. This was found to be a mixture of volatile compounds, such as turpentine, benzine, kerosene and volatile oils (oil of sassafras predominating). No phenol, no heavy metals and no arsenic were present. The material would appear to have some value as an insecticide, but would be of little use as a disinfectant.

Gasoline. The sample examined contained no adulteration.

Habit-forming Drugs. Three samples taken on prisoners were examined, one proving to be heroin and the other two morphin sulphate.

Intestinal Cleanser for Chickens. This was found to be essentially a mixture of free sulphur, sodium bicarbonate, magnesium sulphate and iron sulphate; possibly also some sodium sulphate was present.

Massage Cream. The sample was tested for heavy metals with negative results.

Mineral. The sample consisted chiefly of silica and silicates of iron, alumina, etc.

Poison Samples. A sample of material found in a coffee cup and suspected of containing poison, was found to be a milk powder with no alkaloids or mineral poisons present. Two samples of tea suspected of containing poison were found to be free from alkaloidal or mineral poisons.

Sediment from Gin. This was found to be glass derived from the container.

Tobacco Infusion. This contained 0.042 per cent of nicotin.

TABLE XVIII:—SUMMARY OF RESULTS OF EXAMINATION OF FOOD AND DRUG PRODUCTS, 1916.

	Not found adulterated.	Adulterated, or below standard.	Compound.	Total number examined.
Sampled by Station.				
Hygienic Coffee	1	4	—	5
Cream of Tartar	31	—	1	32
Diabetic Foods	—	—	—	22
Condensed Milk	40	3	—	43
Skim Milk Powders	2	—	—	2
Allspice	21	3	—	24
Cloves	21	6	—	27
Mustard	30	—	—	30
Pepper, black	28	4	—	32
Pepper, cayenne	8	20	—	28
Pepper, white	24	4	—	28
Sage	—	—	—	20
Thyme	—	—	—	16
Dovitam	—	1	—	1
Vegetable Extracts	1	1	—	2
Magnesium Sulphate	37	—	—	37
Sodium Phosphate	5	6	—	11
Effervescing Sodium Phosphate	—	3	—	3
Proprietary Medicines	—	—	—	38
Total	249	55	1	401
Sampled by Dairy Commissioner.				
Butter	247	102	—	349
Cider	1	—	—	1
Clams	5	6	—	11
Coffee	18	—	—	18
Cordial Chocolates	—	4	—	4
Eggs	—	8	—	8
Ketchup	14	—	4	18
Lard	—	—	8	8

	Not found adulterated.	Adulterated, or below standard.	Compound.	Total number examined.
Milk	164	*144	—	308
Molasses	—	3	19	22
Oysters	3	13	—	16
Sausage	1	1	—	2
Vinegar	2	—	—	2
Bay Rum	—	4	11	15
Hair Tonic	—	1	—	1
Hydrogen Peroxid	—	1	—	1
Physicians' Drugs	38	15	—	43
Rum	—	1	—	1
Toilet Water	—	2	—	2
Turpentine	39	5	—	44
Whiskey	—	1	—	1
Wine	1	—	—	1
Total	533	311	42	886
Samples from private individuals	56	26	—	82
Total from all sources	838	392	43	1369

* Including 49 samples below standard in solids-not-fat.

PART V.

Report of the Plant Breeder.

D. F. JONES.

THE EFFECTS OF CROSS- AND SELF-FERTILIZATION IN TOMATOES[1].

H. K. HAYES AND D. F. JONES.

Numerous investigations made during the last century have established the fact that inbreeding in naturally cross-pollinated plants generally causes a decrease in vigor and, conversely, that a first generation cross between varieties of somewhat different constitution is frequently more vigorous than either parent. These results have led to many experiments designed to test the commercial possibility of first generation crosses. The value of growing first generation crosses as a commercial crop depends on the cost of producing crossed seed and on the amount of increased vigor due to crossing.

The object of this experiment was to test the value of first generation crosses in tomatoes and the effects of continued self-pollination within the variety.

PREVIOUS WORK ON FIRST GENERATION TOMATO CROSSES.

There are a number of published observations which lead to the belief that a cross between tomato varieties is more vigorous than the parents, and Wellington (1912) has reported a careful series of experiments designed to test the commercial value of first generation tomato crosses. He came to the conclusion, from

[1] The experiments included in the four sections of this report were outlined by the senior writer and carried out under his direction up to the close of the year 1914. The plants from which the data were obtained were grown at the Connecticut Agricultural Experiment Station farm.

a study of crosses between Dwarf Aristocrat and Livingston Stone, and Dwarf Aristocrat and Hedrick, that the increased vigor which was exhibited either in increased fruit number, or increased fruit size, or both, would more than pay for the extra trouble of making the cross.

With maize, greater increases have been obtained by crossing inbred strains than by crossing open-pollinated varieties. Theoretically a greater increase from crosses of inbred strains is possible, on account of the greater degree of heterogeneity secured by crossing plants which have become more homogeneous by inbreeding. If tomatoes are naturally cross-fertilized to any appreciable extent, a greater increase in vigor from crosses between artificially selfed strains than from crosses of commercial varieties would be expected. A reduction in vigor should also be apparent in the first successive inbred generations. On the other hand, if the tomato is naturally self-fertilized, no reduction of vegetative vigor should be observed when artificial self-fertilization is practiced, and crosses between such strains would not be expected to give greater increases than those between varieties not artificially self-pollinated.

Methods Used and Materials.

Four commercial varieties of tomatoes were used in the experiments reported here, namely, Lorillard, Sutton's Best of All, Livingston's Stone and Dwarf Champion[2].

Dwarf Champion differs from the other three varieties in the color of the fruit, which is pinkish purple instead of red, in the production of somewhat smaller fruit, earlier bearing, and in its dwarf habit of growth. The other three varieties are similar in color and size of fruit and in habit of growth, except that Best of All has a somewhat stockier habit of growth than has either Stone or Lorillard.

In making the crosses between the two varieties, the same plants which were used to make the cross were also used to produce the selfed seed each year. In the first two years of the experiment, 1912 and 1913, the original seed secured from the

[2] Seed of Lorillard and Best of All was obtained from J. M. Thorburn & Co., New York City; Stone and Dwarf Champion from The Frank S. Platt Co., New Haven.

seed dealers in 1910 was used to produce the plants for the non-selfed parents. This seed was at least three years old in 1913. In order that the age of the seed might not affect the vitality of the plants, off-pollinated seed of each variety was produced in 1913 by hand-pollinating several flowers with a mixture of pollen from twenty other plants of the same variety. This seed was used for the non-selfed parents in 1914, and similar seed was produced that year for the 1915 test.

The plants were started in the greenhouse in sterilized soil, transferred to pots, and later set in the field. An effort was made to have the plants in a uniform condition when transplanted to the field and to grow them under uniform cultural conditions.

The characters considered in the experiment were, size of fruit as measured by the average weight of ripe fruits, number of ripe fruits produced per plant, and average total yield in pounds of fruit per plant. The unripe fruit at the end of the season was included in the yield, but diseased or decayed fruit throughout the season was not included, as no marked difference between the varieties was noted in regard to the amount of this kind of fruit.

The Effects of Self-Fertilization.

The effects of continued self-fertilization upon vigor, as expressed in yield and size of fruit, are shown in Tables I and II.

The first selfed generation of all four varieties exceeded the non-selfed plants in both total yield and the average size of fruit, with the one exception of Dwarf Champion, of which the selfed strain was less than the non-selfed variety in size of fruit. In succeeding generations two of the selfed varieties (Best of All and Stone) showed a slight decrease in yield when compared with the non-selfed plants of the same variety grown during the same year. The other two selfed varieties maintained the increased yield which all varieties gave in the first selfed generation. When it is considered that old seed was used for the non-selfed plants in 1912 and 1913, these yearly yield variations are not significant. It is apparent from these results that continued self-fertilization does not cause any marked decrease in yield.

No non-selfed plants of Stone were grown in 1915 because of a failure to obtain off-pollinated seed. The other three non-selfed varieties showed a uniform increase in yield in 1915 as compared with their yields in the previous year, due, no doubt,

TABLE I.

A Comparison of the Yield of Selfed and Non-Selfed Tomatoes.

Variety.		Yield in Pounds of Fruit per Plant.													
		Stone.			Dwarf Champion.				Lorillard.			Best of All.			
Year grown.	A	B	C	D	B	C	D	A	B	C	D	B	C	D
1912	..	..	..	..	..	..	..	1	14.97	14.69	102	16.59	14.89	111
1913	1	17.85	16.29	110	15.71	14.96	105	2	19.38	17.07	114	16.98	17.47	97
1914	2	20.74	21.08	98	19.56	15.65	125	3	23.67	21.39	111	20.73	23.02	90
1915	3	23.15	26.13*	89	20.95	18.83	111	4	28.11	26.39	107	25.55	29.25	87

A = Number of generations selfed.
B = Yield of selfed plants.
C = Yield of non-selfed plants.
D = Yield of selfed plants as per cent. of yield of non-selfed.

* Calculated from the 1914 yield of Stone by the average increase (23.98 per cent.) of the other three varieties in 1915, as compared with these average yields of the varieties in 1914.

to a better growing season. The average increase of 23.98 per cent of these three varieties in 1915 over the yields of the same varieties in 1914 was used to calculate a yield for the Stone variety for 1915 from the yield in 1914. Although not accurate, this gives a fairly good measure of the yield of the non-selfed Stone in 1915, which may serve for comparison with the yield of the selfed plants. The average size of fruit for the Stone variety in 1915 was calculated in the same way; the average increase of the other three varieties being 49.36 per cent above the weight in 1914.

In average weight of fruit, Best of All showed a slight decrease in the selfed strain as compared with the fruit from the non-selfed plants of the same variety grown in the same years. Two of the selfed strains of the other three varieties retained a size larger than the non-selfed plants, and one a size smaller, throughout the successive generations of inbreeding. The excess in Stone was an average of 7.5 per cent, and in Lorillard 26 per cent. In Dwarf Champion there was an average deficiency of 18 per cent of the selfed plants below the non-selfed plants in average size of fruit.

These results show no harmful effects on fruit size from self-fertilization and are most logically explained by assuming that self-fertilization has isolated strains differing somewhat from the original variety.

The successive generations of self-fertilization reduced progressively both the yield and size of fruit in Best of All. Stone was reduced in yield and increased in size of fruit. Dwarf Champion remained reduced in fruit size and increased in yield, and Lorillard remained increased in both fruit size and yield throughout the experiment.

It seems logical to conclude from these results that self-fertilization of tomatoes simply isolates genotypic lines which may or may not exceed the original variety. As tomatoes are generally self-fertilized naturally, as later data will show, it is not to be expected that there is any great degree of heterozygosity in a commercial variety, especially in old established varieties used in these experiments. Commercial non-pedigreed seed of all self-fertilized crops has proven, as a rule, to contain a mixture of numerous strains. Artificial self-fertilization simply isolates these different strains.

TABLE II.

A Comparison of the Size of Fruit on Selfed and Non-Selfed Tomatoes.

Variety.		Stone.			Dwarf Champion.				Lorillard.			Best of All.		
		Average Weight in Pounds of Individual Ripe Fruits.												
Year grown.	A	B	C	D	B	C	D	A	B	C	D	B	C	D
1912	..	..	..	..	..	..	..	1	.255	.221	115	.273	.237	115
1913	1	.291	.279	104	.179	.223	80	2	.286	.199	144	.262	.228	115
1914	2	.266	.238	112	.165	.186	89	3	.231	.182	127	.242	.218	111
1915	3	.379	.355*	107	.219	.279	78	4	.345	.293	118	.303	.303	100

A = Number of generations selfed.
B = Weight of fruit of selfed plants.
C = Weight of fruit of non-selfed plants.
D = Weight of selfed fruit as per cent. of weight of non-selfed.

* Calculated from the 1914 weight of fruit of Stone by the average increase (49.36 per cent.) of the other three varieties in 1915, as compared with the average weights of fruit of these varieties in 1914.

There is some indication, however, that the variety Best of All may have been sufficiently heterozygous at the start so that a slight reduction was obtained by self-fertilization. In order to have heterozygous plants in a commercial variety there must be some natural cross-pollination. That there is a small amount of natural crossing among tomatoes is shown by results reported elsewhere (Jones, 1916), in which seed produced by open-pollinated dwarf plants interplanted among standard plants gave approximately 2 per cent of standard plants. This indicated that there was, in this case, from two to four per cent of natural crossing, since there was an equal chance for dwarf plants to be cross-pollinated with other dwarf plants as well as with standards. The standard plants could only have been produced from the seed of dwarf plants by being crossed with standard plants. Growing the next generation from these naturally crossed plants showed that they were hybrids because they gave both standard and dwarf plants in the approximate ratio of three to one.

The Effects of Cross-Fertilization.

As the results show no appreciable harmful effects of from three to four generations of selfing in tomatoes, the value of the first generation crosses may be determined by comparing them with the selfed strains used in making the crosses. In 1912 the Stone × Dwarf Champion cross is compared with commercial seed of these two varieties. From 1913 to 1915 the crosses were, in all cases, made between the same plants as were used in the production of the selfed strains.

Table III gives a comparison of average weight per fruit of the selfed varieties and the first generation crosses between them. The average size of fruit varied in different years, owing probably to different growing conditions.

The 1912 and 1913 Stone × Dwarf Champion crosses gave an average increase in fruit weight of 7.5 per cent over the average of the parents. This is exactly the same as the average gain for the years 1914 and 1915, when the parents that were used in making the crosses were one and two years selfed respectively.

In the Lorillard × Best of All cross the increases obtained in the three years from 1913 to 1915 were somewhat greater than

the increase in 1912 when the cross was made between non-selfed parents, but the results varied considerably.

It is apparent that no marked advantage is secured by crossing selfed strains rather than non-selfed. The four-year average increase in fruit weight over the parental average was 8 per cent in the Stone × Dwarf Champion cross and 3 per cent in the

TABLE III.

A Comparison in Average Weight Per Fruit of Self-Fertilized Tomatoes with Their First Generation Crosses.

Year Grown.	1912		1913		1914		1915		Average.
No. of Plants Grown.	64		48		36–46		23–30		
Variety.	A	B	A	B	A	B	A	B	B
Stone	0	.271	1	.291	2	.266	3	.379	.302
(Stone × Dwarf Champion) F_1	0	.244	0	.258	1	.213	2	.346	.265
Dwarf Champion	0	.193	1	.179	2	.165	3	.219	.189
Average of Parents	..	.232	..	.235	..	.216	..	.299	.246
Difference between F_1 and average of Parents	..	+.012	..	+.023	..	−.003	..	+.047	+.019
Per cent. Increase or Decrease	..	+5	..	+10	..	−1	..	+16	+8
Lorillard	1	.255	2	.286	3	.231	4	.345	.279
(Lorillard × Best of All) F_1	0	.247	1	.285	2	.232	3	.370	.284
Best of All	1	.273	2	.262	3	.242	4	.303	.270
Average of Parents	..	.264	..	.274	..	.237	..	.324	.275
Difference between F_1 and average of Parents	..	−.017	..	+.011	..	−.005	..	+.046	+.009
Per cent. Increase or Decrease	..	−6	..	+4	..	−2	..	+14	+3

A=Number of generations parents selfed.
B=Average weight per fruit in pounds.

Lorillard × Best of All cross. It is of interest to note that the latter cross exceeded the larger parent in average fruit size, although the increase is not great.

Table IV shows a comparison of the average number of ripe fruits per plant of the crosses with that of their parents. There is an appreciable increase over the average of the parents in the Stone × Dwarf Champion cross, amounting to 8 per cent. In

the Lorillard × Best of All no consistent results were obtained. The average of the first generation crosses for the four years was just the same as that of the parents. In neither case did the crosses between the parents which had been selfed give any greater increases than did those between the non-selfed parents.

Since both the number and size of fruits in the Stone × Dwarf

TABLE IV.

A Comparison in Number of Ripe Fruit per Plant of Self-Fertilized Tomatoes with Their First Generation Crosses.

Year Grown.	1912		1913		1914		1915		Average.
No. of Plants Grown.	64		48		36–46		23–30		
Variety.	A	B	A	B	A	B	A	B	B
Stone	0	50	1	53	2	77	3	54	59
(Stone × Dwarf Champion) F_1	0	64	0	65	1	112	2	72	78
Dwarf Champion	0	62	1	74	2	116	3	87	85
Average of Parents	..	56	..	64	..	97	..	71	72
Difference between F_1 and average of Parents	..	+8	..	+1	..	+15	..	+1	+6
Per cent. Increase	..	+14	..	+2	..	+15	..	+1	+8
Lorillard	1	59	2	55	3	102	4	75	73
(Lorillard × Best of All) F_1	0	62	1	50	2	106	3	70	72
Best of All	1	61	2	55	3	85	4	79	70
Average of Parents	..	60	..	55	..	94	..	77	72
Difference between F_1 and average of Parents	..	+2	..	−5	..	+12	..	−7	0
Per cent. Increase or Decrease	..	+3	..	−9	..	+13	..	−9	0

A=Number of generations parents selfed.
B=Average number of fruits per plant.

Champion cross were increased, the total yield was necessarily greater than the average of the parents, and was even considerably greater than the better parent in each of the four years grown, as shown in Table V. In the Lorillard × Best of All cross the number of fruits was not increased by crossing, but the size of fruit was, so that, although the first generation cross did not exceed the better parent, it was slightly above the average of the two parents.

The results shown in Table V indicate that crossing may increase the yield of tomatoes, and that in some crosses the increase is large enough to make the practice of growing first generation tomato crosses worthy of consideration. It must be understood that the advantage derived from crossing is only obtained at the maximum in the first generation following the cross. In order to utilize the increase in yield shown by the

TABLE V.

A Comparison in Yield of Self-Fertilized Tomatoes with their First Generation Crosses.

Year Grown.	1912		1913		1914		1915		Average. B
No. of Plants Grown.	64		48		36–46		23–30		
Variety.	A	B	A	B	A	B	A	B	
Stone	0	13.52	1	17.85	2	20.74	3	23.15	18.82
(Stone × Dwarf Champion) F_1	0	15.53	0	19.87	1	24.04	2	27.14	21.65
Dwarf Champion	0	11.90	1	15.71	2	19.56	3	20.95	17.03
Difference between F_1 and better parent	..	+2.01	..	+2.02	..	+3.30	..	+3.99	+2.83
Per cent. Increase	..	+15	..	+11	..	+16	..	+17	+15
Lorillard	1	14.97	2	19.38	3	26.67	4	28.11	21.53
(Lorillard × Best of All) F_1	0	15.44	1	17.88	2	24.68	3	27.75	21.44
Best of All	1	16.59	2	16.98	3	20.73	4	25.55	19.96
Difference between F_1 and better parent	..	−1.15	..	−1.50	..	+1.01	..	−0.36	−0.09
Per cent. Increase or Decrease	..	−7	..	−8	..	+4	..	−1	0

A = Number of generations parents selfed.
B = Yield of fruit per plant in pounds.

Stone × Dwarf Champion cross, it is necessary to plant crossed seed each year.

It should also be noted that not every cross is more desirable than the parents, as is shown in the Lorillard × Best of All cross, which did not surpass the better parent sufficiently in any character to make it worth growing commercially. The results do show, however, that, when a desirable combination is found, it can be counted on to give approximately the same increase in yield every time the cross is made.

The Effect of Crossing upon the Time of Production.

The commercial value of tomato varieties, aside from those grown for the canning industry, consists largely in their earliness. The behavior of the first generation crosses in respect to the time of production is compared with the behavior of the parents by dividing the entire picking season for all varieties and their crosses into two parts. That date was taken each season at which the earliest variety, Dwarf Champion, had produced half of its total crop. The per cent of the entire crop produced in the first part of the season, divided arbitrarily in this way, gives some idea of the comparative earliness of the parents and their

TABLE VI.

A Comparison of the First Generation Cross with the Two Parents in Respect to the Time of Production in Four Successive Years.

Year.	Date which divides the season.	Per cent. of total yield produced in the first part of the season.		
	September.	Dwarf Champion.	First generation cross.	Stone.
1912	9	53	52	35
1913	11	54	58	44
1914	8	56	64	46
1915	13	58	62	37
Average.	..	55	59	41

first generation crosses. The results of the Stone × Dwarf Champion cross for the four years are given in Table VI.

Lorillard and Best of All differed very little in their season for producing fruit, and the first generation cross did not differ from them in respect to this character. The data on the time of production for this cross are not given. On the other hand, Stone produced only an average of 41 per cent of its crop in the first part of the four seasons, while Dwarf Champion produced an average of 55 per cent of its crop in the same time. The first generation of the cross between these varieties, which thus differ considerably in earliness, was somewhat earlier than the earlier parent, producing an average of 59 per cent of its crop in the same time that Dwarf Champion produced 55 per cent of its

crop. From the market gardener's standpoint, the Stone × Dwarf Champion cross would be more valuable than either parent because it produced in the four years tested 15 per cent more fruit than the late parent and was earlier than the early parent.

The fact that a hastening of the time of production was obtained in the cross whose parent differed in time of production and not in the cross whose parents did not differ should not be taken to mean that the hastening of the time of production was due to that fact. The hastening of the time of production is simply one manifestation of the vigor derived from crossing, which also increases the yield. The other cross did not show hybrid vigor as expressed by yield, neither did it result in a hastening of the time of production.

Darwin (1876) gives the time of flowering of twenty-eight crosses between different strains within many different species which show positive evidence of hybrid vigor. Of these twenty-eight crosses 81 per cent flower before their parents. Four cases are given in which the crosses are less vigorous than the parents, and in each of these the crosses flower after their parents.

Recent experiments in hybridization show that many crosses which result in an increase in vigor also result in a hastening of the time of flowering and maturing. One exception to this statement must be noted in a cross between a large dent and a small pop variety of maize, reported by Emerson and East (1913). This cross showed distinct evidence of hybrid vigor in an increase in internode length over that of both parents. The parents differed in time of flowering by twenty-five days. The first generation of the cross grown the same year as the parents was, however, distinctly intermediate in time of flowering. Results obtained in crosses between inbred strains of maize, on the contrary, show in the majority of cases that, when crossing results in an increase of size, a hastening of both the time of flowering and maturing is to be expected.

East (1916) has stated that heterozygosis "effects a result comparable to favorable external conditions." In a cross between two varieties of Nicotiana he found that the first generation gave a noticeable increase in the amount of growth as shown by the height and general size of the plant, as the result of hybrid vigor. The corolla length of the flowers, which is very little affected by environmental factors, was not increased in the first generation cross above the average of the two parents.

Although in general it is evidently true that heterozygosis affects many characters in the same way as the environment, it should be noted that in time of production and maturity these two factors have directly opposite effects. It is generally recognized that favorable external conditions, such as abundant rainfall, increased fertility, etc., which result in a total greater amount of growth, tend to delay both the time of flowering and the completion of growth. Conversely, unfavorable external conditions which stunt the plants and limit their growth tend to hasten their time of flowering and maturing. The vigor derived from crossing, on the other hand, not only increases the amount of growth and yield of fruit or grain, but makes it possible to produce that increased yield in a shorter time than the parents take to produce a smaller yield.

SUMMARY.

1. Continuous self-fertilization during periods of three and four years in four commercial varieties of tomatoes did not cause any significant decrease in the size or yield of fruit, but merely resulted in isolating, in the first year, types which varied either above or below the original unselected variety in these characters.

2. In average weight per fruit the Stone × Dwarf Champion cross showed an average increase of 8 per cent over the parental average. The other cross showed a 3 per cent increase over the average of the parents and slightly exceeded the larger fruited parent.

3. In average number of ripe fruits per plant the Stone × Dwarf Champion cross gave an 8 per cent increase over the average of the parents and approached the fruit number of the better parent. The Lorillard × Best of All cross gave no increase in fruit number over the parental average.

4. Since the Stone × Dwarf Champion cross gave an appreciable increase in both size and number of fruits the total yield was necessarily increased, and even exceeded the better parent by 15 per cent. Moreover, the increase above the better parent was uniform thruout the four years of the test. The increases ranged from 11 to 17 per cent and were sufficient to make the practice of growing first generation tomato crosses commercially profitable.

Although the Lorillard × Best of All cross exceeded slightly the better parent in average weight of fruit it did not excel in total yield.

5. These results show that not all combinations of tomato varieties give the vigor usually derived from crossing, but when a desirable combination is found it can be counted on to give the increase in yield every time the cross is made.

6. Vigor due to crossing as measured by increased yield was not appreciably greater in crosses between artificially selfed strains than in crosses between ordinary commercial varieties. These results are in agreement with the fact that the tomato is naturally almost completely self-fertilized.

7. The cross of Stone × Dwarf Champion which gave a significant increase in yield also showed a hastening of the time of production. It not only gave a 15 per cent larger yield than the later parental variety but was earlier in its time of production than the earlier parent. Hence its value to market gardeners was increased.

8. In respect to the hastening of the time of production, hybrid vigor effects a result directly opposite to favorable environmental conditions which tend to delay maturity.

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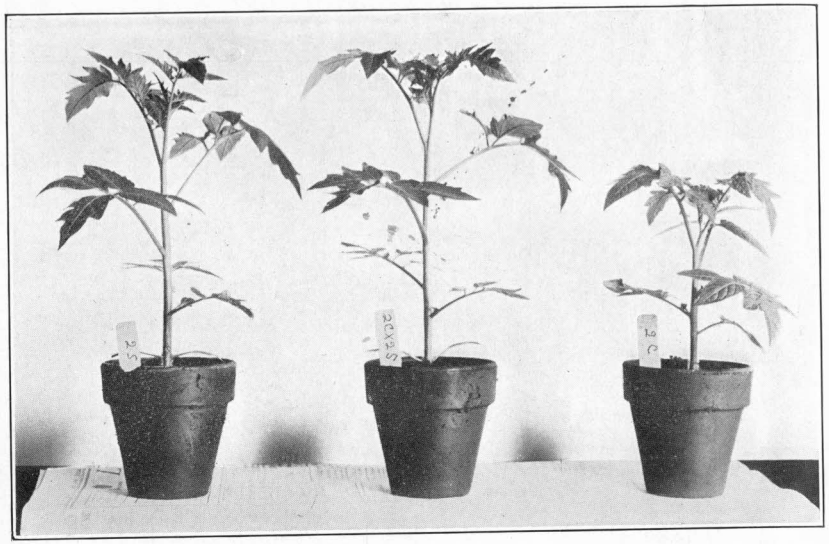
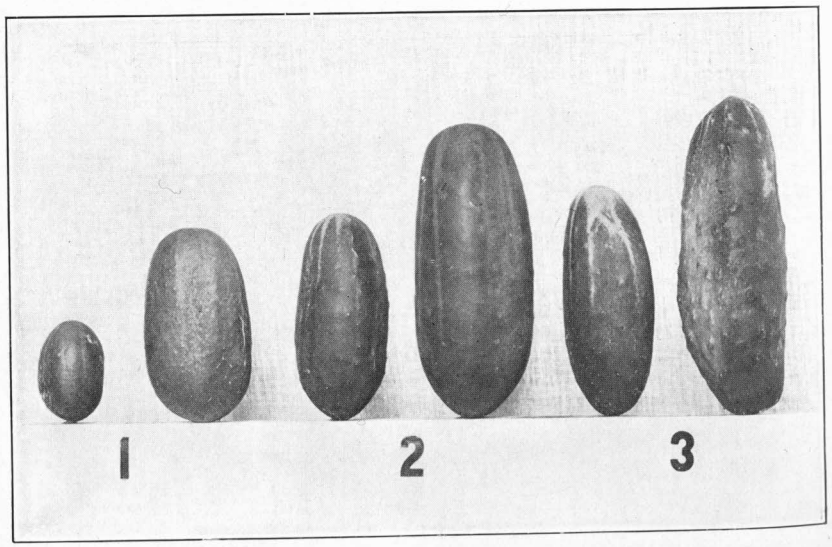
a. Dwarf Champion at the left; the first generation of the cross of Dwarf Champion by Stone at the right. All of the F_1 plants are standard like the Stone parent.

b. Dwarf Champion by Stone at the left; Stone at the right. This cross has yielded 15 per cent more than the Stone variety and has been somewhat earlier.

PLATE XVIII.



a. The tomato plants at the time of setting in the field. Stone on the left; Dwarf Champion at the right and the first generation cross of these two varieties in the center.



b. A first generation cucumber cross showing the longest and shortest fruits of each of the two parental varieties and of the cross. No. 1, Early Russian; No. 2, Early Russian by Fordhook Famous; No. 3, Fordhook Famous.

FIRST GENERATION CROSSES IN CUCUMBERS.

By

H. K. Hayes and D. F. Jones.

It was the plan of this experiment to make a two year test of a few plants of various cucumber crosses as a preliminary survey of the value of first generation crosses, and finally to test the better crosses on a commercial scale. The plants grown in 1914 were so badly attacked by the Mosaic or White Pickle* disease that no reliable results were obtained. As another attempt was made in 1915 with even less satisfactory results due to the same trouble, the testing of the crosses on a larger scale was abandoned and the preliminary results which were obtained in 1913 are given here.

In the spring of 1912 commercial seed was obtained of the following 4 varieties of cucumbers, Early Russian, White Spine, London Long Green and Fordhook Famous.

The vines of Early Russian do not grow to as large a size as those of the other three varieties. They produce a large number of male and female blossoms, with a tendency to set fruit in clusters. White Spine produces fruit of medium size and medium sized vines while Fordhook Famous and London Long Green produce large sized fruit and vigorous vines.

A few plants of each variety were grown in 1912 and four crosses were obtained. Unopened male and female blossoms were covered with a paper bag and when the female flowers opened they were pollinated with the desired male pollen. The following crosses were obtained: Early Russian × White Spine, White Spine × London Long Green, London Long Green × Fordhook Famous and Fordhook Famous × White Spine.

Each variety and the four crosses were planted in 1913 in hills in rows five feet apart each way. As soon as the plants were well started they were thinned to one plant per hill, for the purpose of making a study of individual plant differences. Two-thirds of the plants of each kind were sprayed about every ten

*For a description of this disease see Part VI of the Annual Report of 1915, p. 430, of this Station.

TABLE I.

First Generation Cucumber Crosses and Their Parents.

Varieties.	No. of Plants grown.	Ave. No. of Fruits per Plant.	Increase above more Prolific Parent.	Ave. Weight of Individual Fruits in Lbs.	Decrease below Larger Fruited Parent.	Ave. Length of Individual Fruits in Inches.	Decrease below Longer Fruited Parent.	Ave. Yield of Fruit per Plant in Lbs.	Increase above Heavier Yielding Parent.	Per cent. Increase in Yield.
Early Russian	7	32.9	...	.19	...	3.4	...	6.2	...	...
Early Russian×White Spine	12	39.5	6.6	.28	.09	4.7	.8	11.1	.2	1.8
White Spine	26	29.3	...	.37	...	5.5	...	10.9	...	...
White Spine×London Long Green	10	37.3	8.0	.37	.08	6.0	.6	13.9	2.7	24.1
London Long Green	9	25.0	...	.45	...	6.6	...	11.2	...	...
London Long Green×Fordhook Famous	10	26.6	1.6	.44	.01	6.5	.1	11.6	.4	3.6
Fordhook Famous	13	22.5	...	.45	...	6.6	...	10.1	...	...
Fordhook Famous×White Spine	9	35.7	6.4	.43	.02	6.2	.4	15.2	4.3	39.4
White Spine	26	29.3	...	.37	...	5.5	...	10.9	...	...

days with Bordeaux Mixture to prevent blight. The remainder of the plot was unsprayed.

The fruits were harvested before they commenced to turn yellow and the length, weight and number of fruits noted for each plant. Some plants were injured by borers, others by wilt and the mosaic disease. Those plants which were injured early in the season are not included in the table.

Table I gives the average number of fruits per plant, the average weight of individual fruits, the average length of fruit in inches and the average yield of fruit in pounds per plant for the varieties and crosses. The unsprayed plants were killed by blight about the seventh of September. The sprayed vines continued to bear until the last week in September.

An average of the sprayed and unsprayed results are given in the table. Column I gives the number of plants of each variety and cross from which data were taken. The number of healthy plants available were too few to base positive statements upon, however, the various crosses gave comparable results.

In average length and weight of fruit the crosses are of intermediate habit and considering the number of plants upon which the figures are based they correspond very closely to the average of the parents. The most important test of hybrid vigor is the total average yield of fruit per plant. The cross between Early Russian and White Spine gave about the same yield as the higher yielding parent; the White Spine × London Long Green cross exceeded the higher yielding parent by 24 per cent; the cross of Fordhook Famous × White Spine exceeded the better parent by 39 per cent while the London Long Green × Fordhook Famous cross gave about the same yield as the parents.

The character in which the increased vigor of the crosses is chiefly manifested is in the number of fruits per plant. All of the crosses exceeded the more prolific parent by an average of 1.6 to 8 fruits per plant which is from 6 to 27 per cent.

Summary of Results.

These preliminary experiments indicate that first generation cucumber crosses may frequently be expected to exceed the higher yielding parent in yield. The only cross which did not exceed the average of the parents in any character by an appreci-

able amount was the one between London Long Green and Fordhook Famous. The parental varieties of this cross are of similar habit, both producing about the same type of vine and size of fruit. The other three crosses were between parents which differ in vine habit, and in size of fruit. These crosses show an increase of vigor which was manifested in an increase in total number of fruits per plant.

INCREASING THE YIELD OF CORN BY CROSSING.

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AND
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Storrs Agricultural Experiment Station.

Two lines of investigation have been carried on at the Connecticut Experiment Station dealing with the improvement of corn by crossing. The first of these was planned to determine the effect of crossing varieties of corn which had been inbred previously for a long series of generations. The result of crossing such inbred strains has been, in many cases, a large increase in vigor and in a general tendency towards greater productivity. The increase obtained is not only above either of the inbred parental strains but surpasses that of the original variety before being subjected to inbreeding. The utilization of first generation crosses between suitable inbred strains promises to be a method of considerable value in improving the yield of corn.

However, the process of inbreeding and testing the crosses of the inbred strains to determine the most advantageous crosses is a matter of time. In order to have something of an immediately practical value the second line of investigation, to be reported here, has been carried out, which has consisted in testing numerous crosses between varieties of corn commonly grown in Connecticut without previously putting them thru the process of inbreeding. This investigation is a continuation of the work described in the 1913 Report of the Connecticut Station, but since that time has been carried on by the two Stations coöperating in order to have the crosses tested as thoroly as possible in different parts of the State.

The crosses have been grown both at Mt. Carmel and at Storrs and many of the same crosses have been grown more than one year. The results given here, together with the previous work carried on at the Connecticut Station (Hayes, 1913) and else-

where,* are considered to be conclusive as to the value of crossing, without previous inbreeding, as a method for increasing the yield of corn.

Varieties Used in the Experiments.

The aim has been to test the crosses between the highest yielding varieties grown in Connecticut that it has been possible to obtain. The corn variety tests carried on by the two stations has made available a large number of excellent varieties from which to select for crossing. The parental varieties used in making the crosses given here are among the best varieties as shown by the variety tests and are probably above the average of the varieties grown in Connecticut.

The following descriptions give the name of the variety, by whom grown and the number by which it is designated in the tables together with some of the chief distinguishing features of the variety:

Flint Varieties.

No. 38, Montgomery's White Flint. From Phelps Montgomery, Mt. Carmel, Conn.

A medium to large flint, maturing in about 100 days.

No. 40, Burwell's Yellow Flint. From E. E. Burwell, New Haven, Conn.

A medium to large flint, maturing in about 100 days.

No. 41, King Phillip. From W. E. Price, Warehouse Point, Conn.

A small, yellow flint with red colored pericarp, which is lighter in color at the crowns of the seeds. Matures in about 100 days.

No. 42, Davis' Yellow Flint. From Perley E. Davis, Granby, Mass.

A large, dark yellow flint, maturing in about 95 days.

No. 43, Taylor's Yellow Flint. From Geo. E. Taylor and Sons, Shelburne, Mass.

A medium sized flint, maturing in about 95 days.

No. 44, Brewer's Yellow Flint. From N. H. Brewer, Hockanum, Conn.

* For publications dealing with corn crosses the reader is referred to the literature list at the end of this report. Names and dates in parenthesis thruout the text indicate individual publications in this list.

A medium to large flint of the Canada Flint type, maturing in about 100 days.

No. 45A, Rhode Island White Flint. From the Rhode Island Experiment Station, Kingston, Rhode Island.

A short-eared flint, maturing in about 90 days.

No. 45B, Rhode Island White Flint. From F. W. Newton, South Canterbury, Conn.

A medium sized flint, maturing in about 100 days.

No. 47, Hill's Red Flint. From S. F. Brown, Windsor, Conn.

A medium large flint similar in type to King Phillip, maturing in about 100 days.

No. 51, Olmsted's White Flint. From O. S. Olmsted, Hazardville, Conn.

A large flint with from 8 to 10 rows on the ears which average over 12 inches in length. The butts are large and the tips do not fill out well. Mr. Olmsted uses this variety for silage. It matures in about 110 days.

No. 62, Lathrop's Yellow Flint. From Jason Lathrop, Plainfield, Conn.

A small-eared flint of the Canada Flint type, maturing in about 100 days.

Dent Varieties.

No. 36, Holcomb's Dent. From Wayne Holcomb, East Granby, Conn.

A medium sized dent of the "shoe-peg" type. Kernels spaced far apart between rows. Matures in about 100 days.

No. 37, Montgomery's White Dent. From Phelps Montgomery, Mt. Carmel, Conn.

A large dent, maturing in about 120 days.

No. 39A, Pride of the North. From A. G. Gulley, Storrs, Conn.

A medium sized, yellow dent, maturing in about 110 days.

No. 48, Tyler's White Cap Dent. From G. D. Hall, Wallingford, Conn.

A medium sized yellow dent with white tipped seeds, maturing in about 110 days.

No. 49, Early Huron Dent. From Joseph Harris Seed Co., Coldwater, New York.

A small eared, yellow dent with well shaped ears and seeds. It matures in about 110 days.

No. 52, Connecticut Dent. From C. L. Howes, Stamford, Conn.
A medium to large, yellow dent, maturing in about 115 days.

No. 53, Brewer's Dent. From N. H. Brewer, Hockanum, Conn.
A medium sized, yellow dent, maturing in about 115 days.

No. 54, Funk's 90 Day. From Funk Bros. Seed Co., Bloomington, Illinois.
A medium to large, yellow dent. Grains well shaped giving a large proportion of grain to cob. Ripens rather late in Connecticut, maturing in about 130 days.

No. 60, Golden Dent. From P. H. Woodford, Avon, Conn.
A distinct type of yellow dent corn with the outer hull or pericarp red on the sides of the seeds giving the ears a reddish appearance. The ears are short and thick. It matures in about 120 days.

No. 67, Dowd Dent. From R. C. Willcox & Sons, Guilford, Conn.
A medium to large, yellow dent. Seeds large and broad. It matures in about 110 days.

No. 83, Minnesota White Cap. From C. S. Griswold, West Hartford, Conn.
A medium to small eared, yellow dent with white tipped seeds, maturing in about 115 days.

Methods of Carrying on the Experiments and Sources of Error.

The crosses grown in any one year have resulted from a number of different varieties all crossed with one variety as a pollen parent by planting them in alternate rows between the variety used as male and detasseling all plants of the varieties to be crossed. The seed obtained from such detasseled and therefore necessarily cross-pollinated plants was grown the following year in a plot between the two varieties used in making the cross. The seed of the parental varieties was obtained each year from the original source so that the crosses and their parents were all grown from one-year-old seed. In a few cases where fresh seed could not be obtained two-year-old seed was used but we do not believe that there is any appreciable difference in the behavior of one or two-year-old seed of corn, and if there was, the number of times that two-year-old seed was used are so few that this factor would be negligible.

The methods used to obtain a fair comparison in yield between the several varieties and their crosses were the same as used in the variety tests. One variety was grown thruout the field in every fifth plot as a control in order to be able to correct for differences in the soil. The variety used as check was the pollen parent of the crosses. The arrangement of the varieties in the field, in all the tests except at Storrs in 1914, was as follows:

Plot No.
1. Male Parent, M (Check Plot).
2. Cross (A × M).
3. Female Parent, A.
4. Female Parent, B.
5. Cross (B × M).
6. Male Parent, M (Check Plot).
7. Cross (C × M).
8. Female Parent, C.
9. Etc.

This series was duplicated and triplicated in other parts of the field whenever space permitted and the separate yields were averaged, after being corrected for differences in the fertility of the soil as shown by the check plots.

Since the cross was grown immediately adjacent to and between its two parents the comparison between the crosses and their parents is a fair one except in some cases where the parents differ greatly in time of ripening. A cross between a late dent for example and an early flint would have a better chance to grow when planted between its two parents than the late, heavier yielding parent because of the fact that the early parent would not grow as tall and as vigorously as the later parent toward the end of the season. Hence the cross would have the advantage of more sunshine and less root competition than the later parent. This is not considered to be a very serious factor in these experiments because the two varieties of flints used as the pollen parent were rather large growing varieties, yielding more than many of the dents in some years. However, in 1915 three rows of each variety and cross were grown together in a plot and the yield taken only from the center row of each plot. This method tends to obviate the advantage noted above, which the crosses might have, because the center row is in competition with only

similar plants on either side of it. In 1915, when this method was followed, the crosses did not show up to quite as good advantage as in other years. This is a source of error which should be taken into consideration in testing first generation crosses.

Hartley et al. (1912) have raised an objection against the accuracy of previous tests of first generation crosses because they thought that the crosses were better acclimatized and adapted than the parents to the climatic and soil conditions where the tests were carried on because the plants to produce the crossed seed were grown the year previous to the test under those conditions, while the parents were not. This objection does not apply to our results as the varieties used were for the most part local Connecticut varieties already acclimatized and adapted to the conditions under which the tests were carried out. Furthermore, the crosses were all made at Mt. Carmel and grown at Storrs as well as Mt. Carmel.

Characters Which May Show the Vigor Derived from Crossing.

Numerous experiments with different species of plants have shown that the vigor due to hybridization may be manifested in many different ways. It is most noticeable in an increase in the general vegetative luxuriance of the crossed plants as shown by an increase in height, thickness of stem and number of leaves and branches in plants where these are indeterminant in number as well as a more vigorous and healthy appearance in general. The most important characteristic of corn crosses is their ability to yield. The yield of grain in some respects is also a good measure of hybrid vigor because it indicates the sum total of a plant's ability to grow. In other ways yield of grain is a poor indicator of hybrid vigor because some crosses between distantly related types are partially or completely sterile, yet exceedingly vigorous in vegetative parts. Moreover, yield depends upon so many things, chief of which are the environmental factors, that it is almost impossible to obtain consistent results when this character is used.

In its effect upon yield hybrid vigor acts in exactly the same

way as favorable external factors. The crossed plants are enabled to make a better use of the situation wherein they may be placed. As far as external appearances go this amounts to the same effect as would be obtained if the external conditions were made more favorable, such as by better cultural methods, more nearly the right amount of moisture or increased fertilization.

In other respects hybrid vigor has a directly opposite effect to that of favorable environmental factors chiefly in that it tends to shorten the time of production, as is noted in the part of this report on tomato crosses, whereas the opposite effect usually results from any external factor which also increases yield. In the experiments on corn reported here the time of ripening of the crosses is exactly intermediate between time of ripening of the two parents. It should be noted, however, that in yield the majority of the crosses exceed the performance of the higher yielding parents, which are almost always the later ones in ripening, so that, since the crosses are intermediate in time of ripening, the rate of growth is greatly accelerated. If by crossing an early variety of corn with a late one a larger yield can be obtained than from either variety and if that larger yield is produced in a week or ten days shorter time than the later parent requires, the saving in time is fully as valuable as the increase in yield. In Connecticut, which approximates the northern limit of profitable corn cultivation, the time of ripening is an important consideration and other things being equal determines the suitability of a variety of corn for growing here.

The Behavior of First Generation Crosses as Compared with Their Parents.

As should always be borne in mind, first generation corn crosses have no value unless they either excel their parents in one or more desirable features or combine valuable characters from two different varieties which can not be obtained in a single variety. In the following tables the yields of 51 first generation crosses are given and the increase of the cross above or the decrease below the higher yielding parent stated in bushels per acre and also in per cent. The yields are based on the average of all plots grown after they have been corrected according to differences

in fertility in different parts of the fields by the following method. Check rows are grown every fifth plot as noted before. Assuming the yields of the check plots to represent the productivity of that part of the field in which they were grown and also assuming that differences in the productivity of the soil graduate uniformly from one check plot to another, a theoretical check yield is calculated for the four plots between every two check plots in the field. The actual yield obtained from each plot is then compared with this theoretical check yield and the deviation above or below this is added to or subtracted from the average of all the check rows grown. The following illustration may help to make this method of correcting the yields clear:

Plot Number.	Corn Grown.	Actual Yield.	Theoretical and Actual Check Yield.	Difference between actual yield of corn tested and theoretical yield of check.	Corrected yield obtained by adding or subtracting this difference to the average of all check plots grown.
1	Check	50	50	0	52.5
2	Cross	75	51	+24	76.5
3	Variety	70	52	+18	70.5
4	Variety	40	53	—13	39.5
5	Cross	50	54	—4	48.5
6	Check	55	55	0	52.5

For the purpose of comparing the crosses with their parents directly it makes little difference whether this method of correcting the yields is followed or not since the crosses are grown close to and between their parents, but for the purpose of comparing the yields of the crosses with other crosses and varieties grown in other parts of the field it is essential to have some means of correcting for differences in soil fertility where these differences are appreciable.

When husking the corn after all of it has been weighed in the field a representative sample is taken and dried to a uniform moisture content and the yields all calculated to bushels of 68 pounds of ear corn, with 12 per cent. moisture, per acre. In this way late maturing varieties and crosses containing a large percentage of moisture when husked are on an equal footing with early maturing varieties.

TABLE I.

COMPARATIVE YIELD OF FIRST GENERATION CROSSES AND THEIR PARENTS, MT. CARMEL, 1914.

Variety No.	Variety Name.	Yield—Bushels per Acre.			Increase above Higher yielding Parent.	Decrease below Higher yielding Parent.	Per cent. Increase or Decrease.	Per cent. Increase over Average.
		Variety.	Variety Crossed by King Phillip.	King Phillip.				
36	Holcomb's Dent.....	76.1	91.1	78.9	12.2	....	15.5	17.5
44	Brewer's Flint.....	85.4	94.1	78.9	8.7	....	10.2	14.5
39A	Pride of the North.....	82.3	89.0	78.9	6.7	....	8.1	10.4
42	Davis' Flint.....	86.0	91.3	78.9	5.3	....	6.2	10.7
37	Montgomery's Dent.....	93.4	98.5	78.9	5.1	....	5.5	14.3
43	Taylor's Flint.....	79.0	81.8	78.9	2.8	....	3.5	3.5
38	Montgomery's Flint.....	75.5	79.6	78.9	.7	....	.9	3.8
53	Brewer's Dent.....	93.9	94.3	78.9	.4	....	.4	9.1
51	Olmsted's Flint.....	93.7	90.3	78.9	....	3.4	—3.6	4.6

TABLE II.

COMPARATIVE YIELD OF FIRST GENERATION CROSSES AND THEIR PARENTS, STORRS, 1914.

Variety No.	Variety Name.	Yield—Bushels per Acre.			Increase above Higher yielding Parent.	Decrease below Higher yielding Parent.	Per cent. Increase or Decrease.	Per cent. Increase over Average.
		Variety.	Variety Crossed by King Phillip.	King Phillip.				
53	Brewer's Dent	57.3	69.5	64.1	5.4	....	8.4	14.5
37	Montgomery's Dent.....	69.2	71.9	64.1	2.7	....	3.9	7.8
43	Taylor's Flint.....	60.0	66.4	64.1	2.3	....	3.6	6.9
39A	Pride of the North.....	67.5	69.7	64.1	2.2	....	3.3	5.9
51	Olmsted's Flint.....	72.1	72.9	64.1	.8	....	1.1	7.0
38	Montgomery's Flint.....	51.2	62.8	64.1	....	1.3	— 2.0	8.8
44	Brewer's Flint.....	50.8	59.3	64.1	....	4.8	— 7.5	3.1
36	Holcomb's Dent.....	71.4	66.4	64.1	....	5.0	— 7.0	—1.9
42	Davis' Flint.....	49.2	57.4	64.1	....	6.7	—10.5	1.2

In the tables the first column following the name of the variety gives the yield of that variety as the female parent of the cross. The second column gives the yield of the first generation cross of that variety with the male parent. King Phillip Flint was used as the male parent in 1914. The third column gives the yield of the male parent. This yield is the average of all

TABLE III.

COMPARATIVE YIELD OF FIRST GENERATION CROSSES AND THEIR PARENTS, MT. CARMEL, 1915.

Variety No.	Variety Name.	Yield—Bushels per Acre.			Increase above Higher yielding Parent.	Decrease below Higher yielding Parent.	Per cent. Increase or Decrease.	Per cent. Increase over Average.
		Variety.	Variety Crossed by Burwell's Flint.	Burwell's Flint.				
53	Brewer's Dent	63.1	77.1	69.6	7.5	....	10.8	16.1
49	Harris' Early Huron Dent	64.1	76.6	69.6	7.0	....	10.1	14.5
52	Howe's Connecticut Dent	48.3	73.6	69.6	4.0	....	5.7	24.7
48	Tyler's White Cap Dent	59.4	72.0	69.6	2.4	....	3.4	11.6
44	Brewer's Flint	59.0	71.3	69.6	1.7	....	2.4	10.9
43	Taylor's Flint	61.7	71.1	69.6	1.5	....	2.2	8.2
45A	Rhode Island White Flint	68.7	70.4	69.6	.8	....	1.1	1.7
47	Hill's Red Flint	62.3	69.6	69.6	.0	.0	.0	5.5
54	Funk's 90 Day Dent	47.9	65.5	69.6	....	4.1	— 5.9	11.4
42	Davis' Flint	62.7	64.9	69.6	....	4.7	— 6.8	— 2.0
41	King Phillip	51.9	59.8	69.6	....	9.8	—14.1	— 2.4
51	Olmsted's Flint	76.9	53.9	69.6	....	23.0	—29.9	—26.5

the plots grown of this variety. The fourth and fifth columns give the increase of the cross above or the decrease below the higher yielding parent in bushels per acre, and the sixth column expresses this difference in per cent. of the yield of the higher yielding parent. The last column gives the increase of the cross in per cent. above the average of the parents.

At Mt. Carmel all but one of the first generation crosses exceeded either parent in yield. At Storrs about half exceeded

the better parent, all but one exceeding the average of the parents. The greatest increase was 15.5 per cent at Mt. Carmel. No uniformity, however, is to be observed in the performance of these same crosses grown at New Haven and at Storrs. Some of the crosses which gave the greatest increase at Mt. Carmel gave a large decrease at Storrs and vice versa.

In 1915 all the varieties were crossed by Burwell's Yellow Flint and the same seed of both crosses and parents grown at

TABLE IV.

COMPARATIVE YIELD OF FIRST GENERATION CROSSES AND THEIR PARENTS, STORRS, 1915.

Variety No.	Variety Name.	Yield—Bushels per Acre.			Increase above Higher yielding Parent.	Decrease below Higher yielding Parent.	Per cent. Increase or Decrease.	Per cent. Increase over Average.
		Variety.	Variety Crossed by Burwell's Flint.	Burwell's Flint.				
49	Harris' Early Huron Dent	....	82.8	67.3	....	....	....	....
51	Olmsted's Flint	59.6	73.6	67.3	6.3	....	9.4	15.9
48	Tyler's White Cap Dent.	69.0	73.5	67.3	4.5	....	6.5	7.8
44	Brewer's Flint	54.4	68.9	67.3	1.6	....	2.4	13.0
43	Taylor's Flint	64.1	66.5	67.3	....	.8	— 1.2	.7
42	Davis' Flint	61.2	66.1	67.3	....	1.2	— 1.8	2.8
41	King Phillip	60.3	61.5	67.3	....	5.8	— 8.6	—3.6
52	Howe's Connecticut Dent	80.1	74.1	67.3	....	6.0	— 7.5	.5
47	Hill's Red Flint	64.9	60.4	67.3	....	6.9	—10.3	—8.6

Storrs and New Haven as in the previous year. At New Haven the majority of the crosses exceeded the better parent while at Storrs about half exceeded and half did not. All but two exceeded the average. On account of an error in determining the moisture in Harris' Early Huron the yield of that variety is not known at Storrs. Since the cross of that variety with Burwell's Flint gave the highest yield of any variety or cross grown that year it is pretty safe to assume that it yielded more, at least, than the average of its parents. It will be so considered in these tabulations. Two crosses, those of Harris' Early Huron and

Tyler's White Cap Dent by Burwell's Flint were among the highest yielding crosses at both Stations. Some of the other crosses, notably Howe's Connecticut Dent and Olmsted's Flint by Burwell's Flint, behaved in exactly the opposite way at the two Stations.

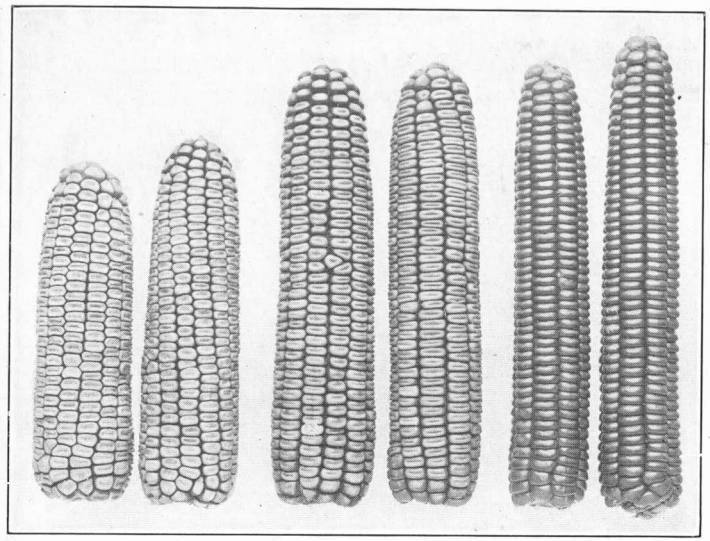
In 1916 the varieties were all crossed with Burwell's Yellow

TABLE V.

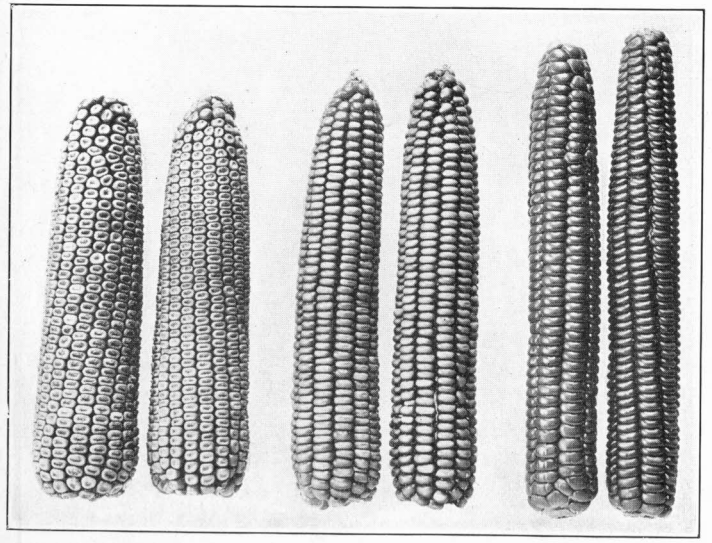
COMPARATIVE YIELD OF FIRST GENERATION CROSSES AND THEIR PARENTS, MT. CARMEL, 1916.

Variety No.	Variety Name.	Yield—Bushels per Acre.			Increase above Higher yielding Parent.	Decrease below Higher yielding Parent.	Per cent. Increase or Decrease.	Per cent. Increase over Average.
		Variety.	Variety Crossed by Burwell's Flint.	Burwell's Flint.				
48	Tyler's White Cap Yellow Dent	75.2	87.2	67.1	12.0	....	16.0	22.5
52	Howe's Connecticut Dent	80.8	91.8	67.1	11.0	....	13.6	24.1
47	Hill's Red Flint	54.4	73.9	67.1	6.8	....	10.1	21.5
60	Woodford's Golden Dent	80.6	86.9	67.1	6.3	....	7.8	17.6
49	Harris' Early Huron Dent	79.1	83.4	67.1	4.3	....	5.4	14.1
41	King Phillip	64.9	70.1	67.1	3.0	....	4.5	6.2
83	Minnesota White Cap Dent	93.6	95.9	67.1	2.3	....	2.5	19.3
45B	Rhode Island White Flint	52.8	68.1	67.1	1.0	....	1.5	13.5
67	Willcox's Dowd Dent	87.5	87.9	67.1	.4	....	.5	13.7
54	Funk's 90 Day Dent	95.0	95.5	67.1	.5	....	.5	17.8
62	Lathrop's Flint	52.9	65.3	67.1	....	1.8	−2.7	8.8
44	Brewer's Flint	....	60.9	67.1	....	6.2	−9.2	....

Flint as in the year before, but were grown only at Mt. Carmel. All but two of the twelve crosses grown exceeded the better parent and three of them gave increases of over 10 per cent. No seed of the Brewer's Flint variety was obtained that year. This cross did not exceed the male parent and it is not known whether or not it would have exceeded the average of the two parents. All the other crosses did.

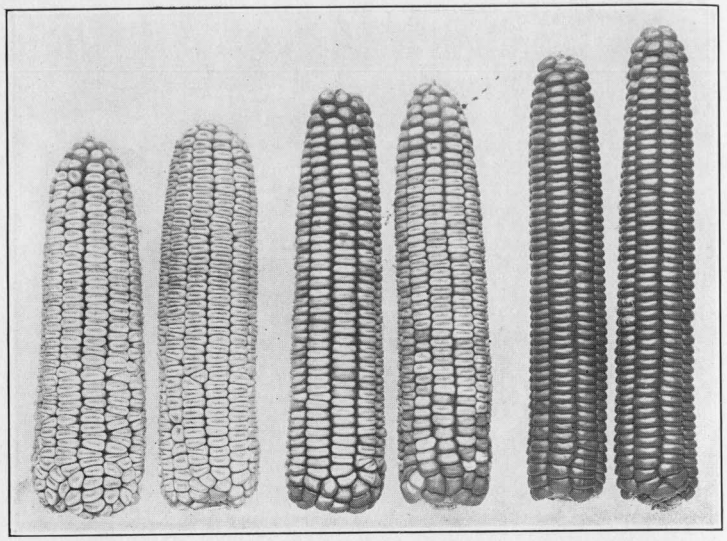


a. At the left Harris' Early Huron, at the right Burwell's Yellow Flint and the cross in the center. This cross has consistently yielded more than the dent parent and has been earlier in ripening.

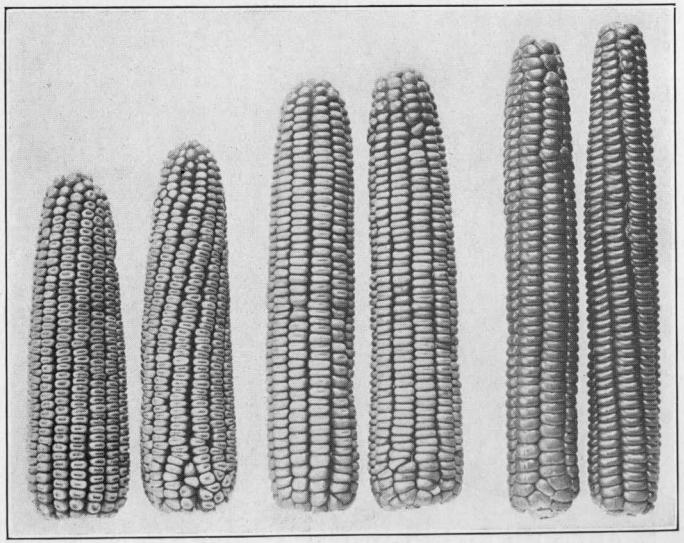


b. At the left Brewer's Dent, at the right Burwell's Yellow Flint and the cross in the center which gave the highest yield obtained in 1915 at Mt. Carmel, 10 per cent higher than the flint parent, the higher yielding parent, and ripened earlier than the dent parent.

PLATE XX.



a. Tyler's White Cap at the left and Burwell's Yellow Flint at the right. The first generation cross of these two varieties has consistently yielded more than the dent, the higher yielding parent.



b. The cross of Howe's Connecticut Dent by Burwell's Flint, shown in the center, has always matured earlier than the dent parent and at Mt. Carmel has also outyielded it.

In Table VI the average height of all the crosses and their parents is given together with the average number of days from planting to tasseling and maturing. In height the crosses exceeded the average of the parents slightly and in time of growth were almost exactly intermediate with the two parents. This fact is of considerable importance, as mentioned before, because in most cases it is possible to obtain not only as large or a larger yield from a cross of two varieties than from the higher yielding parent, but also to get this yield in a shorter time. For instance, in 1916, Howe's Connecticut Dent crossed with Burwell's Yellow Flint gave an increase of 13.6 per cent above the higher yielding parent and matured a week earlier than the dent

TABLE VI.

A Comparison of First Generation Crosses with their Parents in Height and Number of Days Required to Tassel and to Mature.

Place of Test.	Year.	Number of Crosses.	Aver. Height in Inches.		Average No. Days to Tassel.		Average No. Days to Mature.	
			Parents.	Crosses.	Parents.	Crosses.	Parents.	Crosses.
Mt. Carmel	1914	9	101	105	69	69	107	106
Mt. Carmel	1915	12	100	104	65	64	105	107
Mt. Carmel	1916	12	90	93	70	69	110	110
Storrs	1914	9	98	100	..	..	..	..
Storrs	1915	9	65	67	..	..	..	..
	Average		91	94	68	67	107	108

variety. Funk's 90 Day crossed with Burwell's Flint did not exceed the later variety in yield by any significant amount but matured in 12 days less time than the late parent, Funk's 90 Day; being almost exactly intermediate with both parents in time of ripening.

The behavior of corn crosses with respect to the time of ripening as compared with their parents is much more uniform than the yield. In general then the value of these corn crosses is found not alone in their ability to outyield their parents in many cases but also in their ability to grow in a shorter time than varieties giving the same yields,—a matter of great importance in Connecticut where the growing season is none too long.

Determination as to the amount of dry fodder produced by the crosses were made only at Storrs. The results for the two years in which crosses were grown there are given in Table VII.

TABLE VII.

THE YIELD OF FODDER OF FIRST GENERATION CROSSES AND THEIR PARENTS AT STORRS.

Year.	Number of Crosses.	Tons of Dry Fodder per Acre.	
		Average of Parents.	Average of Crosses.
1914	9	2.52	2.57
1915	12	2.90	2.98
Average.		2.71	2.78

The increase above the average of the parents in the amount of fodder produced is apparent each year but is inconsiderable. In corn the vigor derived from crossing seems to be expended in the production of grain rather than in vegetative parts.

Summing up all the crosses given in the preceding tables and classifying them according to their yields being more or less than either parent or average of parents the results given in Table VIII are obtained.

TABLE VIII.

SUMMARY OF THE CROSSES GIVEN IN TABLES I TO V.

Classification of all Crosses Yielding:	Tests at Mt. Carmel.			Tests at Storrs.		Total.	Per Cent.
	1914	1915	1916	1914	1915		
More than Either Parent.	8	7	10	5	3	33	66
More than Ave. of Parents.	1	2	1	3	4	11	22
Less than Ave. of Parents.	0	2	..	1	1	4	8
Less than Either Parent.	0	1	..	0	1	2	4
Total.	9	12	11	9	9	50	100

It can be seen from Table VIII that a large majority of the crosses exceeded either parent in yield and that 88 per cent exceeded the average of the parents. In all experimental work

with field crops there is a large fluctuation of results. Even if there were no tendency to increased yielding resulting from crossing, many crosses would be above the average or even above either parent as well as below, following the rule of chance variation. However, the fluctuations due to uncontrollable factors, which were above, would be balanced by an approximately equal number of fluctuations below. In these experiments the fact that 88 per cent of the crosses yielded more than the average of the parents means without any doubt that there is a tendency for hybrid vigor to result from crossing and that this added vigor increases yield.

In order that this hybrid vigor may have a practical value it must not only increase the yield above the higher yielding parent or shorten the time of growth, but must make it possible for some crosses to surpass any variety that it is possible to obtain. In other words, the corn grower, before he can give this method of improving corn any consideration, must know that it is possible to obtain, on the average, higher yields from crosses than from pure varieties. In this connection we can say that at the New Haven Station during the past five years* the testing of first generation crosses has been carried along with a test of all the most promising varieties of corn obtainable. From 15 to 65 varieties have been grown each year and a total of 78 different varieties in all tested in the five years. Altho only a fourth of these varieties were represented among the crosses, *every year the highest yield obtained was from a first generation cross.* The difference between the highest yielding cross and the next highest yielding variety was small but taking into consideration the fact that many new excellent varieties were added each year to the test as they were obtained which were not represented among the crosses makes the uniform excellence of the crosses of considerable importance.

To be strictly fair, the crosses should be compared with only the varieties used in making the crosses. This is done in Table IX by giving the distribution of the crosses and varieties in respect to yield. The yield classes are divided into differences of five bushels in yield. When the crosses and varieties both occur in highest yielding class the highest cross in every case

* Including the two years' results given in the 1913 report.

TABLE IX.

THE DISTRIBUTION OF ALL CROSSES AND THEIR PARENTS WITH RESPECT TO YIELD.

Year.	Yield, Bu. per Acre.	45–49	50–54	55–59	60–64	65–69	70–74	75–79	80–84	85–89	90–94	95–99	Ave.
1914 Mt. Carmel	Crosses	..	..	..	..	..	..	1	1	1	5	1	90.0
	Parents	..	..	..	..	..	..	12	1	2	3	..	82.0
1915 Mt. Carmel	Crosses	..	1	1	1	2	5	2	..	..	..	..	68.8
	Parents	2	1	2	5	13	..	1	..	..	..	..	62.6
1916 Mt. Carmel	Crosses	..	..	..	1	2	2	..	1	3	1	2	80.6
	Parents	..	3	..	1	12	..	2	2	1	1	1	70.5
1914 Storrs	Crosses	..	..	2	1	4	2	..	..	..	..	..	66.3
	Parents	1	2	1	10	2	2	..	..	..	..	..	62.5
1915 Storrs	Crosses	..	..	..	2	3	3	..	1	..	..	..	69.7
	Parents	..	1	1	4	10	..	..	1	..	..	..	65.8
Total Both Stations	Crosses	..	1	3	5	11	12	3	3	4	6	3	75.0
	Parents	3	7	4	20	37	2	15	4	3	4	1	69.0

outyielded the next highest yielding variety by from 0.2 to 3.0 bushels. This excess is small and occurring a few times would have little real significance but since it occurs every year and the crosses, as a whole, surpass the parents by an appreciable amount the results show clearly that crossing is a method of considerable importance in increasing the yield of corn. On the average the crosses exceed their parents by 6 bushels per acre or about 9 per cent.

It is not alone necessary that a cross should outyield its parents

TABLE X.

THE BEHAVIOR OF FIRST GENERATION CROSSES GROWN IN DIFFERENT YEARS AND IN DIFFERENT PARTS OF THE STATE.

Variety number.	Variety Crossed.	Per cent. Increase in yield above (+) or Decrease below (–) Higher yielding Parent. Storrs. 1915	Mt. Carmel. 1915	Mt. Carmel. 1916
49×40	Early Huron× Burwell's Yellow Flint	......	+10.1	+ 5.4
48×40	Tyler's White Cap× " " "	+ 6.5	+ 3.4	+16.0
52×40	Connecticut Dent× " " "	– 7.5	+ 5.7	+13.6
44×40	Brewer's Flint× " " "	+ 2.4	+ 2.4	– 9.2
43×40	Taylor's Flint× " " "	– 1.2	+ 2.2	......
47×40	Hill's Red Flint× " " "	–10.3	0	+10.1
54×40	Funk's 90 Day× " " "	......	– 5.9	+ .5
51×40	Olmsted's Flint× " " "	+ 9.4	–29.9	......
42×40	Davis' Flint× " " "	– 1.8	– 6.8	......
41×40	King Phillip× " " "	– 8.6	–14.1	+ 4.5

in any one year but it must be counted on to give that increase in most of the years grown in order to have real value. In Table X all of the crosses which were grown in more than one year and in more than one place are given and it can be seen that not all crosses behave uniformly in this respect.

Since no certain varieties for the most part give the highest yields year after year in the same locality or in different places in the same year, it cannot be expected that crosses between these variable varieties will differ from them in this respect. All we can say is, that our results show that on the average, with any varieties that may be grown, a higher yield can be expected from these varieties when crossed among themselves than can be

obtained from the varieties themselves and that on the average this increase amounts to about 9 per cent. Moreover, the crosses will produce a given amount of grain in a somewhat shorter time than their parental varieties require.

Whether or not these advantages resulting from crossing are sufficient to justify the increased cost of producing crossed seed is largely an individual matter. So much can be accomplished towards increasing the production of corn by growing the varieties best suited to a given locality and improving the cultural conditions under which these varieties grow that rightly the chief emphasis should be placed on these methods of improvement. But when all that can be done profitably has been done toward improving the methods of growing corn and when the varieties best adapted to the conditions under which they are grown are obtained, any further improvement must come thru either a process of selection within a variety or by utilizing the increased vigor to be derived from crossing suitable varieties. The process of selection within a variety is usually attended with more or less uncertain results. Moreover, the increase in yield which may be obtained in the first years of selection by the ear-to-row method, or progeny preformance test, usually ceases after selection has been practiced for a few years, owing to the more or less certain amount of inbreeding which takes place. At this stage a further increase in yield can be obtained only from crosses of certain varieties which crosses by thorough testing have been proven to surpass any variety known for the particular conditions in which the corn is grown.

Desirable Crosses.

The results show that certain crosses are clearly more desirable than others.

Tyler's White Cap Dent × Burwell's Flint has consistently outyielded the dent parent and has matured at about the same time.

Harris' Early Huron × Burwell's Flint has given high yields and has been earlier than the dent parent.

Howe's Connecticut Dent × Burwell's Flint has not always surpassed the higher yielding parent, but has always ripened considerably earlier.

Montgomery's Dent × King Phillip Flint gave the highest yield at Mt. Carmel in 1914 and the third highest yield at Storrs of all the varieties and their crosses, and was 15 days earlier in ripening at Mt. Carmel than the dent parent.

Brewer's Dent × King Phillip gave the second highest yield at Mt. Carmel in 1914 and was 6 days earlier in ripening. It also gave a good yield at Storrs that year.

Brewer's Dent × Burwell's Flint gave the highest yield in 1915, 10 per cent higher than Burwell's Flint, the higher yielding parent that year, ripening about a week later than the flint but earlier than the dent parent.

General Characters of the Crosses.

In nearly all hereditary characters these first generation crosses are as uniform as the parent varieties and generally intermediate with the two parents in such characters as the number of rows of grain on the cob, size, and shape of seeds, number of suckers and height of plant. Crosses between yellow and white seeded varieties give a mixture of yellow and white seeds in the ears. This mixture is no doubt rather objectionable in a market corn, altho it detracts nothing from its feeding value. If one or both of the parents has colored pericarp as for example, King Phillip, the first generation has red colored ears like the colored parent. Where there is such a mixture, this pericarp color nearly obscures the mixture of yellow and white endosperms underneath.

Special Consideration of the Crosses.

As would be expected there is a high correlation between the average yield of the two parents and the first generation crosses between them as shown in Table XI. This means that comparative yield is to a great extent determined by inheritance as would be expected, and that any effect which hybrid vigor may have on the crosses is uniform in its influence.

It was also expected that the greatest increases in yield of crosses above the average of their parents would be found in varieties which did not, themselves, give the highest yields,—simply for the reason that the amount of grain which any conceivable variety can yield is necessarily limited for physiological reasons, altho what that limit is may not be known. As varie-

ties approach that physiological limit it becomes increasingly more difficult for any increase in yield to be possible. However, in Table XII the crosses studied do not show any marked negative correlation between the average yield of the two parents and

TABLE XI.

CORRELATION BETWEEN AVERAGE YIELD OF PARENTS AND YIELD OF CROSSES.

Average Yield of Parents—Bu. per Acre.	Yield of Crosses—Bu. per Acre.										
	50–54	55–59	60–64	65–69	70–74	75–79	80–84	85–89	90–94	95–99	
55–59		2	1	1	1						5
60–64			2	5	4						11
65–69			1	3	9	2					15
70–74	1				1		1	2	1		6
75–79							2	1	1		4
80–84								1	2	2	5
85–89									2	1	3
	1	2	4	9	15	2	3	4	6	3	49

the per cent increase of the cross over the average of the parents. Altho the largest increases did not occur when the highest yielding varieties were crossed, the varieties, on the other hand, which were above the average in yield taken all together gave fully as large increases when crossed as those crosses whose parents were below the average in yield.

TABLE XII.

CORRELATION BETWEEN AVERAGE YIELD OF PARENTS AND PER CENT INCREASE OF THE CROSSES ABOVE THE AVERAGE YIELD OF PARENTS.

Average Yield of Parents—Bu. per Acre.	Per cent Increase of Crosses above Average Yield of Parents.										
	26–30	21–25	16–20	11–15	6–10	0–(−5)	+5–0	6–10	11–15	16–20	21–25	
55–57							1					1
58–60							1	2	2		1	6
61–63						1		1	2		1	5
64–66					1	2	2	4	2	2		13
67–69						1	1	3	1			6
70–72											1	1
73–75	1						1		1	1	1	5
76–78							1		1	1		3
79–81							1	1		2		4
82–84									2			2
85–87							1	1	1			3
	1				1	4	9	12	12	6	4	49

It is of considerable interest to note that the largest increase above the average of the parents occurs when the parents differ widely in yield as shown in Table XIII by the moderate correlation between the difference in yield of parents and per cent increase above the average of the two parents. This is due to the fact that greater increases occurred in the dent × flint crosses than in the flint × flint crosses. The deviation of all the flint × flint crosses was on the average 1.8 per cent below the average of the higher parents. The deviation below

TABLE XIII.

CORRELATION BETWEEN THE DIFFERENCE IN YIELD OF THE PARENTS AND THE PER CENT. INCREASE OF THE CROSSES ABOVE THE AVERAGE YIELD OF THE PARENTS.

Difference in Yield of Parents—Bu. per Acre.	Per cent. Increase of Crosses above Average Yield of Parents.										
	26–30	21–25	16–20	11–15	6–10	0–(−5)	+5–0	6–10	11–15	16–20	21–25	
0– 2					1		2	2				5
3– 5							2	4		1		7
6– 8	1					3	1	3	4	2	1	15
9–11									2			2
12–14							2	2	3	1	2	10
15–17							2	1	1			4
18–20						1			1			2
21–23									1		1	2
24–26												
27–29										2		2
	1				1	4	9	12	12	6	4	49

is largely due to one cross, in 1915 at Mt. Carmel, which was very much below the yield of the higher yielding parent. The dent × flint crosses gave an average increase of 5.7 per cent above the higher yielding parent which in nearly all crosses was the dent variety.

These results are in agreement with the conclusions reached by others who have tested first generation crosses, namely: that, in general, varieties of a more or less different type or from different geographical regions tend to show the greatest amount of hybrid vigor when crossed. This fact has an important bearing upon the cause of hybrid vigor. It has been assumed (East and Hayes, 1912) (Shull, 1914) that this stimulus to

development, so frequently accompanying cross-fertilization, was a physiological effect dependent upon the degree of heterozygosity in the organism and unrelated to the normal inheritance of definable, alternative characters. A way has recently been shown (Jones, 1917) by which it is possible to consider hybrid vigor as due to the bringing together of a greater number of favorable growth factors in one individual than were present in either parent alone, some of these favorable factors being contributed by one parent, some by the other. On this view, dent varieties of corn, in general, have certain characters which enable them to grow and produce grain which the flint varieties do not have. On the other hand, varieties of flint corn have certain characters which the dents do not have. Both types must have many characters in common. It is not unreasonable to assume that some varieties have many favorable characteristics which others do not possess. This must be so, or there could be no superiority of one variety over another in certain inherited characters. In order to apply this fact to a means of accounting for hybrid vigor it is necessary only to assume that no one variety has all the favorable characters. Crossing different varieties combines in the first generation all the characters which both parents possessed. True, these characters are all hybrid, i. e., represented by one determiner instead of two, but it has been shown that many characters are almost if not quite as well developed when in a hybrid as in a pure condition.

The chief objection previously held against this view has been the supposition, that if it were true, it would be possible to recombine in some individuals, in a pure or homozygous condition all the favorable growth characters which might be scattered about among different varieties of a species and that these fortunate recombinations could not be reduced in vigor by any amount of inbreeding. Since no such variety was known in corn or any other naturally cross-pollinated species it was thought that this objection was valid. Such, however, is not the case, because it has been shown, in the last few years, that characters are inherited in groups (linkage of hereditary factors*) and that there is not an independent reassortment of the characters

* For a complete account of factorial linkage see "The Mechanism of Mendelian Heredity" by Morgan, Sturtevant, Muller and Bridges. New York. 1915.

represented in these groups. For this reason it is not possible to accumulate all the desirable characters in one individual, and ultimately in a variety, in a pure condition unaffected by subsequent inbreeding.

In the varieties of corn as they exist at present many of the favorable growth characters are kept in a continual hybrid condition due to the constant crossing going on. Inbreeding automatically sorts out these hybrid characters so that certain of the inbred strains get some of the desirable characters and some get others in a pure condition together with the characters which all have in common. No one strain gets all of the favorable growth factors. Thus it is that inbreeding a naturally, widely crossed species is always attended by a reduction of vigor and that crossing these inbred strains brings back an immediate return, if the right combination is made, to a vigorous growing condition.

In the process of inbreeding many weak and undesirable types appear. These are eliminated, in time, by their own inability to reproduce themselves at as fast a rate as the more vigorous types. This result takes place whether or not there is a conscious selection of the more desirable types. With many unfavorable characters eliminated, crosses between inbred strains naturally grow to better advantage than the original variety, as has been shown by actual experiments (Shull, 1909; East and Hayes, 1912). Crossing different varieties of corn, as in the experiments reported here, has the same effect as crossing inbred strains, but to a lesser degree. From this view of the situation it is also possible to understand why crosses between varieties of a naturally self-pollinated species, as for example the tomato, may also give an increase in growth over either parental variety on the assumption that each variety has something to contribute to the cross which the other variety does not possess.

In the generations following the first one after the cross the automatic segregation of the different characters takes place whether the cross is artificially self-pollinated or left to pollinate itself at will. The reduction in vigor is most noticeable in the generations immediately following the first, in which the maximum stimulus to increased development is obtained. For this reason only first generation crosses give any promise of commercial value.

It is a well known practice among stock feeders to cross two pure breeds of live stock and grow only the first generation of this cross without attempting to breed from these crossed animals. They have found that such crossed animals are often more vigorous, less liable to disease, grow faster and are for these reasons more profitable to raise than the pure breeds. They know from actual experience that the following generations are usually not desirable.

For almost as long a time as animal husbandry itself has been given thought this practice of crossing fixed types of animals, to take advantage of hybrid vigor, has been followed. The principles underlying this phenomenon are essentially the same in plants as in animals. From the numerous crosses reported here and elsewhere it seems entirely as feasible for the corn grower to utilize this means of increasing production as it is for the live stock raiser.

Summary.

1. Fifty first generation corn crosses have been compared with their parents. Eighty-eight per cent. yielded more than the average and of these 66 per cent yielded more than either parent.

2. In time of ripening the first generation crosses were on the average intermediate when compared with their parents. Thus in crosses between varieties differing widely in time of ripening the first generation crosses not only yielded more than the late parent but matured considerably earlier. This increase in the rate of growth is considered to be fully as important under Connecticut conditions as any increase in yield.

3. The highest yielding parents gave the highest yielding crosses, as would be expected, but a rather unexpected result was obtained in that there was apparently no relation between the yield of the parents and the increase in the yield of the cross. High average yielding parents gave as large increases, when stated in per cent, as low yielding parents.

4. There was a tendency for the crosses whose parents differed in their ability to yield to give the greatest increase. This is also shown by the fact that the dent × flint crosses gave greater increases in growth than the flint × flint crosses.

5. These facts bear out the assumption that hybrid vigor is not the result of an indefinite physiological stimulation but merely

the result of the bringing together of greatest number of favorable growth factors. Crosses between varieties of diverse type therefore possess a greater total number of favorable growth factors than crosses between similar varieties and hence give larger increases when crossed.

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THE PURIFICATION OF SOY-BEAN VARIETIES.

D. F. JONES AND H. K. HAYES.

In the variety test of soy beans in 1913 a variety known as Kentucky appeared to be quite variable in plant habit and in flower and pod color. This variety was imported from Manchuria in 1911 and grown the following year in Kentucky. From its appearance, as grown in 1913, it was evident that the variety was not pure but consisted of a mixture of more or less diverse types. In order to obtain a uniform variety from this mixed stock it was necessary to select individual plants and propagate from them. It was thought that by selecting the more promising plants and testing their progeny that it might be possible to improve the variety somewhat.

Since the soy bean is a naturally self-pollinated plant the method of procedure for improvement by selection is the same as for any plant which is also naturally self-pollinated as for example wheat or beans. In varieties of such species numerous different types or pure lines often exist and these may differ from each other not only in visible characters but also in productiveness. All that selection can do in these naturally selfed varieties is to isolate these different pure lines after proper testing. When once isolated no further improvement in a pure variety is expected by continued selection. This does not mean that selection may not have some effect on self-pollinated plants altho in most plants any real change seems doubtful. All investigations on the efficacy of selection in pure lines of cultivated plants show that, for all practical purposes, selection is without results after the homogeneous type or strain is isolated.

The question may be raised, if self-pollinated plants do not vary, how do mixed varieties, such as this variety of Kentucky soy beans, come to exist? Such a mixed variety may result either from a mechanical mixture of seed, from cross-pollination or there may be actual germinal changes or mutations bringing about variation in a variety originally coming from a single plant. Some natural cross-pollination takes place in other closely related leguminous plants, as for example, peas and beans, altho self-pollination in these plants is the rule. No clear cases of natural

crosses are known to the writers to occur in soy beans but it is not unlikely that crossing does sometimes take place. The chances for mechanical mixing of seed are also very great where several varieties are grown and stored together.

From the Kentucky variety of soy beans grown in 1913 twenty-three plants were selected. These differed considerably in height and number of pods and in minor points with regard to color and shape of seed as shown in the accompanying table. Seed from these mother plants was planted in 1914 and records made of height, average number of pods and yield of seed calculated to bushels per acre. Notes were also made of differentiating characters such as time of flowering, color of flowers and seeds and habit of plant. These are all given in the table.

From this tabulation it can be seen that the selections grown from individual plants differ markedly in such definite characters as flower, seed and pod color and in type of plant. They also differed in quantitatively variable characters such as time of blossoming, height and number of pods. In these last two characters the progeny do not correspond closely to their parents, showing that these characters are largely fluctuations due to environment. Probably the yields are also largely fluctuations of similar nature. However, some of this difference in yield may be due to inheritance.

Unlike the original mixed variety all the plants in any selection were uniform in color of flowers, color of pods (one exception noted in table) and general type of plant.

Ten of the highest yielding selections in 1914 were grown the following year in plots consisting of three rows 100 feet long. The mixed seed of the original variety was grown in four different plots as checks and the yields corrected according to the check plot yields as explained in the part of this report on corn crosses. The yields of seed in pounds per acre of the ten different selections were as follows:

Variety.	Yield: Bu. per Acre.
Kentucky, unselected (ave. 4 plots)	25.9
Selection No. 1	24.1
" " 1 (Duplicate)	30.0
" " 2	25.6
" " 8	28.3
" " 9	30.0

TABLE SHOWING DIFFERENCES IN PURE LINES

	Parent Plants Grown 1913.			Progeny	
Selection.	Height of Parent Plant—Inches.	Number Pods on Parent Plant.	Color of hairs on Pods.	Average Height Inches.	Average Number of Pods.
Kentucky	(Unselected variety)	variable	grey and brown	40.4	57.4
1	23	106	grey	48.2	44.9
2	28	58	grey	48.8	46.8
3	25	82	grey (2 plants brown)	44.0	47.3
4	28	64	brown	42.4	44.0
5	16	62	brown	48.9	47.4
6	13	35	grey	34.6	35.5
8	31	32	grey	48.0	52.6
9	21	98	brown	43.0	52.7
10	29	79	grey	54.0	42.7
11	16	70	brown	40.3	36.2
12	24	117	brown	43.0	35.0
13	26	83	grey	41.0	22.5
15	29	43	grey	38.0	51.8
18	32	89	grey	40.0	30.4
18a	26	90	grey	46.0	40.0
20	21	92	grey	33.0	20.7
22	34	125	grey	42.0	53.6
23	28	162	brown	46.0	36.0
24	18	105	grey	35.7	34.2
25	23	109	grey	39.0	35.3
26	30	94	brown	32.0	29.3
27	21	94	brown	40.0	30.4
28	19	121	grey	35.0	23.8

Variety.	Yield: Bu. per Acre.
Selection No. 10	25.7
" " 11	30.4
" " 18a	26.2
" " 22	24.2
" " 24	32.8
" " 25	29.0

Two plots of selection No. 1 were grown in different parts of the field. They differed in yield by nearly as much as any two of the selections so that no great importance can be attached to the observed differences in yield. All but two exceeded the original variety in yield.

In 1916 three of these selections were grown in the general variety test of soy beans carried on that year. The yield of seed was not determined but in yield of forage, as published in bulletin 193 of this Station one of the selections was consistently more productive than the others and gave the third largest yield of dry forage of all the varieties grown.

Along with these selections from the Kentucky variety a

SELECTED FROM A MIXED VARIETY OF SOY BEANS.

GROWN 1914.

Selection.	Yield Bu. per Acre.	Color of Blossoms.	Date Blossomed.	Color of Seeds.	Plant Habit.
Kentucky	30.2	.....	.....	variable.....	.....
1	24.3	White	Aug. 1	yellow, uncolored eye	Falls down early
2	31.2	White	Aug. 1	light buff, brown eye	Nearly erect
3	23.3	Purple	Aug. 4	light buff, uncolored eye	Falls down badly
4	23.3	White	July 27	yellow, uncolored eye	Nearly erect
5	25.2	Purple	Aug. 1	greenish yellow, brown eye	Erect, red stalks
6	17.8	White	July 27	yellow, uncolored eye	Erect
8	27.6	White	Aug. 1	yellow, uncolored eye	Twining on tip
9	27.6	Purple	July 28	greenish yellow, black eye	Nearly erect
10	25.5	White	Aug. 1	greenish yellow, brown eye	Twining at ends
11	26.7	White	July 27	buff, uncolored eye	Nearly erect
12	22.3	Purple	Aug. 1	greenish yellow, black eye	Erect
13	18.0	White	July 27	greenish yellow, uncolored eye	Erect
15	24.7	.....	.....	yellow, uncolored eye	Nearly erect
18	22.3	White	July 29	yellow, uncolored eye	Nearly erect
18a	28.5	White	July 28	yellow, uncolored eye	Nearly erect
20	15.6	White	July 25	yellow, uncolored eye	Erect
22	37.4	.....	.....	yellow, uncolored eye	Nearly erect
23	22.3	Purple	Aug. 1	greenish yellow, uncolored eye	Falls down, retains leaves
24	26.8	White	July 28	yellow, uncolored eye	Erect
25	27.9	White	July 28	yellow, uncolored eye	Erect
26	20.1	Purple	Aug. 1	greenish yellow, black eye	Erect
27	16.8	Purple	Aug. 1	greenish yellow, black eye	Erect, red stem
28	25.7	White	July 28	yellow, uncolored eye	Erect, red stem

similar selection experiment was carried on with another variety known as Ito San. This variety, unlike Kentucky, was quite uniform. Seventeen selections were made in 1913 and grown the following year. These selections ranged in yield from 12.4 to 25.1 bushels of seed per acre whereas the unselected variety yielded 30.2 but was favored by its position in the field. Five of the highest yielding of these 17 selections were grown in larger plots in 1916 together with the original unselected variety. Their yields were as follows:

Variety.	Yield: Bu. per Acre.
Ito San, unselected (ave. 2 plots)	22.5
Selection No. 1	21.2
" " 2	22.8
" " 15	22.3
" " 29	20.3
" " 38	21.8

The yields of these selections are so nearly equal to each other and to the original, unselected variety that it is evident that the variety itself was quite pure and did not contain any types dif-

fering appreciably in productiveness just as no visible differences were observed.

No extensive experiment was planned with regard to methods of improving soy beans as the principles underlying the improvement of self-pollinated plants have already been fairly well determined. These results simply show that a mixed variety of soy beans can be purified and made uniform by selecting individual plants and increasing their progeny. These selections represent separately what was present in the original variety mixed together. Since these isolated types differ in visible, qualitative characters they may also differ in quantitative characters, such as height and productiveness as the results obtained indicate. If pure strains can be isolated which are more productive than the original variety the result is an improvement over the original variety.

The improvement, however, is more than in yield alone. A variety of a self-pollinated species composed of plants of similar hereditary constitutions tends to remain the same from year to year under different environmental conditions. A mixed variety tends to fluctuate from one year to another as the different component types respond differently to varying environments so that a variety may be greatly changed in a few years. This is due to the fact that the several types of which the variety is composed are not equally productive under different growing conditions.

This may be made clear by taking an assumed case, as an illustration, of a mixture of rye and wheat. If rye is assumed to be more productive than wheat on poor soil and that wheat is more productive than rye on good soil the results would be far different, in a few years in such a mixture, grown on a poor soil, than in the same mixture grown on good soil during the same period of years. If equal parts of the two grains were taken at the start the plot grown continually on poor soil would show an increasing proportion of rye. The plot on good soil would give an increasing proportion of wheat. The rate of change might be so rapid, if no selection was practiced and a representative sample, of the mixture harvested, planted each year, that conceivably in time one lot would become all rye and the other all wheat.

Something like this process is going on in mixed varieties of plants. Where productiveness of seed is the only consideration for which a variety is grown such fluctuations may not detract from its value since the more productive types, other things being equal, tend to be perpetuated. But if other considerations such as quality and yield of products other than seed, are sought, which are not correlated with seed production such fluctuations within a mixed variety may result in a marked decrease in the value of that variety. In this way also a chance mechanical mixture of one seed of a foreign variety might entirely change a variety in time if no selection was practised.

This is a rather extreme picture of what, in actual practice, is probably going on to a limited extent. It may, however, account in part for the present great confusion of names in soy bean varieties. Many quite different varieties are now being grown under the same names. It may also account for some of the apparent "running-out" of seed which is thought to take place in many varieties of plants. At least it emphasizes the importance of keeping varieties selected to type.

CO-OPERATIVE POTATO SPRAYING 1916.

G. P. Clinton, *Botanist.*
F. E. Rogers, *Farm Bureau Agent.*

NATURE OF EXPERIMENTS.

This is an account of co-operative experiments of the Connecticut Agricultural Experiment Station and the New Haven County Farm Bureau, with certain farmers in this county, to test the relative merits of Bordeaux Mixture and Pyrox, in spraying Green Mountain potatoes for the blight, etc., under ordinary farm conditions. The experiments were carried on at the farms of C. R. Treat and A. D. Clarke of Orange, and D. L. Clarke & Sons of Milford. The Pyrox used was kindly furnished by the Bowker Insecticide Company of Boston.

Iron-Age, horse-power sprayers of 50 gallon tank capacity were used, spraying four rows at once. In the case of D. L. Clarke & Sons and A. D. Clarke, two nozzles per row were used, whereas on C. R. Treat's patch only single nozzles were tried. Seven sprayings were made on the following dates:—1st, June 22d; 2d, July 3d; 3d, July 19th; 4th, July 28th; 5th, August 4th; 6th, August 17th; 7th, August 30th. This last spraying was omitted at A. D. Clarke's because the weeds at that time were too abundant to allow proper and efficient treatment. In the first and second sprayings of Bordeaux, lead-arsenate paste about 3-50, was added to control potato-bugs. Pyrox contains lead arsenate, so none was added to this. The checks were also given the 1st and 2d sprayings with lead arsenate only. The details of the treatments on the different farms were as follows.

TREATMENT AND FIELD CONDITIONS.

At the Treat farm as only one nozzle was used per row, it was thought advisable in order to secure a thorough coating of all of the vines with both the Pyrox and Bordeaux, that these plots be sprayed twice at each treatment. To compare with these and the checks, two other plots were gone over once, at each treatment, with Bordeaux. These latter served to determine the value of an imperfect method of spraying, which is very often followed. At both of the Clarke farms the plots were too large

to allow a single tank to cover them twice over at a single treatment. A tank was sufficient, however, to cover a plot about 1⅔ times over at A. D. Clarke's, and 1⅘ times at D. L. Clarke & Sons'. Each alternate time the spraying was started so that the portion which received only one application at the previous treatment, was sprayed twice over. At A. D. Clarke's there was also a Bordeaux plot that received only a single treatment at each application.

C. R. Treat.

The potato field here occupied a low level piece of ground where blight was liable to appear early and do considerable injury, if the season was favorable for its development. It contained about 4 acres with 90 rows running lengthwise averaging about 660 feet long, and planted 2 feet 10 inches apart. Rows 53-90, while not in the experiment, received partial treatment. The cultivation was good, although no hand work was given, and the field was well fertilized. The fertilization was not quite the same on the whole field, part receiving potash; but this was not taken into consideration, as the owner was not sure where it was applied, and no difference in the appearance of the plants was apparent. The vines made a very luxuriant growth, densely covering the field when fully grown.

The plan of spraying was as follows:

Rows 1– 8, Bordeaux, 4–4–50, once over each treatment.
" 9–12, Check. No treatment except two applications twice over of lead arsenate.
" 13–28, Pyrox, 10–50, twice over each treatment.
" 29–44, Bordeaux, 4–4–50, twice over each treatment.
" 45–48, Check. Same as rows 9–12.
" 49–52, Bordeaux, 4–4–50, same as rows 1–8.

A. D. Clarke.

This potato field was on a piece of ground much higher than that of Mr. Treat's, although in the same general neighborhood. It was also more uneven, so that during a wet period at one of the sprayings in July a few of the rows at one end could not be sprayed. The more elevated portions suffered somewhat from drought during the drier periods. The soil also was not so heavy, being more of a gravel. The potatoes received good fertilization and cultivation, except that after cultivation was

over the weeds gave more trouble than at the other farms. The field contained about three acres, with 123 rows varying somewhat in length because of its irregular shape. Those from which the yields were taken averaged about 475 feet long, and were planted 2 feet and 9 inches apart. The vines while making a good growth, did not so completely cover the ground as at the other two places.

The plan of spraying was as follows:

Rows 1– 8, Check. No treatment except two applications twice over of lead arsenate.
" 9– 32, Pyrox, 10–50, 1⅔ times over each treatment.
" 33– 56, Bordeaux, 4–4–50, 1⅔ times over each treatment.
" 57– 64, Check. Same as rows 1–8.
" 65–123, Bordeaux, 4–4–50, once over each treatment.

D. L. Clarke & Sons.

This was a level field somewhat similar to that of Mr. Treat's, except that as compared with the surrounding country it was more elevated, and the soil was somewhat lighter and more sandy. It was well fertilized and cultivated, and while the weeds in general were kept in control, nut-grass was plentiful in certain areas. It is not known what effect its presence exercised on the yield of potatoes. The field was about two acres in extent, containing 59 rows averaging about 525 feet in length, and 2 feet 10 inches apart. The vines were so luxuriant that it was difficult in the later sprayings to follow the rows across the field without running over the matted vines. The same difficulty was encountered at Mr. Treat's, but in a lesser degree, due to the higher ridging of the rows.

The plan of spraying was as follows:

Rows 1–16, Check. No treatment except one application of lead arsenate twice over.
" 17–36, Pyrox, 10–50, 1⅘ times over each treatment.
" 37–56, Bordeaux, 3–3–50, 1⅘ times over each treatment.
" 57–59, Check. Same as 1–16.

BLIGHT CONDITIONS.

Blight first appeared between July 19th and 28th, following a period of rainy and cloudy weather, when it got started over the state, and was seen in all three experimental fields, perhaps most

abundantly in that of Mr. Treat. Fortunately the weather changed soon afterwards and a bright dry period followed, so that on August 4th the blight had not made much further progress. By August 17th its gradual increase was becoming more evident on the checks, and some little was showing on the imperfectly sprayed vines. From this period until the end of the season it progressed slowly, but the damage was not as great as expected because of the check the disease received after its first appearance, and the bright dry weather during the latter part of the summer.

At the time of the last spraying, August 30th, the blight at A. D. Clarke's did not show prominently on either the sprayed or unsprayed plots, although the vines in all of these plots were dying prematurely, apparently from competition with the weeds. On this account the last spraying was omitted, as it would have been of little value. At Charles R. Treat's, while from the street no very marked difference was apparent between the sprayed and unsprayed plots, when one walked into these plots and examined the plants carefully, it was quite evident that the twice over Bordeaux had very little blight and the foliage was in excellent shape, whereas the checks had considerable blight, with the result that a large part of the foliage was either dead or dying. The once over Bordeaux and the Pyrox were intermediate between these two extremes.

At D. L. Clarke & Sons' from a distance there was perhaps the most contrast between the vines sprayed with Bordeaux and Pyrox and those unsprayed, the latter showing stiff erect vines largely denuded of their foliage, while the former still held their leaves for the most part unaffected.

COST OF SPRAYING.

A general account of cost of labor and material used in the different treatments was kept. We have figured that a man and boy were necessary to do the spraying, the boy to help make the fungicide and follow the machine to watch the nozzles. For success it is essential to thoroughly strain the mixture as it is put into the tank, and to clean the tank carefully at the close of each spraying to remove sediment. As a general rule it takes one hour to fill a 50 gallon tank and spray it on the vines.

This time will vary with the number of nozzles used and the distance of the field from the water supply. With single nozzles, spraying four rows, 50 gallons will spray on the average one acre once over, varying with the speed of the horse, etc. At the Treat farm it took one hour and one tank of material to spray an acre once over. At the Clarke farms where two nozzles were used per row, it took approximately one and one-seventh tanks of material and one and one-seventh hours of time to spray an acre.

Computing the expenses has been more difficult than in ordinary years due to the great variation in prices of materials and labor, which, through all the season have been higher than usual. Somewhat arbitrarily these have been placed as follows:—

Copper sulphate @ 15c per pound.
Lime @ 1c per pound.
Lead arsenate (paste) @ 13c per pound.
Pyrox @ 13½c per pound.
Man with horse and spray-cart per day of 10 hours $4.50, or 45c per hour.
Boy per day of 10 hours $1.25, or 12½c per hour.

The actual costs for each of the various treatments based on uniform plots of one acre, are as follows:—

Charles R. Treat.

Bordeaux twice over:	
7 sprayings (14 tanks), @ 64c per tank of 4–4–50 Bordeaux, ...	$8.96
12 lbs. lead arsenate in 2 sprayings of above, @ 13c per lb., ...	1.56
Cost of making and applying same, 14 hours, @ 57½c per hour, ..	8.05
Total cost, ...	$18.57
Cost of spraying with lead arsenate, ...	3.86
Net cost over check, ...	$14.71
Bordeaux once over:	
7 sprayings (7 tanks), @ 64c per tank of 4–4–50 Bordeaux, ...	$4.48
6 lbs. lead arsenate, @ 13c per lb., ...	.78
Cost of making and applying same, 7 hours, @ 57½c per hour, ..	4.02
Total cost, ...	$9.28
Cost of spraying check with lead arsenate, ...	3.86
Net cost over check, ...	$5.42

Pyrox twice over:	
7 sprayings (14 tanks) of 10–50 Pyrox, @ $1.35 per tank,	$18.90
Cost of mixing and applying same, 14 hours, @ 57½c per hour,	8.05
Total cost,	$26.95
Cost of spraying check with lead arsenate,	3.86
Net cost over check,	$23.09
Check, no fungicide:	
12 lbs. (4 tanks) lead arsenate, 2 sprayings, twice over,	$1.56
Cost of applying same, 4 hours, @ 57½c per hour,	2.30
Total cost,	$3.86

A. D. Clarke.

Bordeaux 1⅔ times over:	
6 sprayings (11 3/7 tanks) 4–4–50 Bordeaux, @ 64c per tank,	$7.31
11 3/7 lbs. lead arsenate in 2 sprayings of above, @ 13c per lb.,	1.48
Cost of making and applying same, 11 3/7 hours, @ 57½c per hour,	6.55
Total cost,	$15.34
Cost of spraying checks with lead arsenate,	3.68
Net cost over check,	$11.66
Bordeaux once over:	
6 sprayings (6 6/7 tanks) 4–4–50 Bordeaux, @ 64c per tank,	$4.39
6 6/7 lbs. lead arsenate in 2 sprayings of above, @ 13c per lb.,	.89
Cost of making and applying same, 6 6/7 hours, @ 57½c per hour,	3.94
Total cost,	$9.22
Cost of spraying checks with lead arsenate,	3.68
Net cost over check,	$5.54
Pyrox 1⅔ times over:	
6 sprayings (11 3/7 tanks) 10–50 Pyrox, @ $1.35 per tank,	$15.43
Cost of mixing and applying same, 11 3/7 hours, @ 57½c per hour,	6.55
Total cost,	$21.98
Cost of spraying checks with lead arsenate,	3.68
Net cost over check,	$18.30
Check, no fungicide:	
11 3/7 lbs. lead arsenate (3.8 tanks), 2 sprayings 1⅔ times over,	$1.49
Cost of applying same, 3.8 hours, @ 57½c per hour,	2.19
Total cost,	$3.68

D. L. Clarke & Sons.

Bordeaux 1⅘ times over:	
7 sprayings (14⅖ tanks) 3–3–50 Bordeaux, @ 48c per tank,	$6.91
12⅓ lbs. lead arsenate in 2 sprayings of above, @ 13c per lb.,	1.60
Cost of making and applying same, 14⅖ hours, @ 57½c per hour,	8.28
Total cost,	$16.79
Cost of spraying check with lead arsenate,	2.20
Net cost over check,	$14.59
Pyrox 1⅘ times over:	
7 sprayings (14⅖ tanks) 10–50 Pyrox, @ $1.35 per tank,	$19.44
Cost of making and applying same, 14⅖ hours, @ 57½c per hour,	8.28
Total cost,	$27.72
Cost of spraying check with lead arsenate,	2.20
Net cost over check,	$25.52
Check, no fungicide:	
6 6/7 lbs. lead arsenate (2 2/7 tanks) 1 spraying, twice over,	$ .89
Cost of applying same, 2 2/7 hours, @ 57½c per hour,	1.31
Total cost,	$2.20

DATA AND CONCLUSIONS.

Manner of obtaining data.

The potatoes of D. L. Clarke & Sons were dug on September 20th, and those of Messrs. C. R. Treat and A. D. Clarke, on October 9th. In each case the vines were entirely dead at the time of digging. To determine the yields in each plot, at least three 100 foot lengths were dug and weighed. These were selected from different rows at each end and the center of the plot. Where possible these lengths were parallel and adjacent to each other in the different plots. The potatoes were weighed as firsts and seconds, the class being determined solely by size, as it was not considered fair to throw scabby potatoes into the second grade, since spraying bears no relationship to scab. The rotten and blight infected tubers were not weighed, but a record kept of the number occurring in each plot. There was not any considerable number found in either the sprayed or unsprayed plots.

The yield per acre for each plot was determined by multiplying

the average weight of the different tests by 145.2, since an acre field 10 by 16 rods with the rows 3 feet apart will contain this number of 100 foot lengths, and by dividing by 60, the number of lbs. per bushel. The actual yields should run somewhat higher than the figures given, since in all the fields the rows were less than 3 feet apart; but to make the results more uniform they were computed on that distance.

Price of Potatoes.

The yields were very satisfactory averaging much higher than those of the ordinary farmer this year, although the yield for the state was also higher than usual. Coupled with the good yields was the unusually high price which the tubers brought when sold. These good yields and prices must be taken into consideration when comparing the results with those of ordinary years. None of the growers sold their firsts for less than $1.25, and a portion of one crop was sold as high as $1.80. A very satisfactory price was also received for the seconds. According to the grading the growers would make, about 1 bushel of seconds was secured to 10 bushels of firsts. It would not seem more than fair, therefore, to estimate the entire crop of each grower at $1.25 per bushel, which figure has been used in determining the results of the different experiments. The results computed on the basis of yields, costs, with gain or loss per acre, are given in the accompanying table.

Conclusions.

A perusal of the table will show that the spraying of these fields with Pyrox was not a profitable venture, since in two of the experiments the yields were actually less than in the adjacent check or unsprayed plots. In the third case (Treat's), the increased yield was sufficient to a little more than pay for the cost of the spraying. Under more satisfactory conditions the Pyrox at least should have given as good yields as the checks, as will be explained later, but due to its greater cost, and its apparently less beneficial results, there seems to be no particular reason for its use in the place of home-made Bordeaux.

The thorough spraying with Bordeaux in two of the three

TABLE I.

YIELDS, COSTS, GAINS OR LOSS PER ACRE FOR DIFFERENT TREATMENTS.

	1sts. bu.	2ds. bu.	Total bu.	+ or − bu. over check.	Value + or −	Cost over check.	Gain or loss over check.
At C. R. Treat's Farm:—							
Bordeaux, 4-4-50, twice over	339.8	28.1	367.9	(+) 70.2	(+) $87.75	$14.71	(+) $73.04
Bordeaux, 4-4-50, once over	286.1	40.6	326.7	(+) 29.0	(+) 36.25	5.42	(+) 30.83
Pyrox, 10-50, twice over	282.7	36.3	319.0	(+) 21.3	(+) 26.63	23.09	(+) 3.54
Checks, with lead arsenate only	265.0	32.7	297.7				
At A. D. Clarke's Farm:—							
Bordeaux, 4-4-50, 1⅔ times over each treatment	187.6	22.5	210.1	(−) 43.0	(−) $53.75	$11.66	(−) $65.41
Bordeaux, 4-4-50, once over each treatment	206.2	29.0	235.2	(−) 17.9	(−) 22.38	5.54	(−) 27.92
Pyrox, 10-50, 1⅔ times over each treatment	194.1	38.7	232.8	(−) 20.3	(−) 25.38	18.30	(−) 43.68
Checks with lead arsenate only	222.1	31.0	253.1				
At D. L. Clarke & Sons' Farm:—							
Bordeaux, 3-3-50, 1⅘ times over each treatment	279.0	44.3	323.3	(+) 30.0	(+) $37.50	$14.59	(+) $22.91
Pyrox, 10-50, 1⅘ times over each treatment	237.8	52.8	290.6	(−) 2.7	(−) 3.38	25.52	(−) 28.90
Checks with lead arsenate only	246.1	47.2	293.3				

experiments (Treat's and Clarke & Sons), gave very satisfactory results. Not only did the yields prove greater than those of the checks, but these were great enough to return a profit of about $73 per acre in one case, and of $23 in the other, after the expense of the spraying had been deducted. In the third case the spraying was not profitable, for the same reason that the Pyrox was not at this farm, as will be stated later.

The less thorough spraying once over with Bordeaux, in one case gave a profit and the other did not. The profit was so much less at the Treat farm, about $31 net as compared with $73 for the thorough treatment, that the latter type of spraying seems to be much more desirable.

Why the Pyrox did not give as large a yield as the checks at the D. L. Clarke & Sons farm is not very clear, since the vines kept green longer and seemed to indicate a higher yield. Possible variation in the fertility of the land may have had something to do with it. At the A. D. Clarke farm there seemed to be a definite reason for the lower yield of both the Pyrox and the Bordeaux plots. As stated previously these plots were greener and freer from blight than the checks up to the end of the sixth spraying on August 17th. About that time, however, the weeds began to make such headway that by the time of the last spraying, August 30th, they were so large as to make the treatment impracticable, and their competition had caused the potato vines, especially in the sprayed plots, to begin to die prematurely. This was at a time when the sprayed vines were just beginning to gain from the treatment by adding to the growth of the tubers. Previously the spraying had caused the vines to develop at the expense of the tubers, and this, together with the slight injuries due to the trampling of the vines in the process of spraying, had made the actual tuber development at this time less than that of the checks; then before they had time to catch up, much less to lead the checks, as they undoubtedly would have done due to the protection of the foliage against blight, they were killed prematurely by the weeds. In the fifteen years of the senior writer's experiments with potato spraying, this is the only case where vines sprayed with Bordeaux mixture have actually given a lower yield than the unsprayed vines, so the explanation seems probable.

REPORT OF ORCHARD WORK ON MOUNT CARMEL EXPERIMENT FARM FOR YEARS 1911 TO 1916 INCLUSIVE.

E. M. STODDARD, *Assistant Botanist.*

The orchard work at the Mount Carmel Experiment Farm has been divided between the Old Apple Orchard, a New Apple Orchard, and a Peach Orchard, and each division will be separately considered. While we believe that a large part of the operations conducted in these orchards are practical for the individual orchardist, they have not been conducted as model, but rather as experimental orchards, where the relation of cost to receipts cannot approximate commercial orchard operations.

THE OLD ORCHARD.

The old apple orchard contained forty-six neglected trees, about twenty-five years old, planted irregularly on approximately one acre of ground. The varieties were chiefly Greenings and Baldwins, with two Russets and four trees of unidentified varieties, presumably local seedlings. These trees were growing in sod and had received very little pruning or care of any kind. The trees on the north end of the plot had received the drainage from a barnyard and had consequently made considerably more growth than the trees on the south end of the orchard.

This orchard has been pruned with the idea of getting low headed trees with open centers on which the fruit can be sprayed and picked easily, and which will also be open enough to permit good coloring of the fruit on all parts of the tree. This has necessarily been done gradually, as excessive pruning at one time would have resulted in sun scald and injury to the trees. At this writing the process of thinning is nearly completed, but the heading back on some of the trees is still being done. The trees which are being headed back are putting out branches lower down on the main limbs very satisfactorily, in fact fruit was gathered in 1915 on branches which have grown since 1911. In connection with the pruning it may be mentioned that rotten stubs have been cleaned out and the holes filled with cement. This was done in

1914, and so far seems to have been successful, as in all cases wood is growing over the cement and all the fillings have held firmly in place.

Four large trees have been grafted to more desirable varieties, and while the limbs in most cases were larger than is usual to graft, a large per cent of the scions are growing vigorously. The grafting was done on the upper part of the trees in 1914 and the remaining part in 1915, to prevent too great a shock to trees by the removal of so many large limbs.

The orchard was badly infested with San José scale, but by careful and thoro fall and winter spraying with commercial lime and sulphur this pest has been practically exterminated. Summer spraying for fungous troubles and insects has been practiced since the summer of 1912, the details of treatment and materials used being given below. In this report it is not desirable to take up the results of spraying in detail; however, comparison with check trees, not sprayed in summer, shows that all the mixtures used, have controlled both fungi and insects.

In 1911 the orchard was left in sod, but since has been plowed each year until 1916 and cultivated to keep out a heavy growth of weeds until cover crops were sown in the late summer or fall. In 1915 the entire plot was seeded to orchard grass and is to be left in sod for a few years, as the trees have made a very heavy growth, evidently at the expense of color on the fruit. The clover sown in 1912 as a cover crop was a failure, but the rye made a rank growth which provided ample cover for the winter, as have succeeding crops of rye.

In 1911 the fruit was inferior and the yield insignificant, no record being kept. The yield of 90 bushels in 1912 was of inferior quality, but was harvested and sold. The largest yield was in 1913, but due to rapid growth following rains in the fall, was of poor color and in general did not keep well. The per cent of first grade fruit increased in 1914 and 1915, and reports from buyers show that the keeping quality was good. The fruit has been picked by hand, sorted immediately, and from lack of storage facilities and the nature of the trade supplied, was put on the market at once. A large per cent of the first grade fruit was sold in boxes, not because it was a particularly fancy grade of fruit, but on account of the ease in handling, the demand of the trade catered to, and the cheapness as compared with barrels.

Three boxes holding somewhat more than a barrel could be had for 39 cents, including cost of assembling, while new barrels with heads cost 45 to 48 cents apiece. A large part of the increase in average price per bushel as noted in Table No. I is due to the increased per cent of first grade fruit, and not to increase in apple prices, for the crop was sold at nearly the same price per bushel for the different grades in 1913, 1914 and 1915.

TABLE I. FERTILIZERS, COVER CROPS, CULTIVATION, YIELD OF FRUIT.

Fertilizers.

1911. None.

1912. 10 tons horse manure and about 31 lbs. nitrogen, 8 of phosphoric acid and 75 of potash in form of nitrate of soda (200 lbs.), muriate of potash (150 lbs.), and basic phosphate (50 lbs.).

1913. About 23 lbs., 32 lbs., and 225 lbs. respectively of nitrogen, phosphoric acid and potash in the same forms as above.

1914. About 31 lbs. of nitrogen and 96 lbs. of phosphoric acid in form of nitrate of soda (200 lbs.) and basic phosphate (600 lbs.).

1915. About 32 lbs. of nitrogen and 116 lbs. phosphoric acid in form of nitrate of soda (150 lbs.), acid phosphate (350 lbs.), and ground bone (300 lbs.).

1916. None.

Cover Crops.

1911. None.
1912. Red clover and rye, sown Aug. 1-7.
1913. Rye, sown Sept. 10.
1914. Rye, sown Sept. 17.
1915. Seeded with 22 lbs. orchard grass July 31.
1916. Hay cut and placed around trees.

Cultivation. Plowed early and cultivated as necessary until midsummer each year.

Yield of Apples	Bushels	Av. price per bushel Cts.
1911	Very few	—
1912	90	50
1913	328	58
1914	202	60.6
1915	240	72.3
1916	160	96.5

Table II gives the cost of all operations included in Table I. The cost of materials represents the actual amounts paid for the various items, while labor is estimated from records of

average time taken for the various operations. Hand labor is computed at 20 cents per hour, double team labor at 50 cents per hour, and single horse labor at 37½ cents per hour. It will be noted that labor comprises 71.6 per cent of total cost, from which it may be supposed that the private individual undertaking the same operations could cut down the actual cash outlay required by doing considerable of the work himself. Also, while this orchard has been managed to a large extent in a commercial way, certain experimental work has increased the labor cost somewhat.

THE NEW APPLE ORCHARD.

The new apple orchard covers an area of 3.03 acres of land which had formerly been an old pasture, overgrown with gray birch, sumac and other bushes, and plentifully besprinkled with all sizes of stones. In the spring of 1911 this piece of land was cleared of the brush and large stones, and the trees planted 40 x 35 feet. The following varieties and numbers of each were set in the spring of 1911:

Baldwin	32	Northern Spy	4
R. I. Greening	16	Gravenstein	4
Rox. Russet	8	Fall Pippin	4
McIntosh	8	Hurlburt	4
Sutton	8	King	4
Wealthy	8	Duchess	4

In making this list of varieties the object sought was to include the standard varieties that are most commonly grown in Connecticut.

At the time of planting the trees were cut to whips about two feet in height for the purpose of inducing a growth of branches low enough down to insure low headed trees. In succeeding years the orchard has been pruned to secure low headed, open, and uniform shaped trees, which will bear crops of fruit where they can be easily sprayed and harvested.

These trees have been sprayed with commercial lime and sulphur, 1–9, each winter as an insurance against attacks of San José scale, and at the present writing only two trees have shown any infection of this insect. Bordeaux and lime and sulphur, with lead arsenate as an insecticide, have been used as a summer spray, the details of which are shown in Table IV.

TABLE II. OLD APPLE ORCHARD.

EXPENSES AND INCOME, 1911–1916.

Year.	Fertilizer.		Cover Crops.		Spraying.		Harvesting.		Cultivating.	Pruning.	Total Expenses for Year.	Receipts.	Gain or Loss.
	Material.	Labor.	Seed.	Labor.	Material.	Labor.	Material.	Labor.					
1911	.....	.....	.....	.....	$ 2.40	$ 7.00	.....	.....	.....	$16.00	$ 25.40	.....	—$25.40
1912	$16.36	$11.00	$3.50	$2.00	8.56	20.00	$ 6.00	$ 6.00	$12.42	10.00	95.84	$ 54.00	—41.84
1913	14.35	3.00	.90	2.00	6.16	13.00	30.00	70.00	12.50	8.00	159.91	192.70	+32.79
1914	8.30	3.00	.75	2.00	13.89	23.75	23.50	48.00	12.23	17.00	152.42	122.48	—29.94
1915	9.07	3.00	3.96	2.00	8.40	13.50	5.00	51.60	11.00	4.00	111.53	173.60	+62.07
1916	.....	.....	.....	2.69	10.92	14.30	18.14	72.00	.....	7.00	125.05	154.10	+29.05
Total	$48.08	$20.00	$9.11	$10.69	$50.33	$91.55	$82.64	$247.60	$48.15	$62.00	$670.15	$696.88	+26.73

Income over expenses in six years, $26.73.
Cost of labor, $479.99; 71.6 % of total cost.
Cost of material, $190.26; 28.4 % of total cost.

The condition of the land previous to planting made cultivation difficult and expensive for the first three years, but the soil is in such condition now that this item can be much reduced in the future. The present plan of cultivation consists of spring plowing followed by clean cultivation to such time as the cover crops are sown.

A variety of cover crops have been used on this orchard, all of which have seemed to serve the purpose satisfactorily, altho it is impossible to say at this time that any one crop has a marked advantage over another as regards growth or appearance of the trees. Considering a crop to cover the ground during the winter and to supply an abundance of green manure to plow in, it is evident from what work has been done that a mixed crop such as on Plot A in 1913-14-15 (see Table III) is most desirable. For the vetch could be substituted red clover, which is cheaper if clover is known to grow well in the soil where it is to be used.

Altho soy beans and cow peas are killed by frost, the leaves and stems falling to the ground make a very satisfactory winter cover which will prevent damage from washing on sloping land. It was found that where soy beans followed buckwheat the beans made unsatisfactory growth the first season, altho in subsequent seasons no difference could be noted. In connection with the mention of buckwheat it might be well to state that no harmful effect was noticed on the trees where it was used as a cover crop.

As will be noted in Table III a definite plan of fertilization has not yet been established, but rather the different elements have been supplied in such quantities as were thought necessary. The excellent growth of the trees has seemed thus far to warrant such a method of application.

TABLE III. FERTILIZERS, COVER CROPS, AND CULTIVATION IN YOUNG APPLE ORCHARD.

Fertilizers per acre.

1911. Complete fertilizer containing about 20 lbs. nitrogen, 30 lbs. phosphoric acid and 28 lbs. potash.

1912. 151 lbs. muriate of potash and 320 lbs. bone meal.

1913. 159 lbs. muriate of potash, 116 lbs. acid phosphate and 1.3 tons limestone.

1914. 100 lbs. muriate of potash, 300 lbs. basic phosphate, 158 lbs. nitrate of soda and 300 lbs. tankage.

1915. 300 lbs. acid phosphate, 165 lbs. nitrate of soda and 330 lbs. tankage.

1916. 636 lbs. tankage and 33 lbs. bone.

Cover Crops on Plot A, southern half of orchard, (per acre).

1911. None.

1912. ⅓ bush. winter vetch and 1 bush. barley.

1913. Self-sown vetch, ½ bush. rye, 7½ lbs. red clover, 14 lbs. crimson clover, 2 oz. cowhorn turnips.

1914. Winter vetch and rye, each 1 bush., 3.8 lbs. timothy, 2 oz. cowhorn turnips.

1915. ⅓ bush. vetch, 1 bush. rye, 3.8 lbs. timothy, 4 oz. cowhorn turnips.

1916. Same as on northern half of orchard in 1914 and 1915, except that no rye was used.

Cover Crops on Plot B, northern half of orchard, (per acre).

1911. None.

1912 and 1913. Cow peas, Soy beans and buckwheat, each on one-third of the area.

1914 and 1915. Soy beans grown in drills. After harvesting and threshing vines and trash were put on the land which was then seeded with 1 bush. rye.

1916. 1 bush. rye.

Cultivation. The land was plowed early and clean cultivated until the end of July.

TABLE IV. SPRAY TREATMENT OF YOUNG APPLE ORCHARD.

1911. None.

1912. Mar. 27. Lime and sulphur.
May 27 and June 29. Bordeaux 4-4-50 and Arsenate of Lead.

1913	Plot I	Plot II
Mar. 28.	Lime and Sulphur.	Lime and Sulphur.
Apr. 29.	Bordeaux and Arsenate of Lead.	Lime and Sulphur and Arsenate of Lead.
May 19.	Arsenate of Lead.	Arsenate of Lead.
June 18.	Bordeaux and Arsenate of Lead.	Bordeaux and Arsenate of Lead.
1914, 1915 and 1916.		
Apr. 8 to 13.	Lime and Sulphur.	Lime and Sulphur.
May 20 to 29 and June 22-July 6.	Bordeaux and Arsenate of Lead.	Lime and Sulphur and Arsenate of Lead.

In the above table it should be noted that Commercial Lime and Sulphur was used 1-9 for dormant spray, 1½-50 for summer spray; Bordeaux 1-4-50, except as noted otherwise; Arsenate of Lead (paste) 3-50, or powder, 1½-50.

Cost Table V has been compiled as was Table II, namely, materials at actual cost, and hand and horse labor estimated at a fixed charge per hour.

TABLE V. YOUNG APPLE ORCHARD.

EXPENSES AND INCOME, 1911–1916.

Year.	Fertilizers.		Cover Crops.		Spraying.		Cultivation.	Pruning.	Total Cost for Year.
	Material.	Labor.	Seed.	Labor.	Material.	Labor.			
1911	$19.12	$6.00	$22.50	$43.14	...	...	$ 93.98	...	$184.74
1912	21.50	6.00	11.84	6.00	$0.15	$0.37	105.91	$0.50	152.27
1913	35.55	6.00	5.59	6.00	.52	.75	67.19	2.00	123.60
1914	34.73	6.00	12.90	6.00	1.10	1.50	40.81	2.00	105.04
1915	31.22	6.00	12.90	6.00	1.10	1.50	16.96	6.00	81.68
1916	40.35	1.25	1.73	6.87	4.72	6.50	44.50	7.00	112.92
Total	$182.47	$31.25	$67.46	$74.01	$7.59	$10.62	$369.35	$17.50	$760.25

Cost of labor, $502.73=66.1 % of total cost.
Cost of material, $257.52=33.9 % of total cost.

The returns have been in potatoes and Soy beans. The latter were used in experimental work and free seed distribution which gave no cash income.

THE PEACH ORCHARD.

The peach orchard covers 1.2 acres, and the land previous to setting the trees was in the same condition as described for the new apple orchard. The slope is entirely to the north and west. The following varieties and numbers of each were set 17 ft. 6 inches x 20 ft. in the spring of 1911:

Heiley	8	Carman	14
Greensboro	8	Mt. Rose	16
Stevens	8	Champion	30
Late Crawford	6	Elberta	60

As with the apples, the varieties selected represent varieties that are commonly grown in the state.

When planted, the trees were cut to whips about one foot high, thus starting the head of the tree as low as is desirable to have it. The aim in pruning has been to have a low, spreading tree with such an arrangement of main branches as to prevent breaking from loads of fruit or from ice and strong winds in winter.

TABLE VI. SPRAYING OF PEACH ORCHARD.

		II	III	IV	V*	VI*	Yield of Fruit. Baskets.	Av. price, cts. per basket.
1911	Not sprayed							
1912	All plots sprayed Mar. 27 with commercial L. & S., 1–9							
1913	Plot I	II	III	IV	V*	VI*		
Mar. 28	L. & S.	L. & S.	L. & S.	L. & S.	L. & S.	L. & S.		
June 4	Self-boiled L. & S.	Atomic Sulphur	Nothing	"	*	*	very few	
July 15	"	"		"	*	*		
1914								
Apl. 8	L. & S.	L. & S.	L. & S.	L. & S.	L. & S.			
June 2	Self-boiled L. & S.	Sulphur paste	Calcium benzoate	Atomic Sulphur	"		185	58.2
June 24	"	"	"	"	"			
July 17	"	"	"	"	"			
1915								
Apl. 12	L. & S.	L. & S.	L. & S.	L. & S.	L. & S.	L. & S.		
June 8	Self-boiled L. & S.	B. T. S.	Sulphur paste	Calcium benzoate	Atomic Sulphur	"	785	30
July 2	"	"	"	"	"	"		
July 16	"	"	"	"	"	"		
1916								
Apl. 13	L. & S.	L. & S.	L. & S.	L. & S.	L. & S.	L. & S.		
June 14	Self-boiled L. & S.	B. T. S.	Sulphur paste	Calcium benzoate	Atomic Sulphur	"	444	75
July 6	"	"	"	*	"	"		
July 29	"	"	"	*	"	"		

* Spraying omitted for lack of material.

For all dormant spraying commercial Lime & Sulphur (L. & S.) was used, 1–9. In summer sprays, 1–150. Self-boiled Lime & Sulphur, 8–8–50. Sulphur paste, 8–50. Atomic Sulphur, 5–50. Calcium Benzoate, 2–50. B. T. S., 4–50.

This method of pruning has been successful, as evidenced by the fact that to date only three trees out of 150 have been broken by ice storms, and only one by weight of fruit. It may be noted that in 1914 no thinning was done on some of the heaviest loaded trees, to test their ability to hold heavy weights of fruit.

In 1915 all the fruit was harvested from these trees without the use of ladders, which indicates the possibility of cutting down the cost of harvesting by keeping the trees low. Of course this process of spreading may in time cause the trees to crowd each other, but that danger is not imminent at this time.

The spraying, with the exception of a dormant spraying with commercial lime and sulphur, 1–9, each year, has been entirely experimental. Various recommended compounds have been used, and thus far all treatments have been nearly equal in control of fungous diseases. From a commercial point of view, self-boiled lime and sulphur, "Atomic Sulphur," and commercial lime and sulphur are evidently the best, with the least cost and greatest ease of preparing in favor of the commercial lime and sulphur. See Table VI for details of spraying.

The remarks on cultivation and cover crops of the young apple orchard apply to the peaches, details of these being given in Table VII.

A comparison of different forms and combinations of phosphoric acid has been made on .12-acre plots in this orchard, and while it is too early yet to draw definite conclusions, the indications are that acid phosphate gives the highest yield, and that lime is detrimental to the production of fruit.

The cost table (No. VIII) has been compiled in the same manner as the foregoing tables, namely, materials at actual cost, and labor estimated at a fixed rate per hour for horse and hand work.

TABLE VII. FERTILIZERS, COVER CROPS AND CULTIVATION IN PEACH ORCHARD.

Fertilizers per acre, Plot A. 1911, same as on young apple orchard. See p. 370.

1912 and 1913. 150 lbs. each of nitrate of soda and muriate of potash and 350 lbs. acid phosphate.

1914. 150 lbs. muriate of potash, 320 lbs. acid phosphate and 264 lbs. basic phosphate.

1915. 275 lbs. nitrate of soda, 117 lbs. acid phosphate. June 15th, 150 lbs. nitrate of potash.

1916. June 15th, 178 lbs. acid phosphate, 105 lbs. nitrate of potash, broadcast and cultivated in.

Fertilizers per acre on Plot B. In 1911 the same was used as on A. In following years B was divided into 5 plots to make a comparison of the effects of acid phosphate and basic phosphate. Plots I, II and III have had yearly 50 lbs. of phosphoric acid per acre, Plot I in basic phosphate, Plots II and III in acid phosphate, and carbonate of lime in amount equal to the lime content of basic slag has been put on Plots II and IV.

In 1912 and 1913 all Plots had per acre 150 lbs. each of nitrate of soda and muriate of potash. In 1914 no fertilizers were used additional to the phosphate and lime above noted. In 1915 125 lbs. nitrate of soda and 167 lbs. acid phosphate was broadcast June 15. In 1916 105 lbs. nitrate of potash was broadcast about the middle of June.

Cover Crops. These were essentially the same as on Plots A and B of the apple orchard.

Cultivation. The whole orchard was plowed early and cultivated until near midsummer.

Table VIII shows the cost and income from the young peach orchard.

Table IX shows the details of an experiment with different substances to prevent attacks of borers and gnawing by mice and rabbits. The only result of this experiment is the fact that none of the substances used caused injury to the trees. The fact that there was no injury to either treated or untreated trees makes the results in control negative.

This report does not necessarily represent work done personally by the author, but rather represents work of all departments pertaining to the orchards, collected and tabulated by him.

TABLE VIII. PEACH ORCHARD EXPENSES AND INCOME.

Year.	Fertilizer.		Cover Crops.		Spraying.		Harvesting.		Cultivation.	Pruning.	Total Cost for Year.	Receipts.	Gain or Loss.
	Material.	Labor.	Seed.	Labor.	Material.	Labor.	Material.	Labor.					
1911	$ 7.58	$2.50	$9.00	$25.00	.....	.....	.....	.....	$37.28	.....	$ 81.36	$ 6.14	−$ 75.22
1912	9.06	2.50	4.06	2.50	$ 0.25	$ 0.38	.....	.....	42.00	$1.00	61.75	.....	−61.75
1913	10.00	2.50	3.13	2.50	3.48	7.50	.....	.....	26.91	4.00	60.02	.....	−60.02
1914	9.50	2.50	4.06	2.50	5.53	9.00	$ 7.00	$ 7.40	16.19	6.00	69.68	107.61	+37.93
1915	11.37	2.50	4.06	2.50	6.00	10.00	23.55	31.40	6.73	6.00	104.11	236.00	+131.89
1916	5.47	2.50	.57	.60	6.00	22.77	18.00	35.00	7.00	7.00	104.91	336.30	+231.39
Total	$52.98	$15.00	$24.88	$35.60	$21.26	$49.65	$48.55	$73.80	$136.11	$24.00	$481.83	$686.05	+$204.22

Cost, $481.83
Receipts, 686.05
Profit, $204.22

Cost of labor, $334.88 = 69.5 % of total cost.
Cost of material, $146.95 = 30.5 % of total cost.

TABLE No. IX. TREATMENT FOR BORERS.

	Plot I.	Plot II.	Plot III.	Plot IV.	Plot V.
1911	Wrapped with tarred paper. Banked with soil.	No treatment.	Banked with soil.	White lead and oil. Banked with soil.	Lead arsenate, ¼ lb. Water, 1 pt. Sulphur, ¼ lb. Banked with soil.
1912	do.	do.	do.	do.	do.
1913	do.	Banked with soil.	Banked with soil.	Banked with soil.	Banked with soil.
1914	Sludge on trunks.	Ditto 1911–12.	Ditto 1911–12.	Ditto 1911–12.	Ditto 1911–12.
	Plot VI.	Plot VII.	Plot VIII.	Plot IX.	
1911	Lead arsenate, ¼ lb. Commercial L. & S., ½ pt. Water, ½ pt. Banked with soil.	Lead arsenate, ¼ lb. Water, 1 pt. Banked with soil.	Wrapped with building paper. Banked with soil.	Wrapped with wire netting. Banked with soil.	
1912	do.	do.	do.	do.	
1913	Banked with soil.	Banked with soil.	Banked with soil.	Banked with soil.	
1914	Wrapped with tarred paper. Banked with soil.	No treatment.	Sludge on trunks.	Sludge on trunks.	

PART VI.

Report of the Forester for 1916

BEING THE

NINTH REPORT OF THE STATE FORESTER.

In the report of the Forester for 1915 it was stated that the intensive forest survey of the town of Redding, made in the summer of 1915, would be published later as a bulletin. It has seemed best, however, to include it as the major part of this report, since the working up of the field notes and the office work in connection with the survey was mostly done during the period covered by the report. The most important project of the year was the investigation and attempt to control the spread of the white pine blister rust. Although much was accomplished during the summer of 1916, the results were far from conclusive, and as the work will be continued during 1917, the publication of results will be postponed until the end of another season.

The forest fire season of 1916 was an unusual one for Connecticut, as is shown by the tables on page 382. Following the record-breaking season of 1915 with its total of 1,443 fires, the total for 1916 was but 487. This is smaller than for any year since 1909, and in that year the reports were by no means complete. For the first four months of 1916 only 163 fires were reported, while 1,220 were reported for the corresponding period of the preceding year. This difference is readily accounted for by prevailing weather conditions. The New Haven Weather Bureau records for March and April, 1915, show a total precipitation of but slightly over two inches, and March had the lowest precipitation recorded for that month in forty-three years. On the other hand, the total precipitation recorded in New Haven during March and April, 1916, was 7.08 inches. Not only was the rainfall abundant and well distributed throughout

these two months, but the preceding winter was a severe one with heavy snows which continued well into March. This fortunate combination of climatic conditions naturally prevented the spread of fires resulting from locomotive sparks, matches, cigarettes and other forms of human carelessness during the period before vegetation started, when fires are usually most serious in the woods.

As though intended to prove that human carelessness is a constant factor in the fire problem, this period of abundant rainfall was followed by two weeks of dry and windy weather culminating in two days of high winds on May 11th and 12th when many serious fires occurred. Of the sixteen fires reported during the year as exceeding one hundred acres in extent, ten occurred on these two days. The total acreage of these ten fires was reported as approximately twelve thousand,—nearly sixty per cent of the entire acreage burned in the state during the year. Four of these fires on May 11th and 12th burned more than one thousand acres each, and the total area burned over by the four was over nine thousand acres. Of the total damage attributed to forest fires during the year ($132,597), at least $80,000, or more than sixty per cent, is accounted for by the ten fires of May 11th and 12th. It would therefore seem that a little extra care on these two days when all conditions indicated the necessity for care, would have prevented more than half the fire damage of the year. Although the fires during the fall months were not unusually numerous or serious, the total was somewhat greater than during the fall months of 1915, and there were more fires than usual reported in December. This was undoubtedly due to the lack of rainfall during the first half of the month, and especially to the lateness of the first snow throughout much of the state.

The cost of fire fighting and protection work during the year was small as compared with 1914 and 1915. In 1914 the total expenditures for this work were $18,959.70; in 1915, $20,906.40; while in 1916 the total amount expended was only $4,540.81. If the ten large fires of May 11th and 12th could have been prevented or checked sooner, this expense would have been greatly reduced. If the amount spent for fire fighting had been spent in the prevention of forest fires, it seems reasonable to believe that the expense of fighting fires might have been still

further reduced, and the damage very largely prevented. A radical change in the present fire warden system would be necessary, however, to accomplish such a result. Until this can be brought about emphasis must be laid on the education of the public to the necessity for care with fire in the open.

The cause of the fires as reported in 1916 were: railroad 45 per cent; unknown 33 per cent; general carelessness (including fishermen and hunters) 17 per cent; burning brush 4 per cent; incendiary 1 per cent. A comparison with the causes of 1915 fires brings out the interesting point that in 1915, a season of numerous fires, the percentage of railroad fires was smaller than in 1916 when the total number of fires was much less; that is, when weather conditions are favorable for fires, the fires of unknown origin and those due to general carelessness increase in numbers at a proportionally greater rate than the railroad fires, while in a year unfavorable to fires the falling off in numbers is less apparent in the case of railroad fires than with other causes. This is undoubtedly due to the fact that conditions along a railroad right of way are more favorable for the starting of fires than in other places, regardless of climatic conditions, and that when unusual climatic conditions result in an abnormal number of fires elsewhere, the number of fires along a railroad right of way does not increase in the same proportion.

The fires due to brush burning show a great falling off in numbers as compared with previous years: in 1914, 7 per cent; in 1915, 12 per cent; in 1916, 4 per cent. This seems to be a logical result of favorable weather conditions rather than an encouraging increase in carefulness on the part of those burning brush.

SUMMARY OF FOREST FIRES BY MONTHS, 1910–1916.

Year.	Total number.	Jan.	Feb.	March.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1910	834	0	0	285	305	45	2	9	0	6	141	41	0
1911	978	5	0	66	425	390	13	20	25	1	10	21	2
1912	526	1	3	27	109	90	34	53	5	3	142	38	21
1913	695	3	7	48	212	174	37	64	83	1	8	43	15
1914	1056	3	9	9	254	228	36	4	5	68	280	153	7
1915	1443	0	16	787	417	106	38	1	0	1	29	48	1
1916	487	3	0	1	159	163	8	1	0	5	43	72	32

FOREST FIRES IN CONNECTICUT DURING 1916.

TABLE I.—SUMMARY BY COUNTIES.

County.	Total No. fires.	Causes.						Acres burned.	Estimated damage to standing timber.	Estimated damage to forest products, buildings and grass.	Cost of fighting.	Cost of protection.
		Unknown.	Railroad.	Careless.	Burning brush.	Hunters.	Incendiary.					
Fairfield....	69	27	28	6	4	4	..	1,048	$ 3,027	$ 203	$ 418.28	$251.76
Hartford....	108	24	49	21	3	11	..	4,767	20,551	1,008	1,212.34	111.27
Litchfield...	73	20	41	5	5	2	..	5,679	12,657	2,014	703.57	89.13
Middlesex..	23	9	12	2	..	..	..	362	790	110	102.00	61.72
New Haven.	82	30	29	13	4	4	2	2,016	2,220	504	389.97	74.37
New London	38	19	9	3	1	6	..	3,948	27,823	55	393.44	32.29
Tolland.....	36	9	24	2	1	..	..	881	2,641	1,344	217.95	13.75
Windham...	58	23	26	3	1	2	3	1,403	3,785	865	450.63	18.34
TOTALS.	487	161	218	55	19	29	5	20,104	$73,494	$6,103	$3,888.18	$652.63

TABLE II.—NUMBER OF FIRES BY MONTHS.

County.	Total number.	Jan.	Feb.	March.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
Fairfield....	69	..	..	..	25	16	1	..	..	1	4	12	10
Hartford....	108	2	..	1	26	35	3	1	..	2	13	17	8
Litchfield...	73	..	..	..	31	25	1	..	..	2	8	4	2
Middlesex..	23	..	..	..	10	6	..	..	..	..	..	6	1
New Haven.	82	..	..	..	26	25	..	..	..	..	6	19	6
New London	38	1	..	..	11	16	1	..	..	..	3	4	2
Tolland.....	36	..	..	..	8	20	1	..	..	..	1	4	2
Windham...	58	..	..	..	22	20	1	..	..	..	8	6	1
TOTALS.	487	3	..	1	159	163	8	1	..	5	43	72	32

TABLE III.—NUMBER AND AREA OF FIRES.

	All fires.	Fires not more than 100 acres in extent.	Fires more than 100 acres in extent.
Number.....	487	471	16
Total acreage burned.....	21,114	7,319	13,795
Average acreage per fire.....	43.3	15.5	862.2

A FOREST SURVEY OF THE TOWN OF REDDING, CONN.

By ALBERT E. MOSS, M.F.

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The Forest Survey of Connecticut, published as Part III of the Annual Report of the Connecticut Agricultural Experiment Station for 1915, was intended as a general study of the forested lands of the state. Although the forests of each county were described in a general way, and the area of forest land estimated for each town, no more specific studies were attempted. It was felt that the expense of making a detailed survey would not be justified, and that one of a general nature would be of more immediate value.

Increasing interest in forestry in certain towns, however, indicated need of further information regarding particular localities. With a view to determining the expense involved in an intensive survey, the best methods to be used in making one, and the results to be expected from it, a study of the town of Redding was undertaken in the summer of 1915. Redding was chosen because of the interest shown there, and because the forest conditions are fairly typical of Fairfield County. The published results should be of especial interest to towns where similar conditions prevail, and will suggest the possibility of similar studies in all the heavily forested towns of the state.

The present town of Redding was included in the land purchased from the Indians for the town of Fairfield in 1639. The earliest survey in 1640 did not include the land between the Ridge-Center road and the present Bethel town line, but this was added to Fairfield before 1725. The first settlement was about 1700 and by 1760 there was much talk of separating Redding from Fairfield. The act making Redding a town was passed in 1767 when the population was about a thousand. Since then the original town lines have been very closely adhered to.

The town is situated in the southwest portion of the state within the western upland. The elevations range only from 300 to 800 feet and the topography is fairly regular with three ridges and four valleys running north and south. The streams are small and drain directly into the Sound. The valleys are narrow, occasionally widening into small level areas subject to overflow in the spring. The ridges are rounded and contain the greater part of the agricultural land. Many small streams rise in swamps scattered over the ridges, and flow into the main streams during wet seasons. Most of these streams do not have a drainage area sufficient to carry them through a dry season.

The location of the town between the turnpikes from New York and Poughkeepsie to Boston, and the general topography, led to the early development of north and south roads connecting the inland and the coast towns. The present Ridge Road is the only turnpike that crossed Redding in this direction although the Danbury to Norwalk road followed its western edge. The main east and west road across the town was the Newtown to Ridgefield turnpike, now the Ridge-Center road. As the first settlements were on the agricultural lands of the ridges, the lines of communication followed these instead of the valleys. The narrower valleys and the slopes were not as accessible and were left in forest. The town was not situated near markets or raw manufacturing material, so that while the water-power was developed to some extent, agriculture was always the most important industry.

The industrial census of 1845 shows that the manufactures were adapted to the local demand, and but little importation of products was needed. The dairy showed perhaps the best development, although cereals were always important. In 1845 the crops listed were as follows: corn 13,680 bushels, oats 18,500 bushels, potatoes 12,000 bushels, butter 63,500 pounds, cheese 11,780 pounds. Sheep were valued at $1,700 with a wool yield of $1,280. These crops were either sold locally or exported to New York. The list of manufactured products of the town shows a very close relation between the forests and the industries. The iron foundry and furnace listed used charcoal for fuel, and some 20,000 bushels valued at $2,000 were burned in the town. The wagon and cabinet factories with an annual output

valued at $14,000 depended on local lumber to a large extent, and at least 1,000,000 feet were cut locally that year. Four or five water-power mills were used in cutting this material. Some 95,000 bricks were burned during the year. With the lime kilns this made a demand for cordwood, a portion of which was supplied by the farmers of Redding with a cut of 425 cords valued at $4 per cord. Brooms were also manufactured in the town.

At that time the value of the forest to the inhabitants of the town was much greater than it is at present. Methods of transportation were so poor that the inhabitants were dependent on the forests for fuel to heat their buildings, as well as for the other uses mentioned above. The best of the timber went into saw logs, and probably only the tops and poorer trees were used as fuel and for charcoal. The relatively small quantity of lumber cut was due to the heavy cost of hauling the logs to the mills and the sawed product to market. The introduction of the portable mill and cheap coal caused great changes in the handling of the woodlands. Now the logs are sawed in the woodlot, and only the sawed material is hauled out. The decreased demand for wood and the total elimination of charcoal from the market has made lumbering operations as conducted at present much more wasteful than formerly.

The town probably reached its greatest industrial development in the years just prior to the Civil War, and as was the case with many other towns of the state, rapid decline followed from which it has never recovered. With the loss of the younger generation, either in the war or by their emigration to the West, the cultivation of much of the land has been abandoned, and crops formerly exported are now brought from the farms of the West. Since the war, only the best of the land has been cultivated, and the remainder allowed to come up to timber or brush. Within the past few years there has been a more general movement of city people towards the country for at least part of the year. Situated as it is within commuting distance of New York, Redding has been much affected by this movement. The greater part of the city people do not live in the town throughout the year, although they spend most of the summer there.

This influence of the summer resident throughout the region results in abnormally high land values compared with actual

agricultural values. The amount of capital necessary to establish a farm is so great that transfers of property for that purpose are infrequent. The business man has introduced his methods into farming, however, so that better results in marketing and purchasing supplies are offsetting the high capitalization necessary to carry on the industry in this region. With this renewed interest in agriculture there have been developed more intensive methods of management, and the area of land cultivated has been decreased, with improved results in many instances. The two influences have balanced to a certain extent, but at present there seems to be a slight gain in the amount of land cultivated in some portions of the town.

The slow transportation of the early part of the nineteenth century necessitated manufacturing dairy products before shipment to market. Changes following the Civil War developed the manufacturing centers at the expense of the farming communities of the state. This concentration of the population in the cities developed a market for milk which is either supplied by the adjoining region or shipped in by rail. The eastern portion of the town was within direct hauling distance of Bridgeport, and the demand for milk has led to the closing of local creameries. Since the advent of the motor truck this influence of the city market is being extended, and better service is given the producer. The manufactured dairy products formerly produced locally are now imported from the western dairy regions. Fruit growing is increasing in importance in the western part of the town as the markets are brought nearer by use of the motor truck. The farms owned for the pleasure they give the owner are usually in one or the other of the above classes. With the increased ease of transportation there is an increasing number of permanent residents from the cities, and an increase in the agricultural land as a result.

In all probability the changes in transportation have had the greatest effect on the forest area of the town. The early manufactories depended on the use of local woods to a great extent. The iron foundries used native charcoal, the chair and cabinet shops used local material, as did the wagon and carriage shops. The fuel used was entirely wood, and during the period just prior to the development of the railroad there was much talk of a wood famine. The development of the railroads made available the vast timber supply of hard and soft woods in the West and South. Coal also became the common fuel, and the problem of a timber shortage was eliminated for many years. The forests of the town were neglected except for small local demands for timber, and for poles or railroad ties. The wood-using industries moved to the source of supply, the forests began to revert to their former condition, and the forest area of the town began to increase with the seeding in of the abandoned lands.

During the past ten years there has been a change in the attitude taken towards the local forests, and with the increase in cost of material from other sections of the country, the local products are again finding their way into the markets. The use of wood for fuel, except for the burning of lime, is only in individual houses, as coal has driven cordwood out of the market for general purposes. There is no charcoal burned in the region at present, and the small quantities used are imported from the wood distilleries of New York and Pennsylvania. The local demand for timber is largely in Georgetown, 350,000 to 400,000 feet of sawed material being used there annually. Of this amount the town supplies practically nothing, although if native oak and pine were obtainable it might supply seventy-five per cent of the demand. The native timber used is largely in the form of plank or dimension material. The lime-kiln in the northern part of the town will take all cordwood within hauling distance, but the prices paid limit the haul to very short distances. This demand for small material makes intensive forestry work possible in this section of the town.

TREE SPECIES.

The distribution of tree species in the United States is limited more directly by climatic than by soil conditions. Maximum and minimum temperatures with rainfall and atmospheric moisture are the limiting factors in their geographic distribution. The range of an individual species may be extended in any direction by changes in elevation that produce the necessary climate.

Connecticut is located along the meeting line of the northern and the southern species, and is not in the optimum range of any tree of commercial importance. Chestnut perhaps came the

nearest to reaching its optimum here, but even this tree attains greater size in the mountains of Tennessee and Kentucky. Gray birch, a relatively unimportant species, is at about its maximum development in this state. Whitewood or tulip, chestnut, the oaks, the hickories, white ash and black birch are some of the southern trees found in this region. White pine, hard maple, paper birch, yellow birch and hemlock are some of the northern trees that occur here. This is known as the "Sprout hardwood region" because of the almost universal occurrence of species that coppice abundantly. This feature of the forest has enabled continued cutting of the wood on a short rotation without regard to seed years or the establishment of reproduction. Even fire will not ordinarily entirely destroy the stand, although repeated burning will reduce its vitality and change the predominant species.

Although there are at least fifty tree species found within the town of Redding (see page 426), there are relatively few that are of economic importance and only ten are of commercial value. Most of the species occur but rarely, or are of poor quality and inferior form, so that they may be compared to the weeds of the farm.

As on the farm, the weed species are the easiest to reproduce and will occupy vacant land much more readily than the more valuable species, since the former are less exacting than the latter as to soil and moisture requirements of the seed-bed and the seeds are much more widely distributed by the wind or birds. Weed species may prove of some value in forming suitable conditions for future forest development. The weed species as a rule are short-lived and exacting in light requirements, so that the better species are able to crowd them out in the end. Many species, neither weed nor commercial, form an underwood in the more mature forest, and help in the preservation of the forest floor.

White Pine (*Pinus strobus*).

This is the most valuable native tree of the region. In the forests found by the colonists the area occupied by this species was much greater than at present. The wood was the easiest worked and best of any found in the colonial forests, and as a result was very largely exported to England. While the species

probably never occupied a very large percentage of the area, the wide distribution of the remaining stands shows that it must have been common throughout the entire town. Pine only reproduces by means of seed and is at a disadvantage in competition with hardwood coppice. The seeds are borne in cones requiring two years to mature. Wings aid in their distribution by the wind, but the seed-bed requirements, together with rodent and bird damage, reduce the number of natural seedlings very greatly. Growth during the early stages is very rapid and a mature stand is much denser than a stand of hardwoods. The product is used for box boards, building material and wherever light, easily worked wood that will keep its shape is desired. Pattern makers use large quantities of the best grades, mostly obtained from the virgin stands of the West. This is the only native species that shows satisfactory profits in plantations, although the red pine of the Lake States gives great promise in recent plantations. Some of the oldest plantations in Connecticut are white pine, and many younger planted stands are now growing throughout the state.

The tree has two serious enemies at present, one an insect and the other a fungus, the insect being perhaps the more serious in this region. (See page 419.) The trees are thin-barked and easily killed by fire during the juvenile stages, but later in life become more fire resistant. The stands prune well, forming clear straight trunks that carry their diameters well into the tops.

Red Pine (*Pinus resinosa*).

This tree occurs rarely within the state, but to the North, especially in the Lake States, it grows with white pine, and is logged at the same time. The mature tree is not as large as white pine, but the growth during the early life of the two species is very similar. Red pine has no insect or fungous enemies at present, and is being favored in planting in this region. The wood is harder and stronger but not quite so valuable as white pine. The tree is not as easily injured by fire, and will grow on much poorer soils to good advantage.

Hemlock (*Tsuga Canadensis*).

This is one of the most admired trees of the town because of its habit of growing near the streams. It is not particular as

to soil requirements, but demands atmospheric moisture for the best development. As a result it is found near streams or in the narrow gorges, and on the steep north slopes of the valleys. Hemlock is very tolerant, and seedling reproduction will come in on the moss and duff under the dense shade of mature trees. Its growth is very slow, and trees fifty years old are often only ten feet high. Removal of the overwood, admitting more light, increases the rate of growth considerably, but at best hemlock is of slow growth. Suppressed trees retain the ability to recover and grow for a long period. Its habit of growth makes this tree very important in this region, from the aesthetic standpoint rather than for its forestry value. The increasing importance of the town as a place of summer residence should indicate to the townspeople that every effort must be made to preserve the scenic beauty of the roads. The valleys are in many cases narrow and their slopes are the natural sites for hemlock. The foliage of the tree is very dense, forming deep shade, and its tolerant character tends to produce a stand of all heights, making these valley roads very attractive even in winter. As there are only a few areas of these evergreens within the town, the contrast with the more common deciduous trees is very pleasing at all seasons.

Although hemlock reproduces well naturally where there are suitable seed-bed conditions, it is very hard to handle in the nursery and the cost of planting stock is high, so that natural reproduction must be secured in most cases. The trees do not prune well naturally, so that the timber is knotty as a rule, and overmature stands are apt to be very defective. Both heart rot and a separating of the growth rings called "ring-shake" are the common defects. The lumber is used as dimension material or rough boards.

Chestnut (*Castanea dentata*).

This is one of the most rapid growing trees of the region, and has been one of the most important hardwoods of the state. The species must be largely eliminated from future consideration because of the ravages of the chestnut blight (*Endothia parasitica*). It was formerly found on all sites except those subject to flooding, but formed the dominant part of the stand only on the better drained, deep soils, as more drought resistant species

crowded it out of the dry sites. The tree grows well, pruning readily, and forms a clean, full bole whether grown pure or in mixture. The lumber is of good quality and very durable in contact with the soil. It has been the chief source of supply for ties and poles within the state.

Red Oak (*Quercus rubrum*).

This is the most northern species of the oaks and its range extends well into Canada. The tree is the most valuable of the black oak group within this region and grows to a large size with good form. It is rapid growing in the juvenile stages, either from seed or coppice. The species demands better soil and moisture conditions than chestnut for its best development, but is less exacting in light requirements. The mature tree has a well formed, full bole, pruning well but with widespreading heavy crown. The timber is coarse-grained compared with other oaks and is not so durable as chestnut. It can be treated with preservative rather easily, however, and should be of great importance for this reason in the future.

With the loss of the chestnut this tree is one of the few hardwoods capable of taking a dominant place in the forest which can be profitably handled. Its root growth in the seedling stage is such that it may be grown in a nursery and transplanted with success. The soil and moisture requirements are similar to those of tulip, and it might be planted to good advantage where the latter species occupies a portion of the area naturally. Tulip will not produce good forest conditions alone, but in mixture with the red oak forms a valuable stand. Red oak is capable of producing good stands if planted pure. It should be favored in all woodlot operations, and the better formed trees left when thinning for cordwood.

White Oak (*Quercus alba*).

This is the most valuable of the oaks native to the United States. The species is at its best in the Mississippi River drainage basin, and is near the northern limit of its range here. However, it has always been important in the development of the industries of the region. The wood is of high quality and largely used where great strength is needed, as in wagon parts and ship timbers. Its close grain and lack of odor or taste has

made it a favorite in tight cooperage. Its use for this latter purpose has not been important in this region, however, since colonial days.

The tree is of slow growth even on the best of soils, and while persisting under shade, it will not recover if suppressed too long. It is common on all areas except those subject to flooding, but is of commercial value only on deep, well drained sites. Pure stands may occur over very limited areas, but mixed stands are more common. Red oak, chestnut, ash, tulip, and other species of less importance are its common associates. The present use of the timber is for ties, carstock, plank and ship timber. Its slow growth with relatively short merchantable length tends to eliminate this tree from forests under management. Because of the high quality of the wood, natural growth may be aided, but new stands will seldom be established.

Tulip (*Liriodendron tulipifera*).

This is one of the most important hardwoods of the southern Appalachians, with a range extending into Southern New England. It is an intolerant tree, exacting as to soil and moisture requirements, growing best on moist, deep soil not subject to flooding. It makes very rapid growth during the juvenile stage, which continues until the tree reaches its maximum growth. For natural production, it seems to be necessary that the surface mulch should be broken up so that the seed may easily reach mineral soil for germinating. This tree forms the cleanest stem of any in the region, and carries its diameter well into the top. It grows vigorously for many years, often living for one hundred and fifty to two hundred years and reaching a diameter of three feet, with a height of two hundred feet. The wood is used for many of the same purposes as white pine, and is also valuable for veneerings and auto or carriage bodies. It is light, soft, uniform in grain, and does not split easily, but is not durable in contact with the soil.

Tulip is one of the most valuable trees to encourage in place of chestnut in the hardwood forests. It is free from insect and fungous damage, but the seedlings are hard to raise in a nursery. The seed is very infertile and natural reproduction is poor, as a rule, thus limiting the spread of the species. The tree will not produce good timber in pure stands, as its shade is not sufficiently

dense to ensure natural pruning. It should therefore be handled in mixture with other rapid-growing species. Where these are not present in the natural stands, tulip reproduction should be encouraged by the removal of inferior species, and supplemented by planting red oak or pine in the openings thus made.

Red or Soft Maple (*Acer rubrum*).

This tree occurs throughout the eastern half of the United States, but attains its greatest size in the Mississippi Valley. In this region it is the typical tree of the swamps where it occurs either pure or in mixture with black ash and elm. The stands will endure flooding for long periods and it is about the only tree in the region that will mature in the wetter swamps. Its commercial value is not great, as the lumber is of small size and inferior quality. It is usually cut for cordwood with a maximum rotation of twenty to thirty years. A longer rotation will reduce the sprouting capacity of the stumps, at the same time failing to secure the best returns from the rapid growth of the young stands. This species will produce a crop on sites not suitable for any other, which is its greatest value from the forester's point of view. The tree has some aesthetic value because of its red blossoms early in the spring and bright foliage in the early fall.

FOREST TYPES.

Under natural conditions, trees tend to associate in communities, each individual having its own life history, and each exerting a direct influence on its neighbors. They must compete with each other for moisture and light in order to grow, and each species has developed certain characteristics that enable it to survive in the struggle for existence. Differences in these characteristics cause each species to predominate on the soil and moisture site conditions to which it is best adapted. The grouping of the tree species in a given region is fairly uniform on similar site conditions, since the same external influences tend to cause the same differences in composition. Such typical groupings or associations of tree species are termed *forest types.*

The following types are distinguished in this report: Mixed hardwoods, old field, swamp maple, oak, chestnut, oak-chestnut, hemlock and pine. The classification is based almost entirely on

the composition of the stand, but as the area is small, the composition indicates the site conditions very clearly. External influences, such as chestnut blight and forest fires, have converted some of the stands into other than the original types within the past few years, and the process is still being carried on, especially in the chestnut and the oak-chestnut types. The types merge into one another with changes in site so that a sharp dividing line is hard to define.

Mixed Hardwoods Type.

This is the most common type of the region and its composition varies with the location within wide limits, commonly containing a large number of weed species and a few scattering commercial trees. The type is natural in some sites, but in others it is the result of damage or changes due to methods of handling. On the moist rocky sites that approach the swamp type but are not subject to flooding, the natural mixture is yellow birch, sugar maple, black birch, elm and ash. Natural reforestation of abandoned land often results in a mixed stand in which a large number of species may be present for the first few tree generations, but eventually the type will revert to one that is natural for the site. Change in type effected by damage is illustrated in the elimination of chestnut by the blight, leaving a large number of inferior species none of which are dominant. Cutting in the oak-chestnut type may result in similar conditions with the removal of these commercial species. The type in general promises profitable results from management in the future. Cuttings should be so made as to assure the reoccupation of the area by species at least as valuable as those cut. The trees to be favored and their reproduction protected are tulip, oak, ash and hickory. At present the percentage of tulip seems to be increasing as competition with chestnut decreases. Introduction of pine by planting is advised where cuttings are made as it will increase the productivity of the area.

Old Field Type.

This type is the result of the abandoning of pastures or cultivated land. Its composition is mostly of the light-seeded species like gray birch, or those spread by the birds such as red cedar. The stands are uneven-aged and rather open as a rule, but

density increases as seeding in from the original trees progresses. Under established tree growth there is very little underbrush, but in the open, shrubs may occupy the ground at first.

The life history of this type may be detailed as follows: Land abandoned after cultivation passes through the pasture stage with a gradual increase in the tree growth. This is at first noticeable along the borders of adjoining woodland and along the fences. Light-seeded species are the most common, but those with edible seeds are soon brought in by birds. Clumps of brush appear in the open lots and around the rocks. Even though cut over a few times to save the pasture, the tree species only coppice more vigorously. As a rule, such species mature very early and seeding in then becomes more rapid. The clumps of brush serve to catch and hold wind-blown seeds, and are themselves soon crowded out by trees which they have helped to establish.

Gray birch is perhaps the best adapted of Connecticut trees to afforest such lands naturally because of the seed production, methods of distribution and seed-bed requirements of the species. The cone-like fruiting bodies produce many small, two-winged seeds which ripen in the fall. These cones fall apart during the winter and the seeds are scattered on the snow. They germinate best in mineral soils, so fields with scant humus are the ideal places. Birch forms a nurse crop for better species of forest trees that are not able to seed in on open lands, but take advantage of improved conditions produced under other trees. This natural succession of species is very slow, and to afforest such an area naturally with a commercial species requires a long time.

Small waste areas are found on most of the farms and this type is one of general distribution throughout the town, but it is most common in the western half. It is largely due to economic changes in the community, such as those following the Civil War which were responsible for more abandoned land than any other single cause. Although some of this land is being reclaimed at the present time, intensive cultivation of the present farms tends rather toward the abandonment of more land. It is at present one of the types most needing attention within the town, as it is not producing anything. If left to nature, many years must elapse before such areas can become productive. In

fact, the owners are paying taxes on the land without any immediate prospects of returns sufficient to pay interest on their investments.

The type occupies some of the best land not now under cultivation, and from the forester's standpoint has great possibilities. Eventually much of the land will doubtless be cleared again for agricultural purposes, but in the meantime there is no reason why the owner should not be getting some returns in the line of forest products. The growing of trees tends to increase the fertility of the soil by depositing on the surface of the ground vegetable material containing much mineral matter. This mineral matter drawn from the lower soil by the roots, is used in the life processes of the trees, a portion of it being returned to the soil by the falling and decay of leaves and twigs. In this way the growing of a crop of timber will increase the future productive capacity of such land. These waste areas alone, if properly planted and managed, would produce more timber than the whole town does at the present time.

Swamp Maple Type.

The region is characterized by numerous hard rock ledges that cross the drainage, forming natural dams. On their lower reaches, the streams as a rule have cut through these, making sufficient fall to prevent swamping, but near the head waters and in the depressions of the ridges there is very little drainage. As a result sediment and vegetable matter has collected until the flow areas have been filled flush with the dams, thus making numerous small level tracts subject to flooding. The soil is very rich and in some cases would make fine farm land, but the cost of drainage and clearing is too great to warrant it at present. Small narrow areas of this type may be found near all the streams where local conditions are suitable.

As the name indicates, the type tree is the red or swamp maple. Other species such as alder, elm and black or splinter ash are also common. While red maple never grows to large size, the stands are often dense, so that it is a good cordwood proposition where there is a market for the product. Its rapid growth during the juvenile stage makes it most profitable to handle this type on a short rotation of twenty-five to thirty years. In this way the possibility of failure to secure coppice reproduction is eliminated, as the species does not begin to lose its vitality until later in life.

The type is very generally distributed throughout the region, especially on the divides. While the established species is of small value, the site conditions are such that there is slight possibility of changing to a more valuable one, except in isolated cases. Draining the swamps for agriculture will probably be a slow development in this region, and the substitution of a better tree species should be attempted wherever the land is not subject to flooding.

Oak Types.

The oaks are the most common tree species in the town. While formerly second in value to the chestnut, they are at present the more important, due to the damage caused by chestnut blight. The species differ greatly in soil and moisture requirements, and the oak type may be found under all conditions with species varying according to site. The timber qualities and rates of growth of different species of oaks also vary greatly, and even in the same species vary with the site. At least eight species are found within the town. The more valuable are white, red, chestnut, black and scarlet oak, while pin and swamp white oak are of relatively rare occurrence. Scrub oak is the least valuable, being one of the most persistent forest weeds.

The most valuable oak type is the result of eliminating chestnut from mixed stands on bottom and lower slope sites, leaving the oaks as the dominant trees. These stands are of relatively small extent as there are a large number of species that compete for such sites, resulting in a mixed hardwoods stand in most cases. Red, white and black oak are the species found under these conditions. The type is slower growing than the chestnut type, but is one of the most valuable in the town for timber, and one that may pay to manage by favoring the better formed trees in making cuttings.

Two other oak types form by far the greater part of the oak stand, but are of relatively little value. The better of these is the ridge type in which the scarlet, and chestnut or rock oak are the principal species. This is usually in pure oak stands on shallow ridge soils, but other species appear as the soil and moisture conditions improve on the slopes. These two oaks are

both capable of making good growth on the better soils, but are not able to compete with other species there because of the limited amount of shade they can endure. Chestnut oak is the better of the two and is used for ties. On the better soils it is capable of fairly rapid growth. Both of these trees are well adapted for a cordwood rotation, as they coppice well and there is usually advance seedling reproduction on the ground. Their light shade allows a fairly heavy ground cover of such shrubs as vaccinium and viburnum.

The scrub oak type results from repeated burning of the oak ridge type. The present growth is of no value except that it covers the ground and develops a better condition of soil which has been damaged by fire. The converting of this type to a more valuable one is important, especially in the western part of the town. The best method to use would probably be underplanting with a desirable species, later removing the oak in a series of liberation cuttings as required for the development of the planted trees. The final elimination of the scrub oak would be accomplished by the shade of the introduced species. The site is not as good nor the conditions as favorable for reforestation as in the old field type, and the scrub oak type might well be left until the old fields are reforested. Better fire protection is necessary if there is to be any improvement in this type.

Chestnut Type.

Chestnut was once the most important timber tree of the region, but the blight has in recent years very nearly eliminated it. There are a few pure stands left but present conditions seem to indicate that the tree will soon be a thing of the past from the lumberman's standpoint. Chestnut grew on almost all sites not subject to flooding, forming an increasing percentage of the stand until on the better class of well-drained slopes a pure chestnut type was found. This was the most rapid growing type of the region, and was of the greatest commercial value.

The growth habit of the species produced stands of two distinct forms:—one a dense coppice of rapid growth up to fifty or sixty years and reaching maturity at about that age; and the other largely made up of seedling trees which, having a slower juvenile growth, continued to increase in volume for one hundred to one hundred and fifty years, forming a much larger tree of somewhat more open crown with a larger number of other species in the stand. The former was the more valuable for the production of poles and ties, as well as of importance for handling on short cordwood rotation, while the latter produced the better grades of sawed material, such as boards and plank. With the cutting of these stands, some rapid growing and commercially valuable species must necessarily be artificially introduced to replace the chestnut, as the remaining trees of value are not capable of doing it.

Oak—Chestnut Type.

This type is a fairly uniform mixture of oak and chestnut, with other species forming a small percentage of the stand. The type is in a transition stage at the present time, as the chestnut is disappearing and oak and other species are beginning to fill the vacant spaces. Because the chestnut is often left until the remaining species are large enough to cut, the change is somewhat slower and not so noticeable as in pure stands of that species. The type was not so productive as pure chestnut, but more so than pure oak, and has been of considerable value to the owners. In the northern part of the town its handling on a short cordwood rotation was very common. The species of oak in mixture with the chestnut varies with the site conditions. In the same way the productive capacity of the type grades from a maximum in the bottom lands to a minimum at the upper limits where it merges into pure oak. The oak species on the bottom lands are red and white, changing to red, black, white, scarlet and chestnut oak on the slopes, and finally to pure scarlet and chestnut oak stands on the ridges.

The substitution of some other rapid growing species in place of the chestnut is essential as the latter is cut out, if the productive capacity of this type is to be maintained.

Hemlock Type.

Hemlock is one of the most exacting trees of the region as to site and environment. A cool slope near a stream or other body of water where there is plenty of atmospheric as well as soil moisture produces the best growth. The tree is very tolerant and reproduces well under the densest shade. This enables

it to shade out other species on the suitable sites and eventually form pure stands. Its rate of growth is very slow at best and while the tree reaches large size, its greatest value in this region is from the aesthetic side. The roads follow many of the suitable locations for the species, and it is of much value because of its attractive habits of growth. The commercial importance of the type is small, as the growth is very slow and the product usually of inferior quality. The type can be handled best by the selection system, removing the defective and larger trees, as the reproduction can stand great shading for a long period and still recover its normal rate of growth if liberated.

Pine Type.

The two species of pine native in the town are white pine which is of importance as a timber tree throughout the northeastern states, and pitch pine which is generally a scrub tree of little commercial importance. Both species are of only local occurrence and of slight commercial importance within the town. Pitch pine forms one open stand at the summit of a small hill on the western side of the town near Georgetown. The site is very exposed and the growing conditions such that other tree growth is almost lacking because of repeated burning. White pine forms a small portion of the stand in the central and eastern parts of the town, but has been mostly introduced there artificially in the reforestation of waste land.

White pine is one of the best trees for forest management as it grows rapidly, in dense, pure stands, and with a large yield per acre. It will not do well on land subject to flooding, but is well adapted for most other sites. A third species, the Norway or red pine, is found within the town in forest plantations, but does not occur naturally here, although native to the extreme northern part of the state. This species is more resistant to insects and fungi than white pine, and is being used in increasing amount for reforestation work in the state.

FOREST DESCRIPTION.

The forests of this region are at present a mixture in which the weed species are the most common, as a result of improper cutting and damage caused by fire and disease. In a region

where there is very little market for cordwood the disposal of such material is a hard problem. Under present conditions there is very little hope of natural improvement in the stand, as the weed trees are best able to hold the land. These trees are usually well equipped by nature for rapid spread into the openings before the more valuable species are able to get a start, with the result that they occupy more area with each cutting.

The best methods of management for these areas involve the artificial introduction of more valuable species wherever possible, with the expectation that they will increase in numbers by natural reproduction. At the same time cuttings should favor any valuable species already on the ground. In the woodlot the cutting of cordwood for home use forms one of the easiest methods of improving the stand. Such cuttings should take out the poorer species such as birch, maple and elm, as well as inferior trees of the valuable species. The openings thus made should be planted with trees of commercial value and rapid growth. This planting will not take much time, and the cost of the stock is not very great. Such a selection of fuel wood followed by planting will eventually make the forest one of only valuable species. This will increase the rate of growth for the thinned stand left, as well as for the rapid growing species introduced, and the final yield will be much greater than for the original unthinned forest.

In the northern part of the town there is a market for cordwood which will permit clear cutting followed by planting. The brush may be piled and burned to lessen the fire danger, or may be scattered so that planting will be possible. Over the remainder of the town there is less market for cordwood, and the cuttings are for lumber, only the valuable trees being removed. The trees remaining are in very bad shape as a rule. As the lumberman only buys the timber he has no interest in the future crops, and his men fell the trees in the easiest way without regard to reproduction or immature trees that may be on the ground. This results in the breaking of much young growth, and the leaving of large weed trees to seed in the vacant areas. Tops are left unlopped and form a bad fire danger, especially if the cutting is in summer when the leaves are on the trees. On such areas it is advisable to have an understanding with the lumbermen that care will be used in felling to protect the younger trees, and also

as to the disposal of the tops. Lopping or "limbing to the tip," as it is sometimes called, is perhaps the best way to dispose of them where burning is impracticable. This allows the limbs to lie in contact with the ground where they rot much more quickly than in the air. After logging, such areas should be planted, scattering the plants in the openings where they will not be unduly shaded.

Areas that are not producing a crop at the present time present a different problem. They are of two classes, the old field and the scrub oak types. Of these the former is the easier to handle and is the one in which the most work should be done in the near future. As a rule the old field is not only good forest land, but present ground conditions offer very little hindrance to planting operations. When there are open conditions with bunch grass or low brush and a few scattering clumps of trees, planting is done without regard to the tree growth, unless there are wide spreading pasture trees which should be removed for cordwood. Spacing the trees six feet apart each way requires 1,210 trees per acre, and assures the establishment of forest conditions at an early age. The planting up of such old fields promises the best returns on the money invested of any operation in forestation.

The second class of non-productive land is the scrub oak type which occupies a minor area in the town, and follows the repeated burning of an oak type which has impoverished the soil to such an extent that the better class of trees can not compete with the more hardy scrub oak. This species sprouts very vigorously after a fire, and seems to increase in numbers every time an area is burned. The final result is the elimination of the better species for a long term of years, and the loss of returns from the land for a much longer time. Natural reforestation with a valuable species is very slow in such cases and may never take place. Scrub oak is a light-requiring tree and if once shaded will soon die out. This fact may be taken advantage of in artificial forestation, as the stand could be planted with a species that would grow under more or less shade and eventually grow up through the scrub oak to supplant it.

While there are a few areas of unbroken forest in the town, the greater part of the tree growth is in the form of woodlots connected with the farms. These woodlots are more or less isolated, many being surrounded with cultivated land and having

very little fire danger. There are no large holdings entirely within the town, but some of the larger estates include considerable forest land. Since the town is naturally divided into three ridges and four valleys extending from north to south, these natural divisions will be followed in the description of the forest areas.

Aspetuck Valley Area.

This stream rises in the northeast corner of the town and flows south near the eastern border. The head waters are in a large estate where the forest is highly prized for its aesthetic value. All parts of this tract are accessible by means of fine roads, and much improvement work is being carried out in the woods. The chestnut is being removed where necessary, and the resulting stand will be oak on the ridges, changing to mixed hardwoods on the slopes and bottomlands. The mixture includes black and yellow birch, ashes, maples, oaks, hickories, tulip, and other less important species. The swamp species are soft maple and black ash with some elm. Very little planting has been carried out here as yet, but probably much of the area opened up by the removal of the chestnut will be reforested in this manner. This and an adjoining estate include some of the oldest stands in the town.

Near these areas but lower down the stream is a ridge on which the topography is not as broken, and here the forests have been cut solely as a commercial proposition. The species are largely oaks of somewhat inferior quality. The soft maple swamps are common along the stream, as the fall is very slight here. The valley widens out with a large percentage of the land cultivated, but near the center of the town the stream enters a narrow valley where the sides are steep and the fall is very abrupt. This was once used for water power, but is now owned by the Bridgeport Hydraulic Company, which is protecting the stream as a source of municipal water supply, and eventually plans to reforest its banks. Hemlock is the ultimate type of the slopes and some very good stands are found along the stream at this point. The ridge to the east is oak, or oak and chestnut, but has been culled of the latter species within the past few years. The valley is largely owned by summer residents, and there is good reason to expect that the forest will be improved, both for

the commercial and the aesthetic values it will add to the properties. The lower valley is again more open, with swamp land along the stream and much of the area cultivated. The forests are on the steep slopes at some distance from the stream.

As a whole the Aspetuck valley offers a very favorable opportunity for forest improvement. Planting should follow the removal of the chestnut, not only to increase the growth of merchantable material but also to improve appearances by the introduction of conifers. At present the only break in the broadleaf forest is the hemlock along the river, which adds greatly to the attractiveness of the road at this point. By scattering rapid growing evergreens throughout the forest the landscape may be made more diversified and more attractive, especially in winter. The rapid growth of pine plantations in this valley is well illustrated on areas just outside of the town to the south.

Redding Ridge Area.

The Ridge extends entirely across the town, dividing the Aspetuck from the Saugatuck drainage. This was one of the earliest settled portions, and contains some of the best of the farming land. This ridge has a relatively uniform elevation, being broad and flat-topped with gradual slopes to the valleys. One of the oldest roads in the town follows it towards Danbury, while the old Newtown-Ridgefield turnpike crossed it at what is now known as Redding Ridge.

The greater part of the original forests were entirely cleared from this section, the present remnant being found as woodlots on the rougher sections. The possibilities of forest management in these woodlots are as good as for the practice of scientific farming on the agricultural lands. At present the woodlots are not being utilized to their capacity. The land occupied is relatively valuable, while the crop produced is of minor quality and quantity. Very little labor would be necessary to convert these stands into a type that would produce a crop in keeping with the rest of the farmlands. There are many small corners in this section that are at present idle but which should be planted for their aesthetic value with financial returns as a secondary consideration.

There extends into the southern portion of the town to the west of the Ridge Road, a more broken area of fairly heavy

woodland. This contains some small pieces of fine timber, although the greater part has been culled. Within this area there are a number of tracts of waste land where the opportunities for reforestation are very good. Some of this idle land is probably agricultural, but does not appear to be needed for the present and should be used for forestry purposes.

While this region is within direct marketing distance of Bridgeport, the cost of hauling wood prohibits its disposal in this manner. The northern part of the region has a market for wood in the lime-kilns, and to a limited extent in Bethel. The greatest use for wood is local in the form of fuel.

Little River Valley Area.

This stream is one of the main branches of the Saugatuck. It crosses the northern boundary of the town east of its center, and flows to the southwest into the Saugatuck near the southern boundary. Its valley is relatively wide, and for the most part agricultural. There are a series of woodlots near the stream, while the slopes are cultivated.

The Putnam Memorial Park at the northern side of the town is of historical interest as it marks the winter camp of a portion of the Continental army during the Revolution. The woodlands of this tract are being improved as park, and the waste land is planted with pine. A small artificial lake at this point is privately owned as a summer camping ground, and the area adjoining it has been planted with pine for the purpose of improving the camp sites in the future. Both of these plantations show good growth.

This valley tends to be swampy, with tree growth of little value. The land will probably be drained at some future time and used for agriculture, but in the meantime the woodlots should be handled on the selection system in order to get the best growth possible, while the small areas of forest soil on the steeper slopes should be planted with conifers in order to bring them into a producing state. Near the lower end there is a sharper gradient, causing the stream to cut through a number of ledges and form a narrow gorge with a series of small falls. The banks are open, or at most covered with brush, giving little indication of the natural beauty of the stream at this point. Small plantings of evergreen trees, such as the spruces or pines,

would make this one of the most attractive places in the town, and would be of great value to the whole community. The cost of such an operation probably would not exceed one hundred dollars, and the future benefits to a town depending on summer residents for much of its income can be readily appreciated.

Gallows Hill Area.

The triangle formed by the Little and Saugatuck rivers with the northern boundary of the town as a base includes the ridge known as Gallows Hill. Redding Center is also located within this area, the broad flat-topped ridge forming some of the best farming land of the town, especially toward the eastern edge of the triangle. The economic changes of the past half century have caused the abandoning of numerous small areas in the western part of the tract which are still unproductive.

In the portion north of the center lies one of the larger forest areas of the town. This forest is very broken in character, due to irregular cuttings. The topography changes as the western edge of the ridge is approached, becoming steeper with more rock outcrop and a larger percentage of true forest soil. The types to be found on this area are extremely variable, but the mixed hardwoods type prevails with a large percentage of oak in the mixture. The chestnut and the oak-chestnut types were once common but chestnut is at present largely eliminated. Maple swamps are common in the depressions.

This area is within the region where cordwood may be handled at a profit, as the haul to the lime-kiln is relatively short. The railroad also is within easy hauling distance, and saw material may be marketed in this manner. At present the tendency in the northern part is to cut clean on a short rotation, while to the south, culling of the stands is the common practice. Intensive forest management is entirely possible here, even under present market conditions, and gives great promise for the future. On the poorer ridge sites, pine should be planted to take the place of the slow growing oak. On the better sites, the selection system in which the best trees are left and the remainder cut for cordwood is recommended, planting the resulting openings with pine. The remaining mixture will then contain only the best of the native species, and will be very productive, since

not only will the mature product be merchantable, but also thinnings and culled material.

South of the center there is not so good a market for cordwood, and intensive management is not so practicable, but the planting of conifers in openings and on waste land would greatly increase the value of the forest in this section. There is at present some good timber, but the greater part of the stand is open and suitable for restocking with conifers. Hemlock increases in abundance near the western side as the Saugatuck is approached, and finally merges into pure stands along the banks of the stream.

Saugatuck Valley Area.

The Saugatuck valley has the form of a question mark with the point of the hook a short distance south of Umpawaug Pond, extending north around Umpawaug Hill and turning southeast to leave the town near the center of the southern boundary. The upper portion of its drainage is characterized by gentle gradients, and swamps are common. The steepest of the slopes are forest soil, but the greater part are cultivated, the forests being mostly of the woodlot type. The mixed hardwood type is most common as the result of the removal of chestnut, but on the rough hill in the northwest corner of the town there are many areas of shallow soil with oak as the dominant tree. With the exception of small isolated stands inaccessible because of the rough character of the topography, the timber of the section has been entirely culled or clearcut. The annual production of the present type is very small, and should be increased by the introduction of pine wherever possible, especially after cutting the merchantable timber. Near the small lake on the western boundary of the town there is a good stand of old hemlock, of value because of its location rather than for lumber. At the north, Umpawaug Hill ends in a rocky outcrop on which the elimination of chestnut, and the burning over of portions by fires originating from the railroad, has resulted in a mixed hardwood type of a more northern character, including hard maple and beech.

Turning south, the stream becomes swifter with a relatively narrow valley, until near the junction with the Little River.

The one exception is at the point where the Newtown-Ridgefield road crosses. Here there are small areas of agricultural land on the slopes and in the valley. The northern end of the valley has mixed hardwood species on the slopes, with some pine near the stream and oak on the ridges. Small areas of maple are common. Below the road the valley narrows for a short distance into what is known as the Glen. The road here has been cut into the hill, as there is only room for the stream in the bottom. Hemlock is the natural type in this section, and the stands add materially to the beauty of stream and road, especially in the summer when the dense shade is very agreeable. Below this the valley widens out into an extensive river meadow, subject to flooding at times. At the lower end of this flat the river passes out of the town over a ledge which, acting as a natural dam, has caused the depositing of sufficient material to produce the meadow conditions above.

This valley as a whole is one in which there is a large percentage of forest land. Its upper portion has the same conditions as the Gallows Hill tract, and the same system of management would apply. Scattering white pines of large size show the possibility of the species in this region. Conditions in the lower portions of the valley are not as favorable for intensive operations, but where they can be carried out without present financial loss, the increased future values of the woodlot would assure a satisfactory profit. In places where chestnut has been cut out, leaving much large timber, conditions are suitable for underplanting with tolerant evergreens such as hemlock and spruce. Other stands that have been cut clear of all merchantable species should be replanted with pine. The natural reproduction of tulip is very good in this region, and should be encouraged. Much of the planting, especially in the northern part, should have the increased beauty of the roads as an object. The effect of evergreen trees on the beauty of the roads is seen in the Glen, and this same effect should be secured in other parts of the valley as soon as possible.

Umpawaug Hill Area.

This section has three distinct parts: the "Seventy Acre" tract, the "Den," and the remainder to the north and east of these which will be called the "Hill" for purposes of description.

The Hill section is largely woodlots, although the Saugatuck Valley forest extends into it at several points on the east. The headwaters of several small streams are within this area, but small swamps are not as abundant as in other sections. The forest as a whole is of mixed species, although small areas of true forest soil are occupied by hemlock or oak. The greater part of the woodlots are on fairly good soil which is not needed for agriculture at present. These stands produce the wood supply of the owners, and on this account are capable of intensive management. Even though a little longer time is required to cut the year's wood, the removal of inferior species only, and the planting of openings in the spring would soon produce increased income from the woodlot.

The area is characterized by a large amount of idle land, much of which is good agricultural soil. The agricultural possibilities of the Hill are apparently as great as of the other ridges in the town, but the area is not so well developed. This is probably due to its being beyond the direct haul to market which has tended to improve other sections of the town. At present there seems to be some indication of increased agricultural activity, with the reclaiming of some waste land. Several plantations of pine have been made which show very good results. The planting of such waste land is perhaps the most important line of forest development at present in this section.

The Den section is only the upper end of a large forest tract that extends into the town from Weston. This tract is along the divide between the Norwalk and the Saugatuck rivers. The relatively level ridge is broken by numerous ledge outcrops, resulting in swamps subject to overflow alternating with rocky ridges. The types vary greatly as to species and value. The ridge type is largely oak which is cut for timber and ties, while the swamp type is maple with a few scattering trees of more value. Towards the eastern side, chestnut becomes more abundant with the increasing depth of soil, especially on the slopes. With the loss of the chestnut, however, this type is changing to the oak or mixed types.

This whole tract, including the portion which is in the town of Weston, should be handled as a unit. There is, however, a fringe of woodlots along the edge that are used by adjoining owners as the source of their wood supply. There are also a

number of areas of waste land that ought to be planted soon in order to produce a crop of timber within a reasonable time. The ridges should also be replanted as the wood is cut off, to increase the annual production of the region.

The Seventy Acre tract is located on the ridge to the north of Georgetown and to the east of Branchville, extending north to a point near Topstone Station. This is perhaps the largest unbroken area of forest soil within the town, and is very favorably located for handling as a small forest unit. The topography is broken, with numerous ledge outcrops and abrupt slopes. The ledges are higher than in the Den section, especially towards the southern end, but they do not prevent all parts of the area being accessible for lumbering. The tract is a divide between the Saugatuck and the Norwalk rivers, with the greater part sloping towards the Norwalk. The railroad follows its western side, and constitutes a serious fire hazard at many points.

The dominant type is the oak ridge with chestnut oak and scarlet oak very abundant. The largest areas of scrub oak are also in this region as the result of repeated burnings by railroad fires. Cuttings have been very irregular. Some of the small swamps apparently have never been cut, as the soft maple and sour gum show virgin conditions. There is a small area of pitch pine on shallow soil at the top of a rocky hill near the railroad where the site is very unfavorable and other species were not so well able to survive. The areas of old field are mostly in the northern end of the area, and are relatively small. Very probably some of these areas will be cultivated again, while other portions will be left to restock with forest trees.

In the development of forestry in European countries, publicly owned forests have played an important part. Forests owned by some of the cities and towns pay the greater part of the expenses of local government. In this country there is a growing tendency toward the purchase of town forests. These are of two classes: one for the protection of the water supply, and the other for the use of the public as parks. In either case there is a definite plan to improve the growing conditions, and realize the greatest income possible. Waste areas are being planted and the forest put in the care of trained men who are carrying out a definite plan of management with an increased future yield as the main object.

The forest area within the Seventy Acre tract amounts to about 1,300 acres, probably one thousand of which will always remain forest. This area is of sufficient size to make a small working unit under management, and is so situated that it could be developed into a very attractive park if owned by the town. Many good camping sites could be provided, and as there is a fair system of woods roads, the development along this line would not be very difficult. A park of this description would not tend to change the character of the forest, except to improve the growing conditions and to protect the area from fire. Much of the growing stock on the area is inferior at present, due to past methods of handling. Because of increased quantity of products, systematic management of the entire area as a unit would permit more economical marketing than is possible at present with a large number of individual owners. Reforestation of the area would be very important, as the species now on the ground are slow growing. Placing this tract of a thousand acres under management with a permanent owner, such as the town, would eventually bring it to its maximum producing capacity. With a rotation of fifty years, pine on an area of this size ought to give an annual yield of at least 700,000 board feet with a stumpage value of about $7,000, and if cut in a mill also owned by the town, ought to produce an income of at least $8,000 per annum. A forest of this kind would be of very great value to any town, but especially to one which has a large number of summer residents.

FOREST FIRES.

Protection from fire is absolutely essential to the practice of forestry. During the past fifty years probably no one factor, not even the chestnut blight, has caused so much damage to the forest resources of Connecticut as fire. The loss has not been so apparent, as it has not often been total, but repeated burnings have gradually changed the character of many valuable stands, lowering their quality and value to the vanishing point in some cases.

To prevent this economic loss, a system of fire wardens has been established by the State. The state forester is, *ex officio*, state forest fire warden. The selectmen of each town appoint a

town fire warden, subject to the approval of the state warden. The town warden in turn appoints district wardens in the sections of his town where there is the greatest fire danger. All wardens have power to arrest violators of the forest fire laws, and to summon such assistance as they may need to control forest fires. The cost of this protection is divided between the towns, the counties and the State.

During the progress of this survey, notes were taken as to areas in the town of Redding which showed signs of having been burned over recently. Approximately 670 acres of woodland were estimated as having suffered from fire damage in the past five or six years. Most of this area is in the western part of the town near the railroad. The total number of fires reported to the state fire warden by Redding wardens from 1910 to June, 1915, was thirty-seven, and the total area of woodland burned was estimated to be about 1,500 acres. It is fair to assume that much of this land was burned over more than once, which would account for the difference in the two estimates of area. The lesser amount is nearly ten per cent of the town's forest area, so that the importance of protection is readily apparent.

Of the thirty-seven fires reported, twenty were attributed to railroad causes, three to brush burning, two to general carelessness, one was thought to be incendiary, and the remaining twelve were of unknown cause. For purposes of discussion, the causes of fire may be divided into three classes: malicious fires, careless fires and railroad fires. Even though none of the fires of unknown origin are attributed to railroad causes, it is evident that the latter class is the most serious in Redding. Carelessness of individuals is undoubtedly responsible for most of the fires whose cause is not determined. Malicious or incendiary fires are liable to occur in any community, and can only be guarded against by strict enforcement of the law.

Careless fires are of two kinds. The least numerous are those due to the escape of fires kindled for the legitimate burning of brush, rubbish, etc. In such cases, the carelessness consists in failure to take proper precautions to prevent the spread of the fires, or poor judgment in choosing a time for burning. The remedy is provided by the law which requires written permission from fire wardens for the kindling of such fires during the ordinary dry periods of the spring and fall. This law gives a

warden an opportunity to insist on necessary precautions being taken, and also gives the public an opportunity to coöperate with him in eliminating one possible cause of forest fires. As the best judgment will sometimes fail, however, there will always be danger of fire from this source, and any one through whose carelessness or poor judgment such a fire is allowed to escape, should be held responsible for the expense incurred by the town in extinguishing it.

Other fires of this class are due to carelessness with matches, smoking materials, etc., by pleasure seekers, hunters and fishermen. While occasional fires may be caused by failure to extinguish a camp fire, it is probable that more are due to the carelessness of smokers, either in the woods or on adjoining highways. A large portion of Redding is fairly well protected against such fires, as most of the woodland is closed to hunting or fishing, and the land along the main auto roads is largely cleared. Picnic parties are most frequent along the streams in this region, where the fire danger is relatively slight. Putnam Park, much used for picnic parties, has a permanent watchman who should be able to guard against fires there.

Careless fires can be entirely prevented by thorough enforcement of the laws, and education of the public to the need for care in such matters. This should be the most important duty of a fire warden, but he must have the full coöperation of his fellow citizens in putting into effect such preventive measures as seem necessary. An increased investment in forest plantations throughout the town will result in a demand for greater protection from fire, and owners of plantations will assist wardens in preventing the careless burning of brush or rubbish by irresponsible neighbors.

The railroad fires are due to sparks from locomotive stacks or ash pans and the danger is increased by conditions along the right of way. The necessity of crossing the divide between the Norwalk and the Saugatuck drainage causes an up-grade run halfway across the town for trains in either direction. The greatest danger is in the southern half where the woodland area is more extensive. The broken topography causes many cuts and sharp curves which makes the fire danger greater than in a level country, as the top of the locomotive stack is closer to the level of the ground in a cut, especially if the high bank is

on the inside of the curve. More level, open ground with numerous swamps reduces the fire danger in the northern half of the town, although there are a few spots where fires are frequently set by sparks. Fortunately the highway follows the railroad the greater part of the way, acting as a fire line and making the region readily accessible for fire fighting. The law requires that all steam locomotives must be equipped with effective spark arresters and ash pans. If there is reason to believe at any time that locomotives are in use with defective equipment of this nature, the state fire warden should be informed at once.

The only method of protection employed within the town at present consists in the fire wardens keeping a lookout for fires. When one is seen, a crew is gathered to put it out. The location of wardens for lookout purposes should be carefully considered, as well as the fitness of each one for the work. One who can overlook a large amount of territory may be able to notify other wardens of fires which they can reach more quickly than he can. Where the railroad is the greatest problem there are two methods that should help in solving it. First; clearing up and disposing of all inflammable material to a distance of one hundred feet from the center of the track, leaving the standing trees as screens to prevent the sparks being blown to a greater distance. This can only be done through the coöperation of property owners with the fire wardens and section men, since the railroad company has as yet no authority to do such clearing outside its right of way. Second; patrolling the track after each train during dry seasons. These two measures together would form a control system that should prevent the spreading of railroad fires. Under normal conditions there would probably be very little need of the patrol, but the location of district wardens so as to overlook the railroad right of way would answer the same purpose.

IMPROVEMENT CUTTINGS.

The cultural operations used in intensive forestry consist of a series of cuttings for the improvement of an existing stand in composition, rate of growth, and value of final product. Such cuttings may be grouped in three classes. 1. Cleanings and liberation cuttings to remove undesirable tree growth interfering

with that of greater value. 2. Thinnings to stimulate the rate of growth. 3. Damage cuttings to remove and utilize material damaged by fire, insects, disease, etc. The possible intensiveness of improvement operations depends on the forest conditions and the market for small products such as cordwood.

The life history of a forest stand is the same whether it is of seed or coppice origin. During the first few years each tree is an individual with plenty of room to develop on all sides and above, but soon the side branches begin to be shaded and the tree increases its height growth in order to keep its crown in the open light. The more intolerant the tree, the greater the height growth at this stage. With the development of forest community life, competition becomes keener, and the intolerant trees grow faster in height, overtopping their more tolerant neighbors, while the weaker are suppressed by the more vigorous. The loss in numbers through competition is consequently very great in a natural stand. The shaded side branches die for lack of sufficient light, are eventually broken off and the tree prunes itself naturally.

Clean lumber can thus be secured from a stand which has grown in crowded condition long enough to produce the degree of pruning and height growth necessary. After the trees attain their height growth, the crowding is from the side instead of by overtopping. The loss in numbers is very much smaller now, but breaks due to the loss of mature trees make openings that allow seeding in from nearby trees, thus maintaining trees of all ages in the stand. As the stand is thinned out by nature, the material removed is lost through decay, returning to the soil in the form of humus. This loss in mature trees offsets the growth of the younger ones, so that a natural forest is usually at a standstill so far as production is concerned.

Thinnings are the artificial means used to relieve excessive crowding, and at the same time to save as great an amount of the material grown as possible. Where there are markets so that the owner can even cover expenses, thinnings will pay because of the increased growth of the remaining timber. Light or medium thinnings will save the material usually lost in decay, while the time necessary to grow special-sized material may be shortened considerably, since each tree can be allowed its maximum growing space. Thinnings of existing stands in this region

should remove the weed species and the defective specimens of the crop trees without making an opening greater than can be closed in five to eight years by the crowns of trees left standing. The spacing of the trees on the ground does not necessarily determine the density of the stand, and only an examination of the space occupied by the crowns will tell how much of a break in the crown canopy a given tree will make if removed. The cutting of all undergrowth in a stand is not advisable, as the small shrubs aid in the formation and protection of the humus.

In a large part of the town there is no market for cordwood except for local fuel. When cuttings of any sort are made in such sections, the top wood should be removed if it will at least pay the cost of the operation, as there will be less fire danger and the remaining stand will be in better growing condition. Where this is not possible, the lumbermen should be required to lop the tops, as well as protect the young growth during cutting. Care should be taken in all operations within the forest to protect the fringe of brush and limby trees along the edge next an opening. These trees and shrubs act as a wind break to prevent excessive air circulation within the forest and help to preserve the humus in this manner. The practice of raking up leaves under the forest trees, either for use as a mulch or because near a summer cabin, will tend to cause drying out of the soil. In some cases this change in the soil moisture conditions, and winter damage to the roots not protected by a covering of leaves, will cause the death of forest trees.

In plantations, the cultural operations prior to thinnings are usually confined to cleanings. These consist in lopping brush and sprouts that are overtopping the planted trees. Only such growth as is directly interfering with them is cut, and then only lopped so as to prevent the rapid growth produced if cut back to the ground, but at the same time freeing the planted trees.

PLANTING.

High labor costs in this country necessitate different methods from those practiced in Europe for the reforestation of abandoned lands, or the changing of species in existing forests. The common method there is to plant seed in more or less cultivated spots, the resulting seedlings being thinned out to the required

number for the area. In this country the seed spot method is seldom used because of cost of labor in preparing, loss of seed by rodents and birds, and injury to the seedlings from excessive competition of other plant growth. Broadcast sowing of seed is also too expensive, as four to ten pounds per acre are required at a cost of $1.50 to $6 per pound for seed. Direct planting of nursery stock is cheapest and most satisfactory in the end in this country, as a stand of the species desired is thus established without loss of time and with the proper spacing.

Selection of the proper species for reforestation purposes is limited by the desires of the owner as well as by the site conditions. From a financial standpoint it is further limited to the rapid growing softwoods or conifers because of the value of the crop and the ease of marketing it. Certain special uses may give some of the hardwoods or broad leaf trees local value for reforestation, but their relatively low yield prevents very attractive financial returns. A comparison of the habits of growth of the hardwoods and conifers in the seedling stages, and their relative ease of handling, is all in favor of the conifers. Since seedlings of the latter do not develop deep taproots as rapidly, they are more easily handled in the nursery, and can be shipped greater distances with less loss. After a forest is established the conifers reproduce naturally from seed more readily than do valuable hardwood species, and for this reason are easier to handle by a natural system of regeneration. The conifers are particularly well adapted to growing in pure stands with a large number of stems per acre. Thinnings have merchantable value even though of small size, as much smaller material is sawed with conifers than is possible with hardwoods. Most of the latter grow best in a mixed stand where the cost of protection is highest, and the logging areas necessarily more extended to get sufficient material for profitable marketing, while the conifers can be grown pure with small logging areas.

The planting of conifers in waste areas near roads would be of great value to the town from the aesthetic point of view. The attractiveness of coniferous growth is well illustrated in the Glen, through which many people drive at all seasons because of the absolute contrast with the ordinary hardwood stands. The Glen without the hemlock would be little more attractive than many other stretches of road within the town. A system of

coöperation between adjacent landholders should be developed to secure plantings of sufficient width to make conditions similar to those in the Glen common throughout the town. The cost would be very slight compared with the benefits to the community.

The stock to be used depends on the site to be planted. Where exposed to root competition with other growth, or where the site has unfavorable conditions, better developed stock is necessary than where the forest growth has just been removed or where underplanting is planned. Nursery stock is of two classes, seedlings and transplants. Seedlings are taken directly from the seed-bed and may be either two or three years old. Transplant stock is produced by setting one- or two-year seedlings in nursery rows, and allowing them to grow one or more years there before use for forest planting. Low cost is the only reason for recommending the use of seedling stock of most species. Transplant stock is better able to withstand adverse conditions, and is more commonly used. The cost of stock varies from six to eight dollars for three-year transplants and about half as much for seedlings.

The field work of planting is very simple and a mattock or grub hoe is the only tool required for the work. The average farm laborer can easily set 500 to 800 trees per day, the number depending much on the site conditions. With experienced labor one thousand trees per day per man can be set on good sites. The usual spacing is six by six feet on open land or where there is no established tree growth. Great care should be taken that the roots do not dry out at any time. The total cost of reforestation should not be greater than ten to twenty dollars per acre when transplant stock is used. The time to set forest trees is as soon as the ground is open in the spring. This is often before conditions are fit for other spring planting and the work should be finished before the middle of May. With reasonable care in the planting and handling of stock, the average plantation should have ninety per cent of the trees living at the end of the first year. Broadleaf trees are only handled as one-year seedlings because of their greater seedling growth. Red oak is the easiest handled of the native species but not much used for reforestation as yet. White ash and tulip are sometimes used but it is not always possible to secure stock. In a region where

hardwoods abound, pine or some other coniferous tree should have preference in planting.

White Pine.

This is a native pine and one of the most valuable timber trees of the United States. It is easily managed and of rapid growth, especially for the first fifty to seventy-five years. Although adapted to all sites that are not subject to flooding, it grows best on a fairly moist loamy site. In planting white pine, three-year transplant stock should be used under most conditions as it is most economical and easiest to handle.

White pine has been the most extensively planted tree in the East and several plantations are of sufficient age to show the yields that may be expected. The condition of such plantations in this and other states, and the growth of natural stands, shows that white pine completes its financial rotation in about forty-five to fifty years. That is, the difference between the sale value of the timber, and the total costs of establishing and protecting the stand plus taxes and interest for the period, is greatest at about this age. The amount of timber is then increasing, but not so fast as the interest on the investment. For this reason, if carried too long, the investment costs will consume all the profits, and there will be a loss on the forestation operation, even though the actual sale value of the crop may be much greater than at the time of greatest financial profit. While the amount of timber which may be expected from an acre varies with the site, it will be safe to assume that the average for the town will be at least 35,000 board feet for a fifty-year rotation, and in this report that figure will be used.

White pine has a serious insect enemy and a threatening fungous disease in New England. The insect is a weevil which lays its eggs in the leader in early summer. The larva or grub develops, and tunnels down the inner bark towards the base of the tree. The length of the tunnel is limited only by the length and size of the tree, as sufficient food material is the only desire of the grub. At maturity it bores into the wood and pupates there. The adult beetle emerges from the middle to the last of July. The best method of control is to cut and burn all infested shoots before the beetles emerge, thus reducing the next year's crop of weevils. In this way, damage may be limited to a

slight crook in the tree attacked, since one of the side branches soon takes the place of the leader removed.

The fungus is a blister rust requiring for its alternate host some species of currant or gooseberry and causing the deforming and death of small trees, especially in the seedling stage. It is a European disease which has secured a foothold in this country and will necessitate measures of control to prevent its further spread. Such measures have been undertaken by the State and Federal government, and the use of white pine for reforestation work need not be entirely discontinued. It should be used with discretion, however, and preferably in mixture with some other species.

Red Pine.

Red or Norway pine is a native of the Lake States and Northern New England where it is cut for lumber with the white pine. It will make a good growth on the drier sites but is not as good on moist sites as white pine or spruce. The growth for a short rotation is about the same as that of white pine. The species is free from insect or fungous attacks, and for this reason should be favored over white pine. The quality of the wood is not as high but it is better adapted to use in places where strength is required. As a rule the material can be sold in the same market. It requires somewhat more light than white pine, and is therefore not as well adapted for underplanting unless the cover is removed at an early age. The mixing of red and white pine is perhaps the best method of planting these species in the average conditions found in the town. As with white pine, three-year transplants should be used in most cases.

Scotch Pine.

This is the main timber tree of Europe, and is of very rapid growth on dry unfavorable sites. The quality of the product is not high, being suitable mainly for dimension material and rough boards. With this species the use of two-year seedlings is best, as the seedling growth is so rapid that larger stock is hard to handle.

Norway Spruce.

The planting of this species is increasing in the state, but at present there are no figures available to predict its growth

or yield. It is very extensively used in Europe, and is common here as an ornamental tree, or for wind breaks. Its growth in the juvenile stage is not rapid until after the fifth or sixth year, and the use of stock smaller than three-year transplants is not recommended. It is well adapted for use as a Christmas tree, and may be grown for this purpose in close spaced plantations, either pure or in mixture with pine.

CONCLUSION.

The survey shows that 43.3 per cent of the town, or 8,880 acres, is classified as forest or waste land. This area is divided among the various forest types as follows: 33 per cent is mixed hardwoods, a large part of which is a changing type due to the loss of chestnut; the oak and old field types each occupy 21 per cent; the swamp type 14 per cent; and the oak-chestnut type 8 per cent. The remaining 3 per cent is divided between the hemlock, the chestnut and the pine types. This shows that 64 per cent of the forest area is in types that produce timber, while the swamp and the old field types occupy the remainder. These two types are of small present value because one produces only cordwood, while the other is producing practically nothing.

Although 64 per cent of the forest area may be considered as in a producing state, it is very irregular both as to species and age. The cuttings for the past few years have greatly reduced the amount of merchantable timber still standing. The rotation necessary to produce a merchantable crop is at least forty-five years for the fastest growing of the native species, while the survey shows that only seventeen per cent of the stand is over forty years old. The poor species in the average stand indicates the relatively poor quality of the present forest. The loss of the chestnut has made great changes in the producing capacity of the stands, as it has removed the most rapid growing species. Weed species are spreading into the vacated areas, as they are better able to take advantage of the increase in the growing space than are the more valuable but slower-growing trees. It is safe to say that at present less than half of the growing space is occupied by valuable species.

The rate of growth of the merchantable species remaining is so low that at best they will not produce annually more than

three-fourths of the amount formerly grown. The yield per acre for a fifty-year rotation with the present species, should vary from 10,000 board feet on the best sites to 3,000 on the poorer, but this is much reduced because of the poor stocking of these stands. The average for the town at present is probably under 4,000 feet per acre on a fifty-year rotation, but 4,500 board feet will be taken as the yield in the following comparison. As the area in productive types amounts to 5,675 acres, the yield for a fifty-year period would be 25,540,000 board feet, so that an average annual cut of 510,800 board feet may be assumed. With a stumpage value of six dollars per thousand, this means an annual income of over three thousand dollars from the present forest area on a fifty-year rotation. Under a working plan which provided for 114 acres being cut over each year, such an income might be expected.

The value of cordwood is for local fuel, unless the stand is cut on a shorter rotation with no other product than cordwood. Taken as a whole there is very little sale value in cordwood at the present time, and the returns from this source may be assumed to barely cover the waste of such material due to lack of a market for it in the greater part of the town. The swamp type comes under this classification at present and is not considered here for that reason.

The old field type occupies some 21 per cent of the forest area, or 1,865 acres. This will not all return to forest during the next rotation, as portions will be cultivated, but it is safe to assume that two thirds of this area might be afforested and produce at least one forest crop before being required again for agriculture. This means about 1,250 acres available for afforestation, and which, although as good as the best of the forest land, is not at present producing a crop of any kind. Planted with pine, this 1,250 acres would yield a crop of at least 43,500,000 board feet in fifty years, and probably 50,000,000 board feet would be an underestimate. The area to be cut annually would be only twenty-five acres. Aside from the better quality of the product, this indicates the greater value of conifers as compared with hardwoods for reforestation purposes. If the stumpage value were figured at ten dollars per thousand, the returns from the cut at the end of the fifty-year period would be from $435,000 to $500,000, and if this material were milled,

the market value would be well over a million dollars. This represents an annual cut of at least 870,000 feet of timber valued at $8,700, from an area of twenty-five acres per year.

The gross income from the original forest on a fifty-year rotation figures about twenty-seven dollars per acre, while in the artificially established coniferous forest it should amount to at least $348. The average value of these forest lands may be assumed to be ten dollars per acre at present, and this may be assumed as a fair average value for the land and growing timber during the past fifty years. This value compounded at five per cent interest for the period equals $114.67, so that the interest charges are $104.67 per acre. At an average rate of ten mills, the taxes for fifty years at five per cent compound interest would amount to about twenty-one dollars, so that the interest on the land plus taxes and interest amounts to $125.67. If the gross sale value of the crop is twenty-seven dollars, a net loss of almost ninety-nine dollars on the crop of timber is sustained on the fifty-year investment. This may be somewhat reduced by the fact that a portion of the cordwood has been used either for fuel or sold in the open market, and that material for repair work on the farm has been cut from time to time. A profit on the land because of increased values might also slightly reduce this loss.

Waste land that is planted would carry an additional charge for the cost of afforestation, that should not average more than ten dollars per acre. On the total investment of twenty dollars per acre, the interest charge at five per cent would be approximately $220.00 for a period of fifty years. If advantage is taken of the law which provides for the listing of forest land for taxation purposes (Chap. 58, P. A. of 1913), taxes for the period can be calculated on the basis of the present valuation at the ten mill rate. The land taxes with interest would be twenty-one dollars as in the other case, and the stumpage products tax of ten per cent on a yield of $350 per acre would be thirty-five dollars. The interest charge plus taxes, therefore, amounts to $276, but as the returns are $350, the plantations would show a profit of seventy-four dollars per acre. In addition there should be returns from thinnings of merchantable size by the thirtieth year, which would offset the carrying charges to a greater extent than the sale of cordwood will under present forest conditions.

The existing forest does not seem to be much more than paying taxes at present. Interest on the investment in land is entirely overlooked and when a sale is made, the owner of woodland looks on the returns as almost pure gain because he has not expended any actual labor in getting the money. As a matter of fact, the rest of the farm has been obliged to pay not only its own share of the taxes and interest on the valuation of the farm, but the forest's share as well. With proper management, the forest might be made to pay its way without having to depend on the agricultural crops to help it along.

Forestation of the entire forest area, excluding swamp and old field types that may be cleared, would bring some 6,900 acres into pine. The possible annual cut would then be 4,800,000 feet with a sale value of $48,000, as compared with the present sale value of perhaps $4,420. Cordwood for local use as fuel could be cut in the form of thinnings, or in the swamp lands too wet for anything but hardwoods. Such a complete change in type could not be accomplished at once, nor is it necessarily desirable. It seems evident, however, that any considerable replacement of slow growing hardwoods by more rapid growing conifers will be an economic gain to the community.

SUMMARY

Redding is an agricultural town increasingly dependent for its tax income on city residents who are turning to the country for permanent or summer homes. Of the total area, 43 per cent is forest or land reverting to forest. This forest area is in very poor producing condition, due to past methods of handling, fire and loss of the most valuable species by disease. The following types are decribed in the foregoing survey.

Types.	Area in Acres.	Per cent. of Forest Land.
Mixed Hardwoods	3000	34
Old Field	1865	21
Oak	1860	21
Swamp	1250	14
Oak-Chestnut	710	8
Hemlock	100	1
Chestnut	70	1
Pine	25	
	8880	100

RECOMMENDATIONS

1.—The forests of Redding have been, and will continue to be, an important factor in its development. The existing forests are not yielding the highest possible returns from the use of the land occupied, and should be managed with a view to increasing the future yield of valuable products.

2.—Weed species should be eliminated and the most valuable species favored in all cuttings. Rapid growing conifers such as white pine, red pine and Norway spruce should be introduced by planting in place of the rapidly disappearing chestnut.

3.—Waste lands not suitable for agricultural crops should be planted with such rapid growing conifers in order that they may become fully productive.

4.—Ornamental plantings along the highways, especially in waste areas at their intersections, will greatly benefit the town by increasing the beauty of its drives. Similar plantings along some of the streams would also be of aesthetic value.

5.—If planting work is planned co-operatively for a week or two early in the spring, more may be accomplished than if individual efforts are depended on. Arbor Day is usually rather late for forest planting, but if roadside and ornamental planting is planned for that day, the school children may be utilized for much of the work.

6.—Absolute protection from fire is most essential if improved forest conditions are to be secured. This involves an active fire warden organization with the full support of the community, and a strong community feeling that forest fires are a cause of economic waste which is unnecessary and can be prevented. Public opinion fully aroused on this subject will insist that every precaution is taken to prevent the starting of fires, and that the forest fire laws are enforced in every case of violation.

TREE SPECIES FOUND IN REDDING.

Acer pennsylvanicum	Striped maple
" rubrum	Red maple
" saccharum	Sugar maple
Alnus rugosa	Smooth alder
Amelanchier canadensis	Shad bush
Betula lenta	Black birch
" lutea	Yellow "
" papyrifera	White "
" populifolia	Gray "
Carpinus caroliniana	Hornbeam
Castanea dentata	Chestnut
Cornus florida	Flowering dogwood
*Crataegus	Hawthorns
Fagus grandifolia	American beech
Fraxinus americana	White ash
" nigra	Black "
" pennsylvanica	Red "
Hamamelis virginiana	Witch hazel
Hicoria alba	Whiteheart hickory or mockernut
" glabra	Pignut hickory
" minima	Bitternut or swamp hickory
" ovata	Shagbark hickory
Juglans cinerea	Butternut
Juniperus virginiana	Red cedar
Kalmia latifolia	Laurel
Liriodendron tulipifera	Whitewood or tulip tree
Nyssa sylvatica	Pepperidge or sour gum
Ostrya virginiana	Ironwood or hop hornbeam
Pinus rigida	Pitch pine
" strobus	White "
Platanus occidentalis	Sycamore or buttonball
Populus grandidentata	Largetoothed aspen
" tremuloides	Quaking "
Prunus serotina	Black cherry
" virginiana	Choke "
Quercus alba	White oak
" coccinea	Scarlet "
" nana	Scrub "
" palustris	Pin "
" prinus	Chestnut or rock oak
" rubra	Red oak
" velutina	Black or yellow oak

*Rhus	Sumach
Robinia pseudacacia	Black locust
*Salix	Willows
Sassafras sassafras	Sassafras
Tilia americana	Basswood
Tsuga canadensis	Hemlock
Ulmus americana	White elm
*Viburnum	Viburnum

* Several species.

TESTS OF WINTER WHEAT.

The following varieties of wheat have been grown for three years in succession on the same land (no other land being available at the time).

Dawson's Golden Chaff, Fultz, Maryland Flint, Dietz Longberry, Early Geneser Giant, Rocky Mountain, Jones' Winter Fife, Bearded Winter Fife, New Amber Longberry, Martin's Amber, Poole, Fultzo-Mediterranean, Mammoth Red, Stover and Klondike.

The main object of the test was to determine whether these varieties were hardy in this climate. The land was run out meadow which had not yielded grass enough for several years to pay for cutting.

It was plowed in July, 1911, and in late August was dressed with seven tons of horse manure, 500 lbs. of basic phosphate and 200 lbs. muriate of potash, disked thoroughly and sown to wheat at the rate of 6 pecks to the acre in the middle of September. Each variety occupied one-fifteenth of an acre. The wheat was harvested July 17, 1912. The land was still "wild," the stand uneven over the plots and the yields of the different varieties were small, an average of 16.3 bushels of wheat per acre and 1,301 lbs. of straw, 23 bushels being the largest yield. In April, 14 lbs. of clover seed was sown on the wheat. It made a fair growth, was turned under September 9, 1912, after adding a ton of ground limestone and seeded with the same varieties of wheat on the 14th. The following winter was very severe for winter crops. Much of the alfalfa in the state was winter killed and clover also in some places. Not one of the wheat varieties, however, was damaged in the least. In the following April, 150 lbs. nitrate of soda, 250 lbs. of acid phosphate and 50 lbs. of muriate of potash were broadcast and the wheat field rolled.

The crop, harvested July 11, 1913, yielded an average of 27.7 bushels of grain and 3,600 of straw per acre with a maximum of 35 bushels. After putting on what little manure we had, about 4 tons to the acre, the field was plowed, dressed with 350 lbs. of acid phosphate and 200 lbs. of muriate of potash, and after fitting the land sown the third time with the same varieties of wheat on September 29. In the following spring 200 lbs. of nitrate of soda was broadcast and the field rolled. There was harvested July — an average of 16.1 bushels of grain and 1,772 lbs. of straw, 20.9 bushels of grain being the largest yield.

The land was uneven in productive power as was evident from experiments on the adjoining land, and there were spots in the field where the growth was never satisfactory so that no judgment can be made of the relative yields of the varieties tested. Of course no one would grow wheat on the same land for three years in succession as a business proposition.

The amounts of fertilizer named above are not of course recommended for wheat. They were used because the land was known to be in poor condition agriculturally, and this was the first crop grown after our purchase of the field.

The experiment, however, showed that any of the varieties named will live through even an inclement winter in this State without damage.

TESTS OF BABCOCK APPARATUS.

It is required by law that all Babcock apparatus used in fixing the price of milk or cream shall previous to such use be officially tested and its accuracy certified. This is done by etching each piece found accurate as follows:—Ct. Ag. St.. This Station has done the work of testing and certifying without charge for creameries and citizens of this state.

Since the last notice in our reports 3,410 pieces of glass ware have been tested, and their accuracy certified except in the case of 29 pieces (0.85 per cent. of the whole number) which were found inaccurate. There were tested

109	cream pipettes
169	milk pipettes
553	cream test bottles
2,579	milk test bottles
3,410	

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