State of Connecticut

PUBLIC DOCUMENT No. 24

TWENTY-FIFTH ANNUAL REPORT

OF

The Connecticut Agricultural Experiment Station

FOR THE YEAR ENDING OCTOBER 31

1901

PRINTED BY ORDER OF THE LEGISLATURE

The publications of this Station are sent free to every citizen of Connecticut who applies for them. Address, the Conn. Agricultural Experiment Station, New Haven, Conn.

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1902

CONNECTICUT AGRICULTURAL EXPERIMENT STATION.

OFFICERS AND STAFF.

STATE BOARD OF CONTROL.

Ex officio.

His Excellency GEORGE P. MCLEAN, *President.*

	Term expires.
Appointed by Connecticut State Agricultural Society:	
B. W. COLLINS, Meriden.	July 1, 1903
Appointed by Board of Trustees of Wesleyan University:	
Prof. W. O. ATWATER, Middletown.	1903
Appointed by Governor and Senate:	
EDWIN HOYT, New Canaan.	1904
JAMES H. WEBB, Hamden.	1902
Appointed by Board of Agriculture:	
T. S. GOLD, West Cornwall, *Vice-President.*	1904
Appointed by Governing Board of Sheffield Scientific School:	
W. H. BREWER, New Haven, *Secretary and Treasurer.*	1902

Ex officio.

E. H. JENKINS, New Haven, *Director.*

STATION STAFF.

Chemists.

S. W. JOHNSON, *Advising and Consulting Chemist.**

E. H. JENKINS, PH.D., *Director.*
A. L. WINTON, PH.B.
I. F. HARRIS, B.S.
G. F. CAMPBELL, PH.B.†
C. LANGLEY, PH.B.§
T. B. OSBORNE, PH.D.
A. W. OGDEN, PH.B.
M. SILVERMAN, PH.B.‖
M. C. WILLIAMS, B.A.‡

Botanist.

WILLIAM C. STURGIS, PH.D.

Entomologist.

W. E. BRITTON, B.S.

In charge of Forestry Work.

WALTER MULFORD, F.E.

Grass Gardener.

JAMES B. OLCOTT, *South Manchester.*

Stenographers and Clerks.

Miss V. E. COLE.
Miss L. M. BRAUTLECHT.

In charge of Buildings and Grounds.

CHARLES J. RICE.

Laboratory Helpers.

HUGO LANGE. WILLIAM POKROB.

Sampling Agent.

V. L. CHURCHILL, New Haven.

* Till July 1, 1901. † Till December 1, 1900. ‡ Till August 1, 1901. § Till March 1, 1901. ‖ From August 1, 1901.

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ANNOUNCEMENT.

THE CONNECTICUT AGRICULTURAL EXPERIMENT STATION was established in accordance with an Act of the General Assembly approved March 21, 1877, "for the purpose of promoting Agriculture by scientific investigation and experiment."

The Station is prepared to analyze and test fertilizers, cattle-foods, seeds, milk, and other agricultural materials and products, to identify grasses, weeds, moulds, blights, mildews, useful or injurious insects, to suggest methods of combatting injurious fungous and insect pests, to advise as to the planting and management of woodland, etc., and to give information on various subjects of Agricultural Science, for the use and advantage of the citizens of Connecticut.

The Station does not undertake sanitary analyses of water.

The Station makes analyses of Fertilizers, Seed-Tests, etc., for the citizens of Connecticut, without charge, provided—

1. That the results are of use to the public and are free to publish.

2. That the samples are taken from stock now in the market, and in accordance with the Station "Instructions for Sampling."

3. That the samples are fully described and retail prices given on the Station "Forms of Description."

The officers of the Station will take pains to obtain for analysis samples of all the commercial fertilizers sold in Connecticut; but the organized coöperation of farmers is essential for the full and timely protection of their interests.

By Acts of Legislature it is made the business of this Station to examine commercial cattle feeds and articles used for human food or drink on sale in Connecticut, with reference to their adulterations.

Through the State entomologist, a member of the Station staff, the Station is also required to make regular inspections of nurseries.

All work proper to the Experiment Station that can be used for the public benefit will be done without charge. The Station undertakes no work the results of which are not at its disposal to use or publish, if deemed advisable for the public good.

Results of analysis or investigation that are of general interest will be published in the Bulletins, of which copies are sent to each Post Office in this State, and to every citizen of the State who applies for them. These results will be summed up in the Annual Reports made to the Governor.

It is the wish of the Board of Control to make the Station as widely useful as its resources will admit. Every Connecticut citizen who is concerned in agriculture, whether farmer, manufacturer, or dealer, has the right to apply to the Station for any assistance that comes within its province to render, and the Station will respond to all applications as far as lies in its power.

☞ Instructions and Forms for taking samples sent on application.

☞ Parcels by Express, to receive attention should be *prepaid*, and communications should be directed to the

AGRICULTURAL EXPERIMENT STATION,
NEW HAVEN, CONN.

☞ Station Grounds, Laboratories and Office are at 123 Huntington street, between Whitney avenue and Prospect street, 1⅝ miles North of City Hall. Huntington street may be reached by Whitney Avenue electric cars, which pass the railway station every twelve minutes.

☞ The Station has Telephone connection and may be spoken from all parts of the State at all hours between 7.30 A. M. and 9.30 P. M.

REPORT OF THE BOARD OF CONTROL OF THE CONNECTICUT AGRICULTURAL EXPERIMENT STATION.

To His Excellency, George P. McLean, Governor of Connecticut:

The Board of Control of the Connecticut Agricultural Experiment Station herewith submits its Report for the year ending October 31st, 1901:

THE CONVENTION OF THE ASSOCIATION OF AMERICAN AGRICULTURAL COLLEGES AND EXPERIMENT STATIONS.

On the 13th, 14th and 15th of November, 1900, by invitation of the Connecticut Stations, this Association held its meetings in New Haven and Middletown. The occasion was notable because it marked the twenty-fifth anniversary of the establishment of the first agricultural station in the United States, which began its work in Middletown in 1875.

LEGISLATION.

At the January Session of 1901 the General Assembly passed three acts directly affecting the Station. The first, an Act Concerning Insect Pests, required the Board of Control of this Station to appoint a State entomologist to serve during the pleasure of the Board and to be responsible to it for the performance of his duties. He "shall have an office at the Experiment Station in New Haven, but shall receive no compensation, other than his regular salary as a member of the Station staff." The Board of Control, in compliance with this act, in July, 1901, appointed Mr. W. E. Britton to be State Entomologist. Mr. Britton has for six years been a member of the Station staff, engaged in entomological study and work in this State.

"An Act Concerning the Reforestization of Barren Lands" requires this Board to appoint a State forester, who shall serve during the pleasure of the Board, shall have an office at the Experiment Station in New Haven, and shall receive no compensation other than his regular salary as a member of the Station staff. In compliance with it, the Board of Control, in July, 1901, appointed as State Forester, Walter Mulford, F.E. Mr. Mulford was already a member of the Station staff, in charge of tree planting and forestry work.

"An Act Concerning the Purchase of Milk and Cream" required that after August 1, 1901, only such bottles and pipettes as have been tested either by this Station or by the Connecticut Agricultural College and marked as accurate, shall be used in testing milk or cream by the Babcock method as a basis of payment. Since the passage of this law, 2,312 pieces of apparatus for the Babcock Test have been examined, marked and returned to their owners,—creameries and dairymen,—by the Station, without charge.

It will be seen that these statutes lay upon the Station a very considerable amount of work, without any additional appropriation.

The Fertilizer Control.

During April, May and June, Mr. V. L. Churchill, agent of this Station, visited ninety-five towns and villages in this State and drew five hundred and forty-three samples of commercial fertilizers, representing all but one of the brands which have been entered for sale in the State.

Other analyses of fertilizers and manurial waste products have brought the total number of analyses of this class up to four hundred and twenty-nine.

These analyses have all been executed by Messrs. Winton, Ogden and Harris, with the assistance of Mr. Lange.

The detailed account of this work has been prepared for publication and is now in the printer's hands.

Examination of Food Products.

During the year, sampling agents of this Station have visited forty-three towns and villages in the State and have bought about thirteen hundred samples of food products for table use.

Four hundred and thirty samples of vinegar, butter and molasses have also been submitted for examination by the Dairy Commissioner.

Of the samples received from these two sources, 1357 have already been examined and 391 are now being tested.

The microscopic work involved has been wholly done by Mr. Winton; the chemical work by Messrs. Winton, Ogden and Silverman.

Examination of Cattle Feeds.

The results of this work, done since the 31st of October, 1900, were printed in the twenty-fourth Report of this Station, in order to bring them to the attention of dairymen and others as soon as possible.

During October of the present year, the sampling agent has drawn two hundred and sixty-one samples of commercial feeds from all parts of the State. Analyses of them will be made and published as soon as is possible.

Microscopic Study.

In addition to the routine microscopic examinations of food products and feeds, Mr. Winton has in hand a study of the microscopic structure of certain foods and adulterants which have not hitherto been adequately described. This will be a contribution to the general knowledge of the subject.

In the twenty-fourth Report appeared the first of the series,—a paper of nine pages, illustrated with woodcuts of nine original drawings,—on The Anatomy of the Maize Cob. The forthcoming Report will contain a second article, The Anatomy of the Fruit of the Cocoanut (*Cocos nucifera*), illustrated with eleven woodcuts of original drawings.

Study of Proteids.

Dr. Osborne, with the assistance of Messrs. Campbell and Williams, has continued his studies on the constitution and properties of nucleic acid, which promise to yield very valuable results.

Botanical Work.

Little has been done in the botanical department this year, owing to the absence of the botanist, Dr. Sturgis, during the spring and summer. Mr. Rorer has, however, answered correspondence and personal calls relating to fungous diseases and has continued the work of collecting economic fungi for the Station herbarium.

The valuable Station herbarium of flowering plants, containing about 5,000 specimens, was carefully gone over during the winter, under Dr. Sturgis' direction, to note and check any insect attack.

Horticultural Work.

This department has been in charge of Mr. Britton. The observations on the comparative availability of the nitrogen of nitrate of soda, cotton seed meal and hard ground bone have been continued in fourteen pot cultures of grass.

To study the effect of different amounts of lime mixed with the compost, twelve cultures of carnations, in plots filled with rich potting soil, have been made in the forcing house.

Screened street sweepings, with and without lime, have also been tried as a soil for growing carnations.

Eighteen plots of lettuce have been grown, some in compost and some in street sweepings, to note the effect of partial sterilization of the soil by steam.

In continuing observations on the influence of the absolute weight of the tomato seed on the quantity and quality of the crop, one hundred and two tomato plants were grown in the forcing house during the winter, and forty in the testing garden during the summer.

Over two hundred chestnut cions of approved varieties were set in sprouts of native growth.

Entomological Work.

The entomological work, done by Mr. Britton, has included a study of the structure, life-history and best means of combatting the "white fly," a serious greenhouse pest.

Considerable time has also been given to experiments on the destruction of the San José scale. Spraying tests have been made in four localities near New Haven. The effect of different insecticides upon both the scale and the trees, when applied at different times during the season, has been carefully noted. Further information has also been gathered and observations have been made on the distribution and spread of this insect in Connecticut.

Ninety-six specimens of insects have been received from Connecticut farmers for identification, information regarding their habits and directions for preventing their ravages, and 466 letters have been written on these subjects.

Observations on various injurious species have also been made during the year in all parts of the State, and since July 1st thirty-two nursery inspections have been made.

Improvement of Waste Lands.

The following work has been done, under the supervision of Mr. Mulford, on the Lockwood field:

White pine seed has been sown broadcast on two acres, divided into half-acre lots, to test the value of this method of planting, at the rate of two, three, four and five pounds of seed per acre.

White and black birch seed have also been sown, to serve as a nurse growth for later plantings of white pine.

A small area has been planted with cuttings of the Carolina poplar, and at present a larger area is being planted with white oak acorns.

A nursery has been established at Poquonock, which contains two-year-old seedlings of white pine and Norway pine (about 1900 of each) and 800 seedlings of Norway spruce.

There are also about 65,000 seedlings of white pine and 30,000 of pitch pine in the nursery, from seed sown in the spring of 1901.

Mr. Mulford has also begun a forest survey of a small area in Hartford County, which will show its present condition, its resources and possibilities of forest production, and may serve as a starting point for further work in this direction.

Mr. Mulford has begun his duties as State Forester.

Tobacco Experiments.

In the season of 1900 and in co-operation with the United States Department of Agriculture, an experiment was made at Poquonock, under the management of the director, to determine whether Sumatra cigar wrapper leaf of good quality could be raised in this State under cloth shade. The experiment was not concluded when this Board made its last report, but the final outcome was most satisfactory, demonstrating that it was possible to produce Sumatra leaf of a very excellent quality and equal to the average of imported Sumatra leaf. Whether this could be done at a profit, naturally could not be determined in one year.

The experiment is being repeated this year by the Station on a larger scale and with added detail, and a number of tobacco growers, stimulated by its success, are, likewise, experimenting on the same subject.

The Fertilization of Peach Orchards.

A study of the effects of different amounts of potash and of the forms of nitrogen best adapted to the crop, begun in 1896 in the orchard of A. E. Plant of Branford, has been continued during the present year under the supervision of the Director.

Station Grounds.

Following a plan previously determined, about fifty white pine trees have been set out and a considerable number of ornamental shrubs which had been grown from seedlings or cuttings in nursery rows. The use of this planting is in part to replace trees which will probably die before many years, to establish a screen between the Station and adjoining land, and in general to improve the appearance and value of the property.

It is proposed to gradually introduce as many species of our native ornamental trees as is practicable.

Seed Testing.

Three hundred and eighteen samples of seeds, chiefly of vegetable and garden crops, have been tested as to their vitality, in the interests of seed growers and purchasers, by Mr. V. L. Churchill.

Changes in the Station Staff.

Prof. S. W. Johnson, who was director of this Station from its incorporation until January, 1900, and who, on resigning that office, continued on the staff, at the urgent request of this Board, as advising and consulting chemist, resigned that position in July, 1901.

Mr. G. F. Campbell, a member of the staff as chemist since 1894, resigned in December, 1900, to accept a position as chemist in a manufacturing establishment.

Mr. M. C. Williams, who succeeded him, resigned in August, 1901.

Mr. Clifford Langley, a member of the staff as chemist since September, 1899, resigned in March, 1901, to accept a position as chemist in a manufacturing establishment.

I. F. Harris, B.S., a graduate of the University of North Carolina, joined the staff as chemist in March, 1901.

Max Silverman, Ph.B., a graduate of Yale University, joined the staff as chemist August 1, 1901.

Dr. William C. Sturgis, botanist of the Station, for urgent family reasons, was given leave of absence in March of the present year. During the summer months of 1901, Mr. J. B. Rorer, a graduate of Harvard University, has very acceptably done the necessary botanical work of the Station.

Miss L. M. Brautlecht was appointed bookkeeper and assistant clerk in February of the present year.

It having been some time before determined to take up a new line of work and study, namely, the improvement of the waste and barren lands of the State, Mr. Walter Mulford was appointed to study these matters, with special reference to the needs and opportunities of the farmer. Mr. Mulford is a graduate of Cornell University and of the Cornell Forestry School, and entered on his work April 1, 1901.

Publications.

The twenty-fourth Report of this Station for 1900, a volume of 513 pages, has been issued in an edition of 10,500 copies. Under the present statute, the State pays for the printing of but 7,000 copies. As our mailing list now numbers 10,250, it has been necessary for the Station to print 3,500 copies at its own expense to meet the demand.

The Food Report and the Report on Fertilizers would need to be printed in still larger numbers if we met all the requests made for them from other states.

The following bulletins have been issued during the year in editions of 10,500 copies: Bulletin 131, November, 1900, "The Protection of Shade Trees in Towns and Cities," 30 pages and 9 plates. Bulletin 132, February, 1901, "Condimental and Medicinal Cattle and Poultry Foods," 7 pages. Bulletin 133, February, 1901, "Commercial Feeding Stuffs in the Connecticut Market," 29 pages. Bulletin 134, August, 1901, "The New Law Concerning Insect Pests," 6 pages. Owing to unusual demands, 1,000 extra copies of Bulletin 131 were printed and distributed several months after the regular edition was exhausted.

There have also been issued in small editions a printed Notice to Users of the Babcock Test, 3 pages, and a Notice to Owners of Waste Lands and Cut-over Woodlands Suitable for Growth of Timber, 3 pages.

Correspondence.

More than 3,160 letters and manuscript reports of fertilizer and other analyses have been written on Station business, in addition to those of the entomologist already mentioned.

Meetings of the Board.

During the year ending October 31st, the Board of Control has held three meetings.

All of which is respectfully submitted,

Wm. H. Brewer, *Secretary.*

New Haven, Conn.
Nov. 1st, 1901.

REPORT OF THE TREASURER.

Wm. H. Brewer, in account with the Connecticut Agricultural Experiment Station for the fiscal year ending September 30, 1901.

Receipts.

State Appropriation, Agriculture	$10,000.00	
State Appropriation, Foods	2,500.00	
State Appropriation, Insect Pests	750.00	
United States Appropriation	7,500.00	
Analysis Fees,	8,727.05	
Sales of Tobacco	865.52	
Sales of other produce	43.90	
From the Lockwood Income	1,054.08	
Miscellaneous Receipts	15.30	
		$31,455.85

Disbursements.

E. H. Jenkins, Salary	$2,800.00
W. H. Brewer, "	1,000.00
V. E. Cole, "	800.00
L. M. Brautlecht, "	320.00
W. C. Sturgis, "	1,044.86
S. W. Johnson, "	962.50
A. L. Winton, "	1,844.45
T. B. Osborne, "	1,800.00
A. W. Ogden, "	1,700.00
C. Langley, "	333.33
G. F. Campbell, "	166.67
M. C. Williams, "	371.12
I. F. Harris, "	502.00
W. E. Britton, "	1,200.00
M. Silverman, "	100.00
J. B. Rorer, "	300.00
W. Mulford, "	367.00
J. B. Olcott, "	800.00
H. Lange, "	720.00
C. J. Rice, "	600.00
V. L. Churchill, "	660.00
Labor	1,274.30
Publications	1,490.06
Postage	189.93
Stationery	378.30

Telephone and Telegraph	$ 92.21
Freight and Express	79.73
Gas	191.11
Coal	813.60
Water	147.00
Chemical Laboratory Supplies	1,262.76
Agricultural and Horticultural Supplies	57.78
Miscellaneous Supplies	127.91
Fertilizers	83.75
Feeding Stuffs	110.56
Library	511.59
Tools and Machinery	47.73
Furniture and Fixtures	38.95
Scientific Apparatus	121.90
Traveling, by the Board of Control	73.65
Traveling, by the Station Staff	180.36
Tobacco Experiments	1,419.17
Fertilizer and Food Sampling	646.84
Insurance	337.49
State Entomologist, on Insect Pest account	550.00
Lockwood Expenses and Forestry	525.67
Unclassified Sundries	830.73
Betterments	458.35
Repairs	327.66
	$30,761.02
Analysis Fees on hand, Sept. 30, 1901	494.83
Insect Pest Funds on hand, Sept, 30, 1901	200.00
	$31,455.85

Memorandum—The accounts of the Treasurer have been duly audited by the State Auditors of Public Accounts. The Report of the Treasurer for the fiscal year of the United States, ending June 30th, 1901, was duly rendered to the Secretary of the Treasury of the United States, and a duplicate to the Secretary of Agriculture. The same classification of receipts and disbursements used in previous years is continued in the above account.

WM. H. BREWER, *Treasurer.*

COMMERCIAL FERTILIZERS.*

During 1901 thirty-six manufacturing firms have entered for sale in this State two hundred and ten distinct brands of fertilizers, viz.:

Special manures for particular crops	88
Other nitrogenous superphosphates	80
Bone manures and "bone and potash"	24
Fish, tankage, castor pomace and chemicals	18
	210

The association of a considerable number of companies in the American Fertilizer and Chemical Co. has reduced the number of firms doing a fertilizer business in Connecticut from fifty-one in 1900 to thirty-six in 1901, and, largely because of this reduction, the number of brands of fertilizers entered for sale has fallen from 249 in 1900 to 210 in 1901.

The duties of this Station regarding fertilizers are prescribed by law as follows:

THE FERTILIZER LAW OF CONNECTICUT.

The General Assembly, in 1882, passed an act concerning Commercial Fertilizers, which, as amended in 1893, is now in force.

Attention is especially called to the following requirements of the law, the full text of which is printed on pages 3–5.

1. In case of *all* fertilizers or manures, except stable manure and the products of local manufacturers of less value than ten dollars a ton, the law holds the SELLER responsible for *affixing a correct label or statement* to every package or lot sold or offered, as well as for the *payment of an analysis fee* of ten dollars for each fertilizing ingredient which the fertilizer contains or is claimed to contain, *unless* the MANUFACTURER OR

*The analyses of fertilizers included in this chapter have been made by the Chemists of the Station, Messrs. Winton, Ogden and Harris, with the help of Mr. Lange. The results have been tabulated and discussed by the Director.

IMPORTER has provided labels or statements and has paid the fee. Sections 4005 and 4007.

The Station understands "the fertilizing ingredients" to be those whose determination in an analysis is necessary for a valuation, and which are generally Nitrogen, Phosphoric Acid and Potash. The analysis fees in case of any fertilizer will, therefore, usually be ten, twenty, or thirty dollars, according as one, two, or three of these ingredients are contained or claimed to exist in the fertilizer.

2. The law also requires, *in the case of every commercial fertilizer,* that a *sealed sample* shall be deposited with the Director of the Station by the MANUFACTURER OR IMPORTER, and that a *certified statement* of composition, etc., shall be filed with him. Section 4006.

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

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

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

The percentage of insoluble phosphoric acid may be stated or omitted.

In case of Bone, Fish, Tankage, Dried Meat, Dried Blood, etc., the statement of chemical composition may take account of the two ingredients, Nitrogen and Phosphoric Acid.

For Potash Salts the percentage of Potash (potassium oxide) should always be given: that of Sulphate of Potash or Muriate of Potash may also be stated.

The chemical composition of other fertilizers may be given as found in the Station Reports.

3. It is also provided that EVERY PERSON in the State, who sells *any commercial fertilizer of whatever kind or price,* shall annually report certain facts to the Director of the Experiment Station, and on demand of the latter shall deliver a sample for analysis. Section 4008.

4. All "CHEMICALS" that are applied to land, such as Muriate of Potash, Kainit, Sulphate of Potash and Magnesia, Sulphate of Ammonia, Nitrate of Potash, Nitrate of Soda, etc., are considered to come under the law as "Commercial Fertilizers." Dealers in these chemicals must see that packages are suitably labeled. They must also report them to the Station, and see that the analysis fees are duly paid, in order that the Director may be able to discharge his duty as prescribed in Section 4013 of the Act.

It will be noticed that the State exacts no license tax either for making or selling fertilizers. For the safety of consumers and the benefit of honest manufacturers and dealers, the State requires that it be known what is offered for sale, and whether fertilizers are what they purport to be. With this object in view the law provides, in Section 4013, that all fertilizers be analyzed, and it requires the parties making or selling them to pay for these analyses in part; the State itself paying in part by maintaining the Experiment Station.

ACTS CONCERNING COMMERCIAL FERTILIZERS.

Chapter CCLIII of the General Statutes of Connecticut as amended by Chapter CLXXII of the Acts of the General Assembly, Session of 1893.

SECTION 4005. Every person or company who shall sell, offer, or expose for sale, in this State, any commercial fertilizer or manure except stable manure, and the products of local manufacturers of less value than ten dollars a ton, shall affix conspicuously to every package thereof a plainly printed statement clearly and truly certifying the number of net pounds of fertilizer in the package, the name, brand, or trademark under which the fertilizer is sold, the name and address of the manufacturer, the place of manufacture, and the chemical composition of the fertilizer, expressed in the terms and manner approved and usually employed by the Connecticut Agricultural Experiment Station.

If any such fertilizer be sold in bulk, such printed statement shall accompany every lot and parcel sold, offered, or exposed for sale.

SEC. 4006. Before any commercial fertilizer is sold, offered, or exposed for sale, the manufacturer, importer, or person who causes it to be sold, or offered for sale, within this State, shall file with the Director of the Connecticut Agricultural Experiment Station two certified copies of the statement prescribed in Section 4005, and shall deposit with said director a sealed glass jar or bottle containing not less than one pound of the fertilizer, accompanied by an affidavit that it is a fair average sample thereof.

SEC. 4007. The manufacturer, importer, agent, or seller of any commercial fertilizer shall pay on or before May 1, annually, to the Director of the Connecticut Agricultural Experiment Station, an analysis fee of ten dollars for each of the fertilizing ingredients, contained or claimed to exist in said fertilizer: *provided,* that when the manufacturer or importer shall have paid the fee herein required for any person acting as agent or seller for such manufacturer or importer, such agent or seller shall not be required to pay the fee prescribed in this section.

SEC. 4008. Every person in this State who sells, or acts as local agent for the sale of any commercial fertilizer of whatever kind or price, shall annually, or at the time of becoming such seller or agent, report to the Director of the Connecticut Agricultural Experiment Station his name and brand of said fertilizer, with the name and address of the manufacturer, importer, or party from whom such fertilizer was obtained, and shall, on demand of the Director of the Connecticut Agricultural Experiment Station, deliver to said director a sample suitable for analysis of any such fertilizer or manure then and there sold or offered for sale by said seller or agent.

SEC. 4009. No person or party shall sell, offer, or expose for sale, in this State, any pulverized leather, raw, steamed, roasted, or in any form, as a fertilizer or as an ingredient of any fertilizer or manure, without explicit printed certificate of the fact, such certificate to be conspicuously affixed to every package of such fertilizer or manure, and to accompany every parcel or lot of the same.

SEC. 4010. Every manufacturer of fish guano, or fertilizers of which the principal ingredient is fish or fish mass from which the oil has been extracted, shall, before manufacturing or heating the same, and within thirty-six hours from the time such fish or mass has been delivered to him, treat the same with sulphuric acid or other chemicals, approved by the director of said experiment station, in such quantity as to arrest decomposition: *provided, however,* that in lieu of such treatment such manufacturers may provide a means for consuming all smoke and vapors arising from such fertilizers during the process of manufacture.

SEC. 4011. Any person violating any provisions of the foregoing sections of this chapter shall be fined one hundred dollars for the first offense, and two hundred dollars for each subsequent violation.

SEC. 4012. This chapter shall not affect parties manufacturing, importing, or purchasing fertilizers for their own private use, and not to sell in this State.

SEC. 4013. The Director of the Connecticut Agricultural Experiment Station shall pay the analysis fees received by him into the treasury of the Station, and shall cause one or more analyses of each fertilizer to be made and published annually. Said director is hereby authorized, in person or by deputy, to take samples for analysis from any lot or package of manure or fertilizer which may be in the possession of any dealer.

SEC. 4014. The Director of the Connecticut Agricultural Experiment Station shall, from time to time, as bulletins of said Station may be issued, mail or cause to be mailed two copies, at least, of such bulletins to each post-office in the State.

OBSERVANCE OF THE FERTILIZER LAW.

Here follows an alphabetical list of the manufacturers who have paid analysis fees, as required by the Fertilizer Law, and the names or brands of the fertilizers for which fees have been paid by them for the year ending May 1st, 1902.

Firm.	*Brand of Fertilizer.*
American Agricultural Chemical Co., The, 26 Broadway, N. Y. City.	Baker's, A. A., Ammoniated Superphosphate,
	Baker's Complete Potato Manure,
	Bradley's Superphosphate,
	" Potato Manure,
	" Farmers New Method Fertilizer,
	" Complete Manure for Potatoes and Vegetables,
	" Corn Phosphate,
	" Potato Fertilizer,
	" Eclipse Phosphate,
	" Tobacco Fertilizer,
	Clark's Cove Bay State Fertilizer, G. G.,
	" " King Philip Alkaline Guano,
	" " Great Planet Manure,
	" " Potato Fertilizer,
	Crocker's Potato, Hop and Tobacco Phosphate,
	" Ammoniated Corn Phosphate,
	" A. A. Complete Manure,
	Darling's Farm Favorite,
	" Potato Manure,
	" Dissolved Bone and Potash,
	" Tobacco Grower,
	Great Eastern Northern Corn Special,
	" " Vegetable, Vine and Tobacco,
	" " General Fertilizer,
	" " Grass and Oats Fertilizer,
	Pacific Soluble Pacific Guano,
	" Potato Special,
	" Nobsque Guano,
	Packers' Union Gardeners' Complete Manure,
	" Animal Corn Fertilizer,
	" Potato Manure,
	" Universal Fertilizer,
	" Wheat, Oats and Clover Fertilizer,
	Quinnipiac Phosphate,
	" Potato Manure,
	" Market Garden Manure,
	" Corn Manure,
	" Potato Phosphate,
	" Climax Phosphate,
	Read's Practical Potato Special,

Firm.	*Brand of Fertilizer.*
American Agricultural Chemical Co., The,—*continued.*	Read's Bone, Fish and Potash,
	" Standard Superphosphate,
	" Vegetable and Vine Fertilizer,
	Wheeler's Corn Fertilizer,
	" Potato Manure,
	" Havana Tobacco Grower,
	" Superior Truck Fertilizer,
	" Bermuda Onion Grower,
	" Grass and Oats Fertilizer,
	" Electrical Dissolved Bone,
	Williams & Clark's Americus Ammoniated Bone Superphosphate,
	" " Potato Phosphate,
	" " High Grade Special,
	" " Americus Corn Phosphate,
	" " Americus Potato Manure.
American Farmers' Fertilizer Co., 133 Front St., N. Y. City.	American Farmers' Market Garden Special,
	" " Complete Potato,
	" " Corn King.
Armour Fertilizer Works, The, Baltimore, Md.	Ammoniated Bone with Potash,
	High Grade Potato,
	All Soluble,
	Bone Meal.
Baker, H. J. & Bro., 100 William St., N. Y. City.	Castor Pomace.
Berkshire Fertilizer Co., Bridgeport, Conn.	Berkshire Complete Fertilizer,
	" Potato Phosphate,
	" Ammoniated Bone Phosphate,
	" Pure Fine Bone.
Boardman, F. E., Route No. 1, Middletown, Conn.	Boardman's Complete Fertilizer for Potatoes and General Crops.
Bohl, Valentine, Waterbury, Conn.	Self-Recommending Fertilizer.
Bowker Fertilizer Co., 43 Chatham St., Boston, Mass.	Stockbridge Special Tobacco Manure,
	" Special Corn Manure,
	" Grass Top Dressing and Forage Crop Manure,
	" Special Potato and Vegetable Manure,
	Bowker's Potato and Vegetable Fertilizer,
	" Hill and Drill Phosphate,
	" Potato Phosphate,
	" Farm and Garden, or Ammoniated Bone Fertilizer,
	" Fish and Potash, Square Brand,

Firm.	*Brand of Fertilizer.*
Bowker Fertilizer Co.,—*continued.*	Bowker's Tobacco Starter. " Sure Crop Phosphate, " Market Garden Fertilizer, " Square Brand Bone and Potash, " Corn Phosphate, " Bone and Wood Ash Fertilizer, " Tobacco Ash Elements, " Tobacco Ash Fertilizer. " Middlesex Special, " Early Potato Manure, " Fisherman's Brand Fish and Potash, " Dry Ground Fish, Nitrate of Soda, Dissolved Bone Black, Muriate of Potash, Fresh Ground Bone, Tankage, Canada Hard Wood Ashes, Acid Phosphate, Castor Pomace.
Buckingham, C., Southport, Conn.	XX Special Formula.
Coe, E. Frank Co., 133-137 Front St., N. Y. City.	E. Frank Coe's High Grade Ammoniated Bone Superphosphate, " Gold Brand Excelsior Guano, " Ground Bone and Potash.
Connecticut Valley Orchard Co., The, Berlin, Conn.	C. V. O. Co.'s Complete High Grade Fertilizer.
Cooper's Glue Factory, Peter, 17 Burling Slip, N. Y. City.	Bone Dust.
Dennis, E. C., Stafford Springs, Conn.	Ground Bone.
Downs & Griffin, Derby, Conn.	Ground Bone.
Ellsworth, F., Hartford, Conn.	Shoemaker's Swift Sure Bone Meal, " " Superphosphate for General Use, " " Superphosphate for Potatoes.
Frisbie, L. T. Co., The, Hartford, Conn.	Frisbie's Fine Bone Meal.
Kelsey, E. R., Branford, Conn.	Bone, Fish and Potash.
Lederer & Co., New Haven, Conn.	Pure Ground Bone.
Listers Agricultural Chemical Works, Newark, N. J.	Listers' Success Fertilizer, " Potato Manure, " Animal Bone and Potash, " Special Corn and Potato Fertilizer.

Firm.	*Brand of Fertilizer.*
Lowell Fertilizer Co., 44 N. Market St., Boston.	Swift's Lowell Bone Fertilizer, " " Animal Brand, " " Potato Phosphate, " " Potato Manure, " " Ground Bone.
Ludlam, Frederick, 108 Water St., N. Y. City.	Cecrops-Cereal Brand, Cecrops-Dragon's Tooth Brand.
MacCormack, Wm., Wolcott, Conn.	Mad River Strictly Pure Ground Bone.
Mapes, F. & P. G. Co., The, 143 Liberty St., N. Y. City.	Potato Manure, Tobacco Starter, Improved, Tobacco Manure, Wrapper Brand, Fruit and Vine Manure, Economical Potato Manure, Vegetable Manure, or Complete Manure for Light Soils, Average Soil Complete Manure, Corn Manure, Grass and Grain Spring Top Dressing, Complete Manure ("A" Brand), Dissolved Bone, Cereal Brand, Seeding Down Manure, Tobacco Ash Constituents.
National Fertilizer Co., Bridgeport, Conn.	Chittenden's Market Garden Manure, " Complete, " Potato Phosphate, " Ammoniated Bone, " Fine Ground Bone, " Universal Phosphate, " Fish and Potash, " H. G. Special Tobacco Manure.
Ohio Farmers Fertilizer Co., The, Columbus, O.	Ammoniated Bone and Potash, General Crop Fish Guano.
Olds & Whipple, Hartford, Conn.	O. & W. Castor Pomace, " Complete Tobacco Fertilizer, " Vegetable Potash and Phosphoric Acid, " Special Phosphate, " Potato Fertilizer.
Peck Bros., Northfield, Conn.	Pure Ground Bone.
Plumb & Winton Co., The, Bridgeport, Conn.	Ground Bone.
Pouleur, Auguste, Windsor, Conn.	Pouleur's Pure Carbonate of Potash Tobacco Starter.
Rogers & Hubbard Co., The, Middletown, Conn.	Hubbard's Pure Raw Knuckle Bone Flour, " Strictly Pure Fine Bone,

Firm.	*Brand of Fertilizer.*
Rogers & Hubbard Co., The,—*continued.*	Hubbard's Oats and Top Dressing, " Soluble Potato Manure, " Corn and General Crops, " Soluble Tobacco Manure, " Grass and Grain Fertilizer, " All Soils, All Crops, " Potato Phosphate, " Corn Phosphate.
Rogers Mfg. Co., The, Rock Fall, Conn.	All Round, Complete Potato and Vegetable, Complete Corn and Onion, Fish and Potash, H. G. Soluble Tobacco and Potato, " Oats and Top Dressing, " Grass and Grain, " Tobacco, Pure Ground Bone.
Russia Cement Co., Gloucester, Mass.	Essex Dry Ground Fish, " A 1 Superphosphate, " XXX Fish and Potash, " Market Garden and Potato Manure, " Corn Fertilizer, " Complete Manure for Potatoes, Roots and Vegetables, " Complete Manure for Corn, Grain and Grass, " Odorless Lawn Dressing, " Tobacco Starter, " Special Tobacco Manure.
Sanderson Fertilizer & Chemical Co., New Haven, Conn.	Sanderson's Old Reliable Superphosphate, " Potato Manure, " Special with 10% Potash, " Formula A, " Formula B, " Fine Ground Bone, Luce Bros.' Bone, Fish and Potash, Nitrate of Soda, Muriate of Potash, Double Sulphate of Potash, Plain Superphosphate.
Shay, C. M., Groton, Conn.	Mystic Gilt Edge Potato Manure, Pure Bone Dust.
Shoemaker, M. L. & Co., see Ellsworth, F.	
Wharton, Joseph, Philadelphia, Pa.	XX Fish and Potash.
Wilcox Fertilizer Works, The, Mystic, Conn.	Potato, Onion and Tobacco Manure, Complete Bone Superphosphate, High Grade Fish and Potash, Potato Manure, Fish and Potash, Dry Ground Fish Guano.

SAMPLING AND COLLECTION OF FERTILIZERS.

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

Litchfield County	6
Hartford County	25
Tolland County	7
Windham County	13
New London County	10
Middlesex County	9
New Haven County	15
Fairfield County	10
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In these places five hundred and forty-three samples were taken, representing all but one of the brands which have been entered for sale in this State.

One brand, Wheeler's Electrical Dissolved Bone, though entered for sale, was not, as we are informed by the manufacturer, actually put on sale here.

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

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

As a rule, the Station will not analyze samples taken—

1. From dealer's stock of less than one ton.
2. From stock which has lain over from last season.
3. From stock which evidently is improperly stored, as in bags lying on wet ground, or exposed to the weather, etc.

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

ANALYSES OF FERTILIZERS.

During the year, 432 samples of commercial fertilizers and manurial waste-products have been analyzed. A classified list of them is given on page 19 and the results of their examination are given in detail in the following pages. When the contrary is not stated, the samples were drawn by an agent of the Station.

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

The following "Explanations" are intended to embody the principles and data upon which the valuation of fertilizers is based, a knowledge of which is essential to a correct understanding of the analyses that are given on subsequent pages.

EXPLANATIONS CONCERNING THE ANALYSIS OF FERTILIZERS AND THE VALUATION OF THEIR ACTIVE INGREDIENTS.

THE ELEMENTS OF FERTILIZERS.

The three chemical elements whose compounds chiefly give value, both commercial and agricultural, to fertilizers, are Nitrogen, Phosphorus, and Potassium. The other elements found in fertilizers, viz.: Sodium, Calcium, Magnesium, Iron, Silicon, Sulphur, Chlorine, Carbon, Hydrogen and Oxygen, which are necessary or advantageous to the growth of vegetation, are either so abundant in the soil or may be so cheaply supplied to crops, that they do not considerably affect either the value or cost of high-priced commercial fertilizers.

NITROGEN in fertilizers is, on the whole, the least abundant of their valuable elements, and is, therefore, their most costly ingredient.

Free Nitrogen is universally abundant, making up nearly four-fifths of the common air, and appears to be directly assimilable by various low vegetable organisms, and with aid of certain bacteria, by leguminous plants (the clovers, alfalfa, peas, beans, lentils, esparsette, lupins, vetches, lathyrus, peanut, yellow locust, honey locust, etc.), and by a few non-leguminous plants, carrying root nodules, viz.: the Oleasters (*Eleagnus*), the Alders (*Alnus*), and a single family of coniferous trees (*Podocarpus*), but not at all, according to present evidence, by the cereals or other field and garden crops.

Organic Nitrogen is the nitrogen of animal and vegetable matters which is chemically united to carbon, hydrogen and oxygen. Some forms of organic nitrogen, as those of blood, flesh and seeds, are highly active as fertilizers; others, as found in leather and peat, are comparatively slow in their effect on vegetation, unless these matters are chemically disintegrated. Since organic nitrogen may often readily take the form of ammonia, it has been termed *potential ammonia.*

Ammonia (NH_3) *and Nitric Acid* (N_2O_5) are results of the chemical change of *organic nitrogen* in the soil and manure heap, and contain nitrogen in its most active forms. They occur in commerce—the former in sulphate of ammonia, the latter in nitrate of soda: 17 parts of ammonia, or 66 parts of pure sulphate of ammonia, contain 14 parts of nitrogen: 85 parts of pure nitrate of soda also contain 14 parts of nitrogen.

PHOSPHORUS is, next to nitrogen, the most costly ingredient of fertilizers, wherein it exists in the form of phosphates, usually those of calcium, iron and aluminum, or, in case of "superphosphates," to some extent, in the form of free phosphoric acid.

Water-soluble Phosphoric Acid is phosphoric acid (or a phosphate) that freely dissolves in water. It is the characteristic ingredient of superphosphates, in which it is produced by acting on "insoluble" (or "citrate-soluble") phosphates, with diluted sulphuric acid. Once well incorporated with the soil, it gradually "reverts" and becomes insoluble, or very slightly soluble, in water.

Citrate-soluble Phosphoric Acid signifies the phosphoric acid (of various phosphates) that is freely taken up by a hot, strong solution of neutral ammonium citrate, which solution is, therefore, used in analysis to determine its quantity. The designation *citrate-soluble* is synonymous with the less explicit terms *reverted, reduced,* and *precipitated,* all of which imply phosphoric acid that was once easily soluble in water, but from chemical change has become insoluble in that liquid.

Recent investigation tends to show that water-soluble and citrate-soluble phosphoric acid are, on the whole, about equally valuable as plant food, and of nearly equal commercial value. In some cases, indeed, the water-soluble gives better results on crops; in others, the "reverted" is superior. In most instances there is probably little to choose between them.

Insoluble Phosphoric Acid implies various phosphates insoluble both in water and in hot solution of neutral ammonium citrate. The phosphoric acid of Canadian "Apatite", of South Carolina and Florida "Rock phosphate", and of similar dense mineral phosphates, as well as that of "bone ash" and "bone black", is mostly insoluble in this sense, and in the majority of cases gives no visible good results when these substances, in the usual ground state, are applied to crops. They contain, however, a small proportion of citrate-soluble phosphoric acid, and sometimes, when they are reduced to extremely fine dust (floats) or applied in large quantities, especially on "sour soils", or in conjunction with abundance of decaying vegetable matter (humus), they operate as efficient fertilizers.

Available Phosphoric Acid is an expression properly employed, in general, to signify phosphoric acid in any form, or phosphates of any kind that serve to nourish vegetation. In the soil, phosphoric acid and all phosphates, whatever their solubilities, as defined in the foregoing paragraphs, are more or less freely and extensively available to growing plants. Great abundance of "insoluble" phosphoric acid may serve crops equally well with great solubility of a small supply, especially when the soil and the crop carry with them conditions highly favorable to the assimilation of plant food.

In Commercial Fertilizers, "available phosphoric acid" is frequently understood to be the sum total of the "water-soluble" and the "citrate-soluble", with the exclusion of the "insoluble."

The "insoluble phosphoric acid" in a commercial fertilizer costing $20 to $45 per ton, has very little or no value to the purchaser, because the quantity of it which can commonly be put on an acre of land has no perceptible effect upon the crop and because its presence in the fertilizer excludes an equal percentage of more needful and much more valuable ingredients.

In Raw Bone the phosphoric acid (calcium phosphate) is nearly insoluble, because of the animal matter of the bones which envelopes it; but when the animal matter decays in the soil, or when it is disintegrated by boiling or steaming, the phosphate mostly remains in an available form. The phosphoric acid of "Basic-Slag" and of "Grand Cayman's Phosphate" is in some soils as freely taken up by crops as water-soluble phosphoric acid, but in other soils is much less available than the latter.

Phosphoric acid in all the Station analyses is reckoned as "anhydrous phosphoric acid" (P_2O_5), also termed among chemists phosphoric anhydride, phosphoric oxide and phosphorus pentoxide.

POTASSIUM is the constituent of fertilizers which ranks third in costliness. In plants, soils and fertilizers, it exists in the form of various salts, such as chloride (muriate), sulphate, carbonate, nitrate, silicate, etc. Potassium itself is scarcely known except as a chemical curiosity.

Potash signifies the substance known in chemistry as potassium oxide (K_2O), which is reckoned as the valuable fertilizing ingredient of "potashes" and "potash salts." In these it should be freely soluble in water and is most costly in the form of carbonate, and cheapest in the form of muriate (potassium chloride). In unleached ashes of wood and of cotton-seed hulls it exists mainly as potassium carbonate.

VALUATION OF FERTILIZERS.

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

Plaster, lime, stable manure and nearly all of the less expensive fertilizers have variable prices, which bear no close relation to their chemical composition, but guanos, superphosphates and similar articles, for which $20 to $45 per ton are paid, depend for their trade-value exclusively on the substances, *nitrogen, phosphoric acid and potash,* which are comparatively costly and steady in price. The trade-value per pound of these ingredients is reckoned from the current market prices of the standard articles which furnish them to commerce.

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

TRADE-VALUES OF FERTILIZER ELEMENTS FOR 1901.*

The average trade-values or retail costs in market, per pound, of the ordinarily occurring forms of nitrogen, phosphoric acid and potash in raw materials and chemicals, as found in New England, New York and New Jerseys markets during 1900, were as follows:

*Adopted at a conference of representatives of the Connecticut, Massachusetts, New Jersey and Rhode Island Stations held in March, 1901.

	Cents per pound
Nitrogen in ammonia salts	16½
in nitrates	14
Organic nitrogen, in dry and fine-ground fish, meat and blood, and in mixed fertilizers	16
in fine* bone and tankage	16
in coarse* bone and tankage	12
Phosphoric acid, water-soluble	5
citrate-soluble†	4½
of fine* ground fish, bone, and tankage	4
of coarse* fish, bone, and tankage	3
of cotton-seed meal, castor pomace, and ashes	4
of mixed fertilizers, if insoluble in ammonium citrate†	2
Potash as high-grade sulphate and in forms free from muriate (or chlorides)	5
as muriate	4¼

The foregoing are, as nearly as can be estimated, the prices at which, during the six months preceding March last, the respective ingredients were retailed for cash, in our large markets, in those *raw materials* which are the regular source of supply. They also correspond to the average wholesale price for the six months ending March 1st, plus about 20 per cent. in case of goods for which we have wholesale quotations. The valuations obtained by use of the above figures will be found to correspond fairly with the *average retail prices at the large markets, of standard raw materials, such as the following:*

Sulphate of Ammonia,	Muriate of Potash,
Nitrate of Soda,	Sulphate of Potash,
Dried Blood,	Plain Superphosphates,
Azotin,	Dry Ground Fish,
Ammonite,	Bones and Tankage,
Ground South Carolina Rock.	

*In this report "fine," as applied to bone and tankage, signifies smaller than 1/50 inch; and "coarse," larger than 1/50 inch. From 1878 on for 10 years, we distinguished five grades of bone, as to fineness. In 1888, one, in 1897, two of the coarser grades were dropped from the list. The smaller grades remain unchanged in dimensions, but "coarse" was for the first 10 years larger than ⅙ inch, for the next 9 years included all larger than 1/12 inch, for the next year all larger than 1/25 inch, and now comprises all larger than 1/50 inch; the former "coarse-medium," "medium," and "fine-medium" having been successively merged in "coarse."

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

Valuation of Superphosphates, Special Manures and Mixed Fertilizers of High Grade.

The Organic Nitrogen in these classes of goods is reckoned at the price of nitrogen in raw materials of the best quality,* 16½ cents.

Insoluble Phosphoric Acid is reckoned at 2 cents per pound. Potash is rated at 4¼ cents, if sufficient chlorine is present in the fertilizer to combine with it to make muriate. If there is more Potash present than will combine with the chlorine, then this excess of Potash is reckoned at 5 cents per pound.

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

The majority of the manufacturers agree that the average cost of mixing, bagging, handling and cartage ranges from $3 to $4.50 per ton.

In 1901 the average selling price of Ammoniated Superphosphates and Guanos was $28.43 per ton, the average valuation was $20.91, and the difference $7.52, an advance of 36.0 per cent. on the valuation and on the wholesale cost of the fertilizing elements in the raw materials.

In case of special manures the average cost was $32.64, the average valuation $23.80, and the difference $8.84 or 37.1 per cent. advance on the valuation.

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

In case of *Ground Bone and Tankage*, the sample is sifted into the two grades just specified (see foot note, page 16), and we separately compute the nitrogen-value of each grade by multiplying the pounds of nitrogen per ton by the per cent. of each grade, multiplying one-tenth

*This concession gives the dishonest manufacturer the opportunity to defraud the consumer very easily and very steadily, by "working off" inferior or almost worthless leather, bat guano, and similar materials which "analyze well," containing up to 8 or 9 per cent. of nitrogen, much or all of which may be quite inert. Since the Station has had no practicable means of determining with certainty the amount of worthless nitrogen or the quality of the nitrogen in a mixed fertilizer, and since honest and capable manufacturers generally claim to use only "materials of the best quality," it would be unjust to them to assume that these fertilizers contain anything inferior. Farmers should satisfy themselves that they are dealing only with honest and with intelligent manufacturers. This can be done at little cost by such coöperation as Farmers' Clubs and Granges may practice, sending a competent and trusty agent to visit factories frequently and unexpectedly and to take samples of raw materials. Honorable manufacturers will be glad to show all their raw materials and processes to their customers, especially if such inspection is insisted on as a preliminary to business. Coöperation may thus insure satisfactory quality of goods, as well as reduced cost.

of that product by the trade-value per pound of nitrogen in that grade, and taking this final product as the result in cents. Summing up the separate values of each grade thus obtained, together with the values of each grade of phosphoric acid, similarly computed, the total is the Valuation of the sample of bone.

Uses and Limitations of Fertilizer Valuation.

The uses of the "Valuation" are two-fold:

1. To show whether a given lot or brand of fertilizer is probably worth, as a commodity of trade, what it costs. If the selling price is not higher than the valuation, the purchaser may be tolerably sure that the price is reasonable. If the selling price is twenty to twenty-five per cent. higher than the valuation, it may still be a fair price; but in proportion as the cost per ton exceeds the valuation there is reason to question the economy of its purchase.

2. Comparisons of the valuation and selling prices of a number of similar fertilizers will generally indicate fairly which is the best for the money.

But the valuation is not to be too literally construed, for in some cases analysis cannot discriminate positively between the active and the inert forms of nitrogen, while the mechanical condition of a fertilizer is an item whose influence cannot always be rightly expressed or appreciated.

For the above first-named purpose of valuation, the trade-values of the fertilizing elements which are employed in the computations should be as exact as possible, and should be frequently corrected to follow the changes of the market.

For the second-named use of valuation, frequent changes of the trade-value are disadvantageous, because two fertilizers cannot be compared as to their relative money-worth when their valuations are deduced from different data.

Experience leads to the conclusion that the trade-values adopted at the beginning of the year should be adhered to as nearly as possible throughout the year, notice being taken of considerable changes in the market, in order that due allowance may be made therefor.

Agricultural Value of Fertilizers.

The Agricultural Value of a fertilizer is measured by the benefits received from its use, and depends upon its fertilizing effect, or crop-producing power. As a broad, general rule, it is true that ground bone, superphosphates, fish scraps, dried blood, potash salts, etc., have a high agricultural value which is related to their trade-value, and to a degree determines the latter value. But the rule has many exceptions, and in particular instances the trade-value cannot always be expected to fix or even to indicate the agricultural value. Fertilizing effect depends largely upon soil, crop and weather, and as these vary from place to place and from year to year, it cannot be foretold or estimated, except by the results of past experience, and then only in a general and probable manner.

CLASSIFICATION OF FERTILIZERS ANALYZED.

	No. of samples
Raw Materials.	
1. *Containing Nitrogen as the chief valuable ingredient.*	
Nitrate of Soda	7
Dried Blood	1
Cotton Seed Meal	45
Castor Pomace	4
2. *Containing Phosphoric Acid as the chief valuable ingredient.*	
Double Superphosphate	1
Dissolved Bone Black	3
Dissolved Rock Phosphate	9
Bone Ash	1
3. *Containing Potash as the chief valuable ingredient.*	
High Grade Sulphate of Potash	5
Double Sulphate of Potash and Magnesia	6
Muriate of Potash	15
Kainit	1
Tobacco Ashes	3
4. *Containing Nitrogen and Phosphoric Acid.*	
Bone Manures	30
Tankage	9
Dry Ground Fish	6
Mixed Fertilizers.	
Bone and Potash	7
Bone and Wood Ashes	1
Nitrogenous Superphosphates	79
Special Manures	102
Home Mixtures	13
Miscellaneous Fertilizers and Manures.	
Cotton Hull Ashes	30
Wood Ashes	27
Lime Kiln Ashes	2
Tobacco Stems	3
Garbage Tankage	8
Muck	3
Ashes of Sheep Manure	1
Lime Refuse	3
Chimney Soot	2
Wool Waste	1
Carbonizing Dust	1
Miscellaneous	3
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DESCRIPTION AND ANALYSES OF FERTILIZERS.

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

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

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

I. RAW MATERIALS CHIEFLY VALUABLE FOR NITROGEN.

NITRATE OF SODA OR SODIUM NITRATE.

Nitrate of Soda is mined in Chili and purified there before shipment. As offered in the Connecticut market it contains about 15.70 per cent. of nitrogen, equivalent to 95.3 per cent. of pure sodium nitrate.

Seven samples have been received from the Connecticut market for analysis, as follows:—

3050. Stock of S. D. Woodruff & Sons, Orange.

3155. Stock of J. G. Schwink, Meriden. Bought from Berkshire Fertilizer Co., Bridgeport.

3469. Stock of Conn. School for Boys. Bought from Berkshire Fertilizer Co., Bridgeport.

3129. Stock of Sanderson Fertilizer & Chemical Co., New Haven.

3099. Stock of Ernest N. Austin, Suffield. Bought of American Agricultural Chemical Co., N. Y. City.

3170. Stock of E. E. Burwell, New Haven. Bought of Bowker Fertilizer Co., Boston.

3154. Stock of Hartford Branch, Bowker Fertilizer Co., Boston.

ANALYSES.

	3050	3155	3469	3129	3099	3170	3154
Nitrogen found	15.68	15.80	15.80	15.68	15.91	15.72	15.56
Equivalent nitrate of soda	95.18	95.91	95.91	95.18	96.57	95.42	94.45
Nitrogen guaranteed	15.8	15.0	15.6	15.6	----	15.0	14.9
Equivalent nitrate of soda guaranteed	96.0	91.0	95.0	94.7	----	91.0	90.5
Cost per ton	$ ----	44.00	44.00	45.00	46.00	46.00	47.00
Nitrogen costs cents per pound	----	13.9	13.9	14.3	14.4	14.6	15.1

All the samples of nitrate of soda examined here in 1901 have been of average quality. The cost of nitrogen in this form has ranged from 13.5 to 15.1 cents per pound and has averaged 14.2 cents.

DRIED BLOOD.

This is slaughter-house blood, dried by steam or hot air. It sometimes contains wool or hair in small amount and occasionally bone. Its composition is, therefore, not at all uniform.

3164. Stock of E. E. Burwell, New Haven. Bought of the Bowker Fertilizer Co., Boston.

This sample contained 9.98 per cent. of nitrogen, the guaranteed amount, and cost $39 per ton, making the cost of nitrogen 19.5 cents per pound.

COTTON SEED MEAL.

This material is of two kinds, which are known in trade respectively as undecorticated and decorticated. In their manufacture cotton seed is first ginned to remove most of the fiber, then passed through a "linter" to take off the short fiber or lint remaining, then through machines which break and separate the hulls. The hulled seed is ground and the oil expressed. The ground cake from the presses is used as a cattle food and fertilizer. The hulls are burned for fuel in the oil factory, and the ashes, which contain from 20 to 30 per cent. of potash, are also used as a fertilizer. In case of undecorticated meal, the hulls and the ground press-cake are mixed together.

In the table, pp. 22–23, are given the percentages of nitrogen found in forty-five samples. The percentage of phosphoric acid in cotton seed meal ranges from 2.69 to 3.44, and that of potash from 1.64 to 2.00, the average being 3.15, and 1.90, respectively. The cost per pound of nitrogen is determined in

Analyses of Cotton Seed Meal.

Station No.	Dealer.	Sampled by	Per cent. of nitrogen.	Cost per ton.	Nitrogen costs cents per pound.
3249	Olds & Whipple, Hartford	Lewis T. Judson, Silver Lane	8.15	$25.50	12.9
3246	" " "	Willard E. Treat, "	8.14	25.50	12.9
3092	H. K. Brainard, Thompsonville	G. A. Douglass, Thompsonville	7.46	24.90	13.7
2905	" " "	Patrick Manning, "	7.80	25.90	13.8
3057	" " "	F. W. Button, "	7.76	25.90	13.8
3093	" " "	G. A. Douglass, "	7.57	25.40	13.9
3132	A. Pouleur, Windsor	Louis A. Clapp, Windsor	7.43	26.50	14.0
2556	Unknown	E. Manchester & Sons, West Winsted	7.66	26.00	14.0
2846	Olds & Whipple, Hartford	J. B. Parker, Jr., Poquonock	7.72	26.50	14.3
2851	" " "	Clark Bros., "	7.74	26.50	14.3
2852	" " "	" " "	7.71	26.50	14.3
3025	" " "	Jacob Lang, "	7.64	26.50	14.4
3026	C. H. Dexter & Sons, Windsor Locks	F. A. Hamilton, Warehouse Point	7.36	26.00	14.7
3090	Arthur Sikes, Suffield	Charles H. Wells, Suffield	6.98	25.00	14.7
3021	Aug. Pouleur, Windsor	J. A. DuBon, Poquonock	7.28	26.00	14.8
3017	Hollister, Chase & Co., New York, N. Y.	Ackley, Hatch & Marsh, New Milford	6.96	25.00	14.8
3065	" " " " "	" " " "	7.29	26.00	14.8
3064	Arthur Sikes, Suffield	E. F. Thompson, Warehouse Point	6.97	25.00	14.8
3151	" " "	W. H. Prout, Suffield	6.96	25.00	14.8
3359		A. P. Hills, Silver Lane	6.80	24.75	14.9
3087	Daniels Mill Co., Hartford	E. S. Seymour, Windsor Locks	7.18	26.00	15.0
3086	Olds & Whipple, "	F. B. Hatheway, "	7.21	26.00	15.0
3085	Daniels Mill Co., "	H. S. Hatheway, "	7.18	26.00	15.0

Analyses of Cotton Seed Meal.—*Continued.*

Station No.	Dealer.	Sampled by	Per cent. of nitrogen.	Cost per ton.	Nitrogen costs cents per pound.
3088	Daniels Mill Co., Hartford	E. S. Seymour, Windsor Locks	7.19	$26.00	15.0
3188	Unknown	Ackley, Hatch & Marsh, New Milford	7.52	27.00	15.0
3275	E. F. Miller, Ellington	M. E. Thompson, Ellington	6.76	26.00	15.0
3144	Arthur Sikes, Suffield	M. Doughney, Windsor Locks	7.24	26.50	15.2
3148	John S. Wolfe Co., Pittsfield, Mass.	Ackley, Hatch & Marsh, New Milford	7.22	26.50	15.2
3441	W. F. Fletcher, Southwick, Mass.	J. B. Cannon, West Suffield	7.25	26.50	15.2
3274	Arthur Sikes, Suffield	A. F. Austin, Suffield	7.05	26.00	15.3
3045	Horace K. Brainard, Thompsonville	John T. Pease, Enfield	6.96	25.90	15.4
3060	Arthur Sikes, Suffield	E. N. Austin, Suffield	7.18	26.50	15.4
3305	" " "	T. C. Austin & Sons, Suffield	7.28	27.00	15.5
3186	W. F. Fletcher, Southwick, Mass.	Alfred H. Griffin, Granby	7.27	27.00	15.5
2902	Ackley, Hatch & Marsh, New Milford	A. W. Camp, Danbury	6.93	26.00	15.6
3326	Arthur Sikes, Mapleton	E. B. Loomis, Suffield	7.22	27.00	15.6
3106	" " "	C. S. Fuller, "	6.92	26.00	15.6
3123	J. Watson and G. Parsons	George Poole, Thompsonville	7.20	27.00	15.7
3059	Geo. B. Robinson, Jr., 18 Broadway, N. Y.	E. N. Austin, Suffield	6.93	26.25	15.8
3304	" " " " "	" " "	6.90	26.25	15.8
3442	W. F. Fletcher, Southwick, Mass.	John B. Cannon, West Suffield	7.11	27.00	15.9
3061	Geo. B. Robinson, Jr., 18 Broadway, N. Y.	E. N. Austin, Suffield	6.75	26.25	16.2
3105	Arthur Sikes, Suffield	Oscar J. Hazard, "	6.91	27.00	16.3
4202	G. M. White & Co., East Hartford	C. J. Dewey, Buckland	6.22	25.50	16.9
3058	J. E. Soper & Co., Boston, Mass.	L. Carlton, Thompsonville	7.44	----	----

each case by deducting $4.42—the valuation of the phosphoric acid and potash—from the ton price, and dividing the remainder by the number of pounds of nitrogen in the ton of meal.

The average ton cost of cotton seed meal has been $26.08.

The percentage of nitrogen found has ranged from 8.15 to 6.22, the average being 7.24, the same as last year.

The cost of nitrogen has ranged from 16.9 to 12.9 cents per pound, and has averaged 14.9 cents per pound, a half-cent higher than last year.

In only a few cases was it possible to learn the name of the manufacturer.

Samples 3045, 3123 and 3442 are meal made by the American Cotton Oil Co., 3017 is made by J. G. Falls & Co., Memphis, Tenn. and 3144 is made by R. W. Biggs & Co., Memphis.

Decorticated cotton seed meal should contain not less than seven per cent. of nitrogen. Four samples have had considerably less than this amount, as follows:—

3359. Sampled by A. P. Hills, Silver Lane, nitrogen 6.80 per cent.

3275. Bought of E. F. Miller, Ellington, nitrogen 6.76 per cent.

3061. Bought of G. B. Robinson, N. Y. City, nitrogen 6.75 per cent.

4202. Bought of G. M. White & Co., East Hartford, nitrogen 6.22 per cent.

CASTOR POMACE.

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

Four samples were analyzed during the season of 1901, as follows:—

3169. Stock of Olds & Whipple, Hartford.

3360. Stock of A. P. Hills, Silver Lane. Bought of S. C. Hardin, Glastonbury.

3168. Stock of Hartford Branch of Bowker Fertilizer Co., Boston.

3455. Stock of S. T. Welden, Simsbury. Bought of H. J. Baker & Bro., N. Y.

Analyses.

	3169	3360	3168	3455
Nitrogen	5.88	4.86	4.60	4.74
Phosphoric acid	1.98	1.49	2.55	----
Potash	0.87	1.11	0.78	----
Cost per ton	$23.00	23.00	23.00	23.00
Nitrogen costs cents per pound*	**17.5**	**21.3**	**21.9**	**21.6**

Castor Pomace is an expensive form of organic nitrogen, at best, and is chiefly used by certain growers of tobacco, under the impression that it is a superior fertilizer for that crop. Careful experiments, however, made by this Station for five successive years, show no superiority of castor pomace over the much cheaper source of nitrogen, cotton seed meal. But here are two distinct kinds of castor pomace sold at the same price. The one grade, represented by sample **3169,** is light colored and contains 5.9 per cent. of nitrogen. The other grade, represented by three samples, is very dark colored and contains a per cent. less of nitrogen.

If the first grade is worth $23.00 per ton as a tobacco fertilizer, the second grade is not worth more than $19.50 per ton for the same purpose.

II. RAW MATERIALS OF HIGH GRADE CONTAINING PHOSPHORIC ACID AS THE CHIEF VALUABLE INGREDIENT.

DOUBLE SUPERPHOSPHATE.

3133. This sample was sent for examination by A. Pouleur, Windsor, with the statement that it was offered for sale by H. J. Baker & Bro., N. Y. City. It is evidently made by treating some form of calcium phosphate with phosphoric acid, instead of oil of vitriol. No price was given.

Analysis.

	3133
Phosphoric Acid, water-soluble	38.81
" " citrate-soluble†	4.37
" " insoluble	1.78
" " total	44.96
Sulphuric Acid	2.20
Chlorine	none

* Allowing 4 and 5 cents per pound for the phosphoric acid and potash, respectively.

† See foot note, page 16.

DISSOLVED BONE BLACK.

Bone black, made by subjecting bone to a red heat without access of air, has been largely used in sugar refineries to decolorize sugar solutions. The waste bone black, dried and treated with oil of vitriol, makes a "superphosphate" of high grade which does not cake together on standing, but remains as a fine powder suitable for application to the land.

The supply of this material now on the market is very small, because bone black has been largely superseded by other materials as decolorizing agents. Only three samples have been analyzed.

3454. From stock of Hartford Branch of Bowker Fertilizer Co., Boston, Mass.

1841. Sent by E. R. Kelsey, Branford.

3214. From stock of H. T. Childs, Woodstock, bought of the American Agricultural Chemical Co., N. Y. City.

ANALYSES.

	3454	1841	3214
Phosphoric Acid, water-soluble	12.96	14.50	12.83
" " citrate-soluble*	2.45	.81	2.41
" " insoluble	1.99	.14	1.05
" " available found	15.41	15.31	15.24
" " guaranteed	15.0	----	15.0
Cost per ton	$21.00	----	----
Available phosphoric acid costs cents per pound	**6.6**	----	----

DISSOLVED ROCK PHOSPHATE OR ACID ROCK.

This material, made by treating various mineral phosphates with oil of vitriol, is the most common source of the phosphoric acid of factory-mixed fertilizers.

Nine samples have been analyzed as follows:

3120. Bought in New York by A. P. Lapsley, Pomfret Center.

3048. Bought in New York by S. D. Woodruff & Sons, Orange.

3468. Stock bought by Conn. School for Boys, Meriden.

* See foot note, page 16.

2912 and **3161.** Bought by J. G. Schwink, Meriden.

3193. Stock of Southport Branch of Bowker Fertilizer Co.

3453. Bought by Clifton Peck, Yantic, from Sanderson Fertilizer & Chemical Co., New Haven.

3452. Stock of Gault Bros., Westport.

3215. Bought by H. T. Childs, Woodstock, from American Agricultural Chemical Co., N. Y. City.

The manufacturers state that sample **3193** represents only a single ton of goods which was shipped into the State by mistake and withdrawn from sale as soon as the mistake was discovered. The analyses appear on page 28.

The cost of available phosphoric acid in these samples has ranged from 4.1 to 6.7 cents per pound.

III. RAW MATERIALS OF HIGH GRADE CONTAINING POTASH.

HIGH GRADE SULPHATE OF POTASH.

This chemical should contain over 90 per cent. of pure potassium sulphate (sulphate of potash), or about fifty per cent. of potassium oxide, the same quantity as is supplied by muriate, and should be nearly free from chlorine.

Each of the five samples examined, the analyses of which are given in the table on page 30, contains about 50 per cent. of actual potash and in no case more than 1.32 per cent. of chlorine, an amount which is not excessive. The average cost per pound of potash has been 4.9 cents.

DOUBLE SULPHATE OF POTASH AND MAGNESIA.

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

In the six analyses given in the table on page 30, the percentages of potash range from 28.42 to 25.38. In no case is the amount of chlorine abnormally large.

The average cost of actual potash per pound has been 5.4 cents.

Analyses of Dissolved Rock Phosphate.

Percentage Amount of	3120	3048	3468	2912	3161	3193	3453	3452	3215
Water-soluble phosphoric acid	9.15	12.46	11.92	7.96	11.36	6.08	11.30	11.47	9.92
Citrate-soluble* phosphoric acid	4.69	2.49	3.40	7.29	3.08	4.85	3.34	3.52	4.17
Insoluble phosphoric acid	1.77	1.17	1.89	0.45	2.00	2.25	1.13	0.87	0.81
Total phosphoric acid	15.61	16.12	17.21	15.70	16.44	13.18	15.77	15.86	14.90
"Available" phosphoric acid found	13.84	14.95	15.32	15.25	14.44	10.93	14.64	14.99	14.09
"Available" phosphoric acid guaranteed	14.00	14.00	14.00	14.00	14.00	11.00	14.00	14.00	14.00
Cost per ton	$	13.75	15.00	16.00	16.00	14.00	20.00	.....	.....
"Available" phosphoric acid costs cents per pound	....	4.4	4.6	5.2	5.3	6.0	6.7	....	....

* Or "reverted," see foot note page 16.

MURIATE OF POTASH.

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

In the table on page 30 are given fifteen analyses of muriate of potash.

Samples **2907** to **2911** in the table represent five different lots of muriate in original sealed packages. The percentages of potash found in these samples are nearly alike and agree satisfactorily with the potash syndicate's guarantees.

The percentages of potash range from 58.63 to 43.44. All of the samples are of good quality with the exception of No. 3248, sold by the Berkshire Fertilizer Co., Bridgeport, which is quite inferior.

The cost of actual potash per pound has ranged from 3.6 to 4.9 cents, the average being 4.27 cents.

KAINIT.

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

A single sample, **3472**, of which the analysis appears in the table, page 30, contained 12.74 per cent. of actual potash. The cost of potash in this article was 5.1 cents per pound.

TOBACCO ASHES.

Ashes have been bought by a number of farmers during the last year, which came from factories where sheep dips are made from waste tobacco. The ashes are, doubtless, those of tobacco

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

Station No.	Drawn from stock in possession of	Sampled and sent by	Percentages found. Chlorine.	Percentages found. Potash soluble in Water.	Percentages found. Equivalent Muriate.	Percentages found. Equivalent Sulphate.	Percentages guaranteed. Muriate.	Percentages guaranteed. Sulphate.	Cost per ton.	Potash costs cents per pound.
	High Grade Sulphate of Potash.									
3172	E. E. Burwell, New Haven	Station Agent	0.82	50.07	----	92.63	----	88.8	$48.00	4.8
3240	Berkshire Fertilizer Co., Bridgeport	" "	0.90	49.90	----	92.31	----	90.0	48.00	4.8
3361	Bowker Fertilizer Co.	A. P. Hills, Silver Lane	1.32	50.14	----	92.76	----	----	48.00	4.8
3101	E. N. Austin, Suffield	E. N. Austin, Suffield	----	50.10	----	92.69	----	90.0	50.00	5.0
3157	Bowker Fertilizer Co., Hartford Branch	Station Agent	1.02	50.04	----	92.57	----	90.0	50.00	5.0
	Double Sulphate of Potash.									
3158	J. G. Schwink, Meriden	Station Agent	0.87	28.42	----	52.58	----	48.0	27.00	4.8
3470	Conn. School for Boys, Meriden	" "	----	27.49	----	50.86	----	48.0	27.00	4.9
3171	E. E. Burwell, New Haven	" "	0.82	26.82	----	49.62	----	44.4	29.00	5.4
3130	Sanderson Fertilizer and Chemical Co., New Haven	" "	2.82	27.38	----	50.65	----	50.0	30.00	5.5
3097	E. N. Austin, Suffield	E. N. Austin, Suffield	----	25.38	----	46.95	----	48.0	30.00	5.9
3156	Bowker Fertilizer Co., Hartford Branch	Station Agent	1.05	26.86	----	49.69	----	48.0	32.00	6.0
	Muriate of Potash.									
2906	J. G. Schwink, Meriden	Station Agent	----	58.63	93.22	----	80.0	----	42.00	3.6
3118	A. B. Lapsley, Pomfret Center	A. B. Lapsley, Pomfret Center	----	52.34	83.22	----	80.0	----	----	----
3160	J. G. Schwink, Meriden	Station Agent	----	51.95	82.60	----	80.0	----	42.00	4.0
3471	Conn. School for Boys, Meriden	" "	----	50.56	80.39	----	80.0	----	42.00	4.2
3173	E. E. Burwell, New Haven	" "	----	53.28	84.72	----	80.0	----	45.00	4.2
2911	Sanderson Fertilizer and Chemical Co., New Haven	" "	----	51.79	82.35	----	81.4	----	45.00	4.3
3049	S. D. Woodruff & Sons, Orange	" "	----	49.56	78.80	----	80.0	----	43.00	4.3
2907	Sanderson Fertilizer and Chemical Co., New Haven	" "	----	51.50	81.89	----	82.2	----	45.00	4.4
2908	Sanderson Fertilizer and Chemical Co., New Haven	" "	----	51.49	81.87	----	82.2	----	45.00	4.4
2909	Sanderson Fertilizer and Chemical Co., New Haven	" "	----	51.30	81.57	----	81.6	----	45.00	4.4
2910	Sanderson Fertilizer and Chemical Co., New Haven	" "	----	51.68	82.17	----	81.6	----	45.00	4.4
3102	E. N. Austin, Suffield	E. N. Austin, Suffield	----	51.70	82.20	----	----	----	46.00	4.5
3159	Bowker Fertilizer Co., Hartford Branch	Station Agent	----	51.32	81.60	----	80.0	----	46.00	4.5
3248	Berkshire Fertilizer Co., Bridgeport	H. J. Ellis, New Britain	----	43.44	69.07	----	----	----	43.00	4.9
3213	H. T. Child, Woodstock	Station Agent	----	51.60	82.04	----	79.0	----	----	----
	Kainit.									
3472	Conn. School for Boys, Meriden	Station Agent	----	12.74	----	----	----	----	13.00	5.1

which has been first extracted with solvents and then dried and burned.

2555. Sent by August Pouleur, Windsor, contained:

Potash, soluble in water	35.16 per cent.
Lime	7.38
Magnesia	2.62
Phosphoric acid	trace
Sulphuric acid	2.00
Chlorine	0.95
Charcoal	2.60
Sand and soil	1.50

Later there were received, sample **3189** from G. W. Phelps, Windsor Locks, and **3147** from J. Amstead, Windsor Locks, both stated to have been bought of A. Pouleur, of Windsor, as "carbonate of potash" or "vegetable potash," for $50.00 per ton.

The analyses of these samples were as follows:

ANALYSES.

	3189	3147
Potash soluble in acid	....	36.16
Potash soluble in water	34.02	34.42
Chlorine	1.53	1.13
Sulphuric acid	2.26	2.31
Cost per ton	$50.00	50.00
Potash costs cents per pound	**7.4**	**7.3**

The composition of the three samples is quite uniform. The percentages of chlorine are small and these ashes are an excellent form of potash fertilizer for tobacco.

IV. RAW MATERIALS CONTAINING NITROGEN AND PHOSPHORIC ACID.

BONE MANURES.

The terms "Bone Dust", "Ground Bone", "Bone Meal" and "Bone" applied to fertilizers, sometimes signify material made from dry, clean and pure bones; in other cases these terms refer to the result of crushing fresh or moist bones which have been thrown out either raw or after cooking, with more or less meat, tendon and grease, and—if taken from garbage or ash heaps—with ashes or soil adhering; again they denote

mixtures of bone, blood, meat and other slaughter-house refuse which have been cooked in steam tanks to recover grease, and are then dried and sometimes sold as "tankage"; or finally, they apply to bone from which a large share of the nitrogenous substance has been extracted in the glue manufacture. When they are in the same state of mechanical subdivision the nitrogen of all these varieties of bone probably has about the same fertilizing value.

The method adopted for the valuation of bone manures, which takes account of their mechanical condition as well as chemical composition, is explained on page 17.

1. *Bone Manures Sampled by Station Agents.*

In the table on pages 34 and 35 are given twenty-one analyses of samples of this class.

The price printed in full-face type in the column showing cost per ton is the one used in calculating the percentage difference between cost and valuation.

The average cost of these bone manures is $30.14 per ton; the average valuation $26.35; showing that the Station valuation is somewhat lower than is justified by the average selling price of ground bone in Connecticut.

Guarantees.

The percentage of nitrogen found in five of the brands analyzed was considerably less than was guaranteed. These five brands were the following:

3241 Bohl's Self-Recommending Fertilizer, nitrogen found, 3.31, guaranteed, 3.7.
3242 Plumb & Winton's Bone Fertilizer, nitrogen found, 4.26, guaranteed, 5.4.
3261 Downs & Griffin's Ground Bone, nitrogen found, 2.64, guaranteed, 4.0.
3198 Shay's Pure Bone Dust, nitrogen found, 2.12, guaranteed, 2.6.
3446 Dennis' Pure Ground Bone, nitrogen found, 3.83, guaranteed, 4.2.

Equal parts of two samples of Hubbard's Raw Knuckle Bone Flour drawn from stock of F. S. Bidwell, Windsor Locks, and of H. W. Andrews, Wallingford, were mixed, making sample **3262**, and analyzed with the following results:

MECHANICAL ANALYSIS.

Finer than $\frac{1}{50}$ inch	47 per cent.
Coarser than $\frac{1}{50}$ inch	53 "
	100

CHEMICAL ANALYSIS.

Nitrogen	3.90
Phosphoric acid	24.01
Cost per ton	$35.00
Valuation per ton	27.49

The manufacturers objected that this analysis did not correctly represent either the mechanical condition or chemical composition of the brand; that the average composition calculated from the Station analyses of the last thirteen years was 3.93 nitrogen and 24.89 phosphoric acid, with 68 per cent. of the bone finer than $^1/_{50}$ inch, and that no change had been made in the quality of bone or method of screening and storing. In view of these facts, another sample was drawn, **3445**, of which

PERCENTAGE COMPOSITION OF BONE MANURES.

Station No.	Name of Brand.	Manufacturer.	Dealer.	Dealer's cash price per ton.	Valuation per ton.	Percentage difference between cost and valuation.	Chemical Analysis. Nitrogen Found.	Chemical Analysis. Nitrogen Guaranteed.	Chemical Analysis. Phosphoric acid. Found.	Chemical Analysis. Phosphoric acid. Guaranteed.	Mechanical Analysis. Finer than 1-50 inch.	Mechanical Analysis. Coarser than 1-50 inch.
	Sampled by station agents.											
3166	Frisbie's Fine Bone Meal	L. T. Frisbie Co., Hartford	Manufacturer	$25.00	$26.36	5.1*	4.25	*3.3*	20.66	*18.0*	50	50
3165	Ground Bone	Berkshire Fert. Co., Bridgeport	J. G. Schwink, Meriden	26.00	27.29	4.7*	2.68	*2.5*	26.16	*20.0*	70	30
3241	Self-Recommending Fertilizer	Valentine Bohl, Waterbury	P. J. Bolan, Waterbury	28.00	27.72	1.0	3.31	*3.7*	25.59	*24.0*	57	43
3212	Swift Sure Bone Meal	M. L. Shoemaker & Co., Phila., Pa.	Olds & Whipple, Hartford	35.00	33.57	4.2	5.46	*4.1*	23.53	*21.5*	70	30
			F. S. Bidwell & Co., Windsor Locks	35.00								
3242	P. & W. Bone Fertilizer	Plumb & Winton, Bridgeport	Manufacturer	28.00	26.27	6.5	4.26	*5.4*	20.60	*18.0*	49	51
3261	Pure Ground Bone	Downs & Griffin, Derby	Manufacturer	30.00	27.91	7.4	2.64	*4.0*	26.46	*23.7*	77	23
3195	Bowker's Fresh Ground Bone	Bowker Fert. Co., Boston, Mass.	Bowker's Branch, Southport	28.00	25.30	10.7	2.70	*2.3*	25.14	*24.0*	52	48
			" " Hartford	28.00								
3444	Swift's Lowell Ground Bone	Lowell Fert. Co., Boston, Mass.	J. P. Barstow, Norwich	32.00	27.87	11.2	2.60	*2.5*	27.25	*23.0*	70	30
			W. D. Penfield, Cobalt	30.00								
3448	Fine Ground Bone	Sanderson Fertilizer and Chemical Co.,		31.00								
		New Haven	Clifton Peck, Yantic	28.00	25.12	11.4	3.50	*2.5*	21.68	*20.0*	52	48
3445	Hubbard's Pure Raw Knuckle Bone	The Rogers & Hubbard Co., Middle-	J. C. Eddy, Simsbury	28.00								
	Flour	town	Manufacturer	34.00	30.45	11.6	3.92	*3.5*	25.24	*24.5*	72	28
3198	Pure Bone Dust	C. M. Shay, Groton	G. M. Williams Co., New London	30.00	26.59	12.8	2.12	*2.6*	27.45	*25.0*	70	30
			Manufacturer	30.00								
3447	Ground Bone	National Fert. Co., Bridgeport	F. Hallock & Co., Derby	32.00	27.40	16.7	4.20	*2.8*	20.93	*20.0*	63	37
3257	Armour's Bone Meal	Armour Fert. Co., Baltimore	F. C. Benjamin & Co., Danbury	32.00	27.39	16.8	3.22	*2.5*	25.06	*24.0*	61	39
			Ansonia Flour & Grain Co., Ansonia	26.50								
3196	Bone	Lederer & Co., New Haven		30.00	25.00	20.0	3.95	---	21.08	----	39	61
3243	Pure Ground Bone	The Rogers Mfg. Co., Rockfall	Meeker Coal Co., Norwalk	31.00	25.82	20.0	2.46	*2.5*	25.53	*25.0*	65	35
3443	Pure Raw Bone Meal	Listers' Agricultural Chemical Works,										
		Newark, N. J.	A. W. Hutchinson, Gilead	30.00	24.74	21.2	2.89	*2.5*	25.05	*23.0*	38	62
3259	Pure Ground Bone	Peck Bros., Northfield	W. H. Scott & Co., Pequabuck	30.00	23.83	25.8	4.18	---	20.76	----	18	82
3244	Hubbard's Strictly Pure Fine Bone	The Rogers & Hubbard Co., Middletown	E. L. Bradley, Norwalk	32.00	25.30	26.4	3.98	*3.5*	22.07	*22.0*	33	67
3446	Pure Ground Bone	E. C. Dennis, Stafford	Manufacturer	28.00	21.60	29.6	3.83	*4.2*	20.09	*20.5*	5	95
3260	Pure Ground Bone	Wm. MacCormack, Wolcott	Manufacturer	30.00	22.65	32.4	3.90	---	20.02	----	18	82
3258	Bone Dust	Peter Cooper's Glue Factory, N. Y.	Apothecaries' Hall, Waterbury	35.00	25.18	38.9	1.04	*0.9*	30.72	*26.7*	61	39
	Sampled by purchasers.		*Sampled by*									
3119	Ground Steamed Bone		A. B. Lapsley, Pomfret Center	----	----	----	2.54	*1.2*	27.06	*26.1*	81	19
2554	Bone Meal	The L. T. Frisbie Co., Hartford	Olin Wheeler, Buckland	26.00	27.84	6.6*	5.26	---	17.10	----	65	35
4203	Ground Bone	" " " "	C. J. Dewey, Buckland	25.00	26.29	4.9*	4.64	---	18.68	----	53	47
3440	Sanderson's Fine Ground Bone	Sanderson Fertilizer and Chemical Co., New Haven	O. G. Beard, Shelton	28.00	24.38	14.8	2.35	*2.5*	24.09	*20.0*	64	36
3394	Wheeler's Pure Raw Bone Meal	American Agricultural Chemical Co., N. Y.	G. H. Pearson, Bethel	30.00	24.17	24.1	1.56	---	28.99	----	43	57
4553	Degelatinized Bone	Unknown	A. E. Plant, Branford	----	23.33		1.26	---	29 27	----	40	60

* Valuation exceeds cost.

Percentage Composition and Valuations of Ground Tankage.

Station No.	Manufacturer.	Sampled from stock of	Dealer's cash price per ton.	Valuation per ton.	Percentage difference between cost and valuation.	Chemical Analysis. Nitrogen. Found.	Nitrogen. Guaranteed.	Phosphoric acid. Found.	Phosphoric acid. Guaranteed.	Mechanical Analysis. Finer than 1-50 inch.	Coarser than 1-50 inch.
3051	----	S. D. Woodruff & Sons, Orange	----	----	----	3.65	4.1	20.47	16.0	50	50
2901	Plumb & Winton Co., Bridgeport	A. P. Wakeman, Fairfield	$24.00	$23.35	2.7	7.00	----	4.34	----	61	39
3247	Bowker Fertilizer Co., Boston, Mass.	F. T. Bradley, Saybrook	33.00	30.97	6.5	7.60	6.6	12.73	9.0	59	41
3163	" " " "	E. E. Burwell, New Haven	33.00	27.83	18.5	7.56	6.6	9.40	9.0	51	49
3137	Strong, Barnes, Hart & Co., New Haven	J. Norris Barnes, Yalesville	----	20.98	19.1	6.35	----	7.59	----	18	82
3197	Lederer & Co., New Haven	Manufacturer	25.00	20.56	21.5	4.27	----	12.13	----	52	48
3473	Berkshire Fert. Co., Bridgeport	Conn. School for Boys, Meriden	26.00	21.24	22.4	5.48	5.8	8.00	----	55	45
3162	" " "	J. G. Schwink,	26.00	21.24	22.4	5.23	5.8	8.83	----	57	43
2913	" " "	" " "	26.00	18.70	39.0	5.72	5.8	5 45	12.0	30	70

* Valuation exceeds cost.

the analysis appears in the table, pages 34-35. This analysis fully meets the expectations of the manufacturers. Attempts were made to get other samples, but the goods could not be found.

II.—*Bone Manures Sampled by Purchasers.*

The table on pages 34 and 35 also contains six analyses of this class.

Sample **3119** was bought, in some considerable quantity, of a New York firm for cash. Anyone who alone, or with his neighbors, buys a car lot of bone and pays cash for it, can usually get quotations at prices from eight to fifteen dollars per ton less than the usual retail rates.

TANKAGE.

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

In the above table are given nine analyses of this material.

These analyses show the usual differences in chemical composition.

The percentage of nitrogen found in three of them is considerably below the percentage guaranteed and in one sample the same is true of the phosphoric acid. The samples which were thus deficient are the following:—

3051 Stock of S. D. Woodruff & Sons; nitrogen found 3.65 per cent. guaranteed 4.1 per cent.

3473 Stock of Berkshire Fertilizer Co., Bridgeport; nitrogen found 5.48, guaranteed 5.8.

3162 Stock of Berkshire Fertilizer Co. Nitrogen found 5.23, guaranteed 5.8.

2913 Stock of Berkshire Fertilizer Co. Phosphoric acid found 5.45, guaranteed 12.0.

DRY GROUND FISH.

This residue from the manufacture of fish oil is often sprinkled with diluted oil of vitriol, to check putrefaction, whereby the fish bones are softened and to some extent dissolved.

Six analyses are given below:

3190. Acidulated Fish Guano; made by the Wilcox Fertilizer Co., Mystic; sampled and sent by E. N. Austin, Suffield.

3458. Wilcox Dry Ground Fish Guano; made by the Wilcox Fertilizer Co., Mystic; sample drawn from stock of Olds & Whipple, Hartford.

3205. Essex Dry Ground Fish; made by the Russia Cement Co., Gloucester, Mass., sample drawn from stock of F. S. Bidwell, Windsor Locks, and of W. J. Cox, East Hartford.

3023. Wilcox Dry Ground Fish Guano; sampled from stock of Olds & Whipple, Hartford, by Olin Wheeler, Buckland.

3456. Bowker's Fine-ground Dry Fish; sampled from stock of Bowker Fertilizer Co.'s Hartford Branch.

3191. Wilcox Dry Ground Fish; sampled and sent by E. N. Austin, Suffield.

As appears from the analyses, all of these samples of fish scrap are of good quality and fully meet the manufacturers' guarantees.

PERCENTAGE COMPOSITION OF DRY GROUND FISH.

	Wilcox' Acidulated Fish. 3190	Wilcox'. 3458	Russia Cement Co.'s. 3205	Wilcox'. 3023	Bowker's. 3456	Wilcox'. 3191
Nitrogen as ammonia	0.50	0.14		0.26	0.30	0.17
Organic nitrogen	5.10	8.86	8.74	8.82	8.19	8.59
Total nitrogen found	5.60	9.00	8.74	9.08	8.49	8.76
Total nitrogen guaranteed	----	*8.50*	*8.00*	----	*8.00*	----
Soluble phosphoric acid	0.96	0.57	0.46	0.54	0.72	0.58
Reverted phosphoric acid	2.86	5.76	9.15	5.10	5.17	4.98
Insoluble phosphoric acid	0.75	1.35	3.44	1.91	1.08	2.01
Total phosphoric acid found	4.57	7.68	13.05	7.55	6.97	7.57
Total phosphoric acid guaranteed	----	*6.00*	*11.00*	----	*6.00*	----
Cost per ton	$21.00	35.00	38.00	35.00	34.00	35.00
Valuation per ton	$21.80	35.10	38.05	34.97	32.99	33.91
Percentage difference between cost and valuation	3.6*	0.28*	0.1*	0.08	3.0	3.2

MIXED FERTILIZERS.

BONE AND POTASH.

Seven samples of fertilizers bearing this brand have been analyzed.

3451. Ground Bone and Potash; made by the E. Frank Coe Co., New York City; sampled from stock of John Horn, Southport.

3424. Darling's Dissolved Bone and Potash; made by the American Agricultural Chemical Co., New York City; sampled from stock of D. E. Hickey, West Thompson.

3353. Square Brand Bone and Potash; made by Bowker Fertilizer Co., Boston, Mass.; sampled from stock of Southport Branch, Bowker Fertilizer Co. and of Southington Lumber Co., Southington.

* Valuation exceeds cost.

PERCENTAGE COMPOSITION AND VALUATION OF "BONE AND POTASH."

	3451	3424	3353	3358	3280	3459	3218
Nitrogen as nitrate	----	0.71	----	----	0.46	----	0.09
Nitrogen as ammonia	0.39	----	----	----	----	----	----
Nitrogen, organic	1.31	1.90	1.86	2.00	1.94	----	0.82
Total nitrogen found	1.70	2.61	1.86	2.00	2.40		0.91
Total nitrogen guaranteed	*2.47*	*2.47*	*1.50*	*1.65*	*2.47*	----	*0.82*
Soluble phosphoric acid	----	5.23	2.72	7.84	3.76	5.92	5.00
Reverted phosphoric acid	14.31	1.91	4.78	2.00	3.17	5.44	3.75
Insoluble phosphoric acid	3.28	0.22	5.17	0.91	1.45	1.82	1.45
Total phosphoric acid found	17.59	7.36	12.67	10.75	8.38	13.18	10.20
Total phosphoric acid guaranteed	*14.00*	*8.00*	*12.00*	*9.00*	*8.00*	*11.00*	*10.00*
Available phosphoric acid found	14.31	7.14	7.50	9.84	6.93	11.36	8.75
Available phosphoric acid guaranteed	----	*6.00*	*6.00*	*7.00*	*6.00*	*10.00*	*8.00*
Potash found	2.00	10.32	2.37	2.66	2.76	1.99	3.33
Potash guaranteed	*4.00*	*10.00*	*2.00*	*3.00*	*2.00*	*2.00*	*4.00*
Cost per ton	$29.00	35.00	26.00	29.00	28.00	22.50	26.50
Valuation per ton	$21.37	23.88	17.06	18.70	17.04	13.24	14.66
Percentage difference between cost and valuation	35.7	46.5	52.4	55.1	64.3	70.0	80.8

3358. Swift's Dissolved Bone and Potash; made by the Lowell Fertilizer Co., Boston, Mass.; sampled from stock of Standard Feed Co., Bridgeport, and of A. S. Bennett, Cheshire.

3280. Armour's Ammoniated Bone with Potash; made by Armour Fertilizer Co., Baltimore, Md.; sampled from stock of F. C. Benjamin & Co., Danbury, of Ansonia Flour and Grain Co., Ansonia, and of Meriden Feed Co., Meriden.

3459. Listers' Animal Bone and Potash; made by Listers Agricultural Chemical Works, Newark, N. J.; sampled from stock of A. W. Hutchinson, Gilead, and of A. I. Martin, Wallingford.

3218. Ammoniated Bone with Potash; made by the Ohio Farmers Fertilizer Co., Columbus, Ohio; sampled from stock of Linus Logee, Thompson, and of D. G. Arnold, Putnam.

It is clear that some of these brands, like **3451** and **3353**, consist of raw bone mixed with potash salts; others are merely nitrogenous superphosphates, not different in composition from those in the tables on pages 44 to 53 and one of them, **3459**, Listers' "Animal Bone and Potash," is not "animal bone" at all, in the common acceptation of the word, but plain superphosphate and potash salts. One of the brands, E. F. Coe's, has very much less than the guaranteed percentages of both nitrogen and potash and contains 3½ per cent. more of phosphoric acid than is guaranteed.

Two others, Swift's and the Ohio Farmers Fertilizer Co.'s, have less potash than is guaranteed.

BONE AND WOOD ASHES.

3302. Bowker's Bone and Wood Ashes; made by Bowker Fertilizer Co., Boston, Mass., sampled from stock of M. D. Stanley, New Britain, and of Bowker's Branch, Hartford.

ANALYSIS.

	3302
Nitrogen as nitrates	1.22
" organic	0.48
" total	1.70
" guaranteed	1.70
Phosphoric acid, water-soluble	0.48
" " citrate-soluble	6.43
" " insoluble	3.00
" " total	9.91
" " guaranteed	8.0
Potash as muriate	0.72
" total	2.19
" guaranteed	2.00
Cost per ton	$25.00

If it is assumed that the potash—other than muriate—is present in form of carbonate and nitrate, and is valued at 7¼ cents per pound, the valuation of this article will be $15.17 per ton.

NITROGENOUS SUPERPHOSPHATES AND GUANOS.

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

I. *Samples drawn by Station Agent.*

In the tables on pages 44 to 53 are given analyses of seventy-one samples belonging to this class, arranged according to the percentage differences between their cost prices and valuations.

Of the seventy-one analyses of nitrogenous superphosphates given in the tables, thirteen, about one-fifth of the whole number, are below the manufacturer's minimum guarantee in respect of one ingredient.

The names of the brands which thus fail to meet the claims made for them are as follows:

3295. Rogers Manufacturing Co.'s Fish and Potash. Nitrogen found 3.09 per cent., guaranteed 3.3 per cent.

3281. Armour's All-Soluble. Nitrogen found 2.55, guaranteed 2.8.

3417. Chittenden's Fish and Potash. Nitrogen found 2.72, guaranteed 3.0.

3421. Chittenden's Complete Fertilizer. Phosphoric acid found 9.51, guaranteed 10.0.

3416. Bowker's Fish and Potash, Square Brand. Phosphoric acid found 5.88, guaranteed 8.0.

3290. Bowker's Farm and Garden Phosphate. Phosphoric acid found 10.55, guaranteed 11.0.

3313. Bowker's Sure Crop Phosphate. Phosphoric acid found 10.30, guaranteed 11.0.

3287. Buckingham's XX Special Formula. Potash found 5.92, guaranteed 7.0.

3265. American Farmers' Market Garden Special. Potash found 6.68, guaranteed 7.0.

3405. Packers' Union Gardeners' Complete. Potash found 9.73, guaranteed 10.0.

3403. Coe's Gold Brand Excelsior. Potash found 5.65, guaranteed 6.0.

3226. Bowker's Market Garden Fertilizer. Potash found 9.70, guaranteed 10.0.

3388. Listers' Success Phosphate. Potash found 1.75, guaranteed 2.0.

In some of these cases at least, a deficiency of one ingredient is accompanied by a very considerable excess of another; these discrepancies being largely explained by imperfect mixing of the raw materials at the factory.

The manufacturer of **3388**, Listers' Success Phosphate, claims that the analysis does not fairly represent the average composition of the goods, in that the percentage of potash found is less than the goods are calculated to contain. An effort was made to find other samples of this brand for analysis, but it was not possible at the time.

Cost and Valuation.

Cost.

The method used to ascertain the retail cost price of the superphosphates is as follows:

The sampling agents inquire and note the price at the time each sample is drawn. The analysis, when done, is reported to each dealer from whom a sample was taken, as well as to the manufacturer of the article, in order to give opportunity for explanation or correction, as regards the price or the analysis itself. When the data thus gathered show a wide range of prices further correspondence is required and the manufacturerers are also consulted.

From the data thus obtained the average prices are computed.

Valuation.

The valuation has been computed in all cases in the usual manner as explained on page 17.

Percentage difference given in the table shows the percentage excess of the cost price over the average retail cost of the nitrogen, phosphoric acid and potash contained in the fertilizer.

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

Which plan is preferable can only be determined by each individual farmer, who should know best what his soil and crops need and what his facilities for purchase and payment are.

In case a fertilizer has sold at two or more different prices, the *manufacturer's price,* when known, has been used in calculating percentage difference.

Otherwise an *average,* or *nearly average price,* forms the basis of comparison between cost and valuation. The price thus employed is printed in heavy-faced type.

The average cost of the superphosphates is $28.43 per ton, the average valuation is $20.91, and the average percentage difference 36.0.

Last year the corresponding figures were:—Average cost, $30.00; average valuation, $19.75; percentage difference, 51.9.

These valuations, it must be remembered, are based on the assumption that the nitrogen, phosphoric acid and potash in each fertilizer are of good quality and readily available to farm crops. Chemical examination shows conclusively whether this is true in respect of potash and phosphoric acid.

2 and 3. *Nitrogenous Superphosphates; Sampled by Manufacturers or Purchasers.*

The Station is not responsible for the accuracy of the sampling of those fertilizers of which the analyses appear on page 54, although it holds the certificates of the persons who drew the samples, stating that the work was done according to the Station's directions. These directions, intelligently followed, will ensure accurate sampling.

3227. XX Fish and Potash, made by Joseph Wharton, Philadelphia; sampled and sent by John Guyer, Milford.

3427. Formula A; made by Sanderson Fertilizer and Chemical Co., New Haven; sampled and sent by O. G. Beard, Shelton.

3396. Formula B, and **3395** Special Fertilizer; made by Sanderson Fertilizer and Chemical Co.; sampled and sent by H. E. Loomis, Glastonbury.

3397. Berkshire Complete Fertilizer; made by Berkshire Fertilizer Co., Bridgeport; sampled and sent by H. E. Loomis, Glastonbury.

3377. Chittenden's Market Garden Fertilizer; made by National Fertilizer Co., Bridgeport; sampled and sent by F. E. Blakeman, Oronoque.

Nitrogenous Superphosphates.

Station No.	Name of Brand.	Manufacturer.	Dealer.	Dealer's cash price per ton.	Valuation per ton.
3287	Buckingham's XX Special Formula	C. Buckingham, Southport	Manufacturer	$31.00	$27.69
3423	Quinnipiac Market Garden Manure	American Agricultural Chemical Co., N. Y.	C. Buckingham, Southport	31.00	27.70
3463	XX Fish and Potash	Joseph Wharton, Phila., Pa.	E. E. Hall, Wallingford	23.00	20.47
3347	Boardman's Complete Fertilizer	F. E. Boardman, Middletown	Manufacturer	30.00	25.80
3207	Wilcox H. G. Fish and Potash	Wilcox Fertilizer Works, Mystic	W. A. Howard, Woodstock Manufacturer	28.00 28.00	23.41
3283	C. V. O. Co.'s Fertilizer	Conn. Valley Orchard Co., Berlin	Manufacturer	27.00	22.31
3321	Bone, Fish and Potash	E. R. Kelsey, Branford	Wilson & Burr, Middletown	28.00	22.67
3300	Mapes' Vegetable Manure, or complete for light soils	Mapes F. & P. G. Co., N. Y.	J. P. Barstow & Co., Norwich Mapes' Branch, Hartford	41.00 40.00	32.19
3210	Swift Sure Superphosphate for general use	M. L. Shoemaker & Co., Phila., Pa.	Olds & Whipple, Hartford F. S. Bidwell, Windsor Locks	35.00 35.00	27.90
3127	Formula A	Sanderson Fertilizer & Chemical Co., New Haven	Manufacturer	35.00	27.85
3375	Williams & Clark's H. G. Special	American Agricultural Chemical Co., N. Y.	W. H. Chappell, Chesterfield F. B. Austin, Silver Mine	34.00 36.00	27.05
3464	Wheeler's Superior Truck	American Agricultural Chemical Co., N. Y.	J. D. Luby, Burlington	33.00	26.14
3208	Wilcox' Complete Bone Superphosphate	Wilcox Fertilizer Works, Mystic	W. A. Howard, Woodstock Manufacturer	28.00 28.00	22.12
3201	Mapes' Average Soil Complete Manure	Mapes F. & P. G. Co., N. Y.	Mapes' Branch, Hartford Birdsey & Raven, Meriden	34.00 35.00	26.77
3204	Wilcox' Fish and Potash	Wilcox Fertilizer Wks. Mystic	Olds & Whipple, Hartford Manufacturer	28.00 25.00	19.60
3221	E. Frank Coe's H. G. Ammoniated Bone Superphosphate	E. Frank Coe Co., New York	J. H. Miner, Waterford J. R. Babcock, Old Mystic	23.00 ----	17.93
3265	American Farmers' Market Garden Special	American Farmers' Fertilizer Co., N. Y.	F. H. Rolf, Guilford D. C. Spencer Saybrook	33.00 35.00 34.00	26.18

Analyses and Valuations.

Station No.	Percentage difference between cost and valuation.	Nitrogen. Nitrogen as Nitrates.	Nitrogen as Ammonia.	Nitrogen Organic.	Total Nitrogen. Found.	Total Nitrogen. Guaranteed.	Phosphoric Acid. Soluble.	Reverted.	Insoluble.	Total. Found.	Total. Guaranteed.	Available. Found.	Available. Guaranteed.	Potash. Found. As Muriate.	Found. Total.	Guaranteed.
3287	11.9	1.32	----	3.08	4.40	4.0	4.16	4.19	1.82	10.17	8.0	8.35	7.0	3.00	5.92	7.0
3423	11.9	0.72	0.70	2.25	3.67	3.3	4.72	4.32	1.64	10.68	9.0	9.04	8.0	7.41	8.01	7.0
3463	12.3	----	----	2.04	2.04	2.1	7.20	4.02	0.55	11.77	7.0	11.22	6.0	0.44	2.97	2.0
3347	16.2	----	----	2.73	2.73	2.0	6.11	2.20	0.52	8.83	8.0	8.31	----	10.30	10.30	10.0
3207	19.6	----	0.28	3.61	3.89	3.3	4.00	2.62	0.54	7.16	6.0	6.62	5.0	5.13	5.13	4.0
3283	21.0	0.82	----	1.90	2.72	2.5	6.08	3.28	1.83	11.19	11.0	9.36	9.0	4.90	4.90	4.0
3321	23.5	----	0.60	3.10	3.70	3.3	3.04	2.94	0.61	6.59	4.0	5.98	----	0.71	4.95	4.0
3300	24.2	2.85	0.28	2.32	5.45	4.9	2.56	5.55	1.27	9.38	8.0	8.11	6.0	0.66	7.90	6.0
3210	25.4	0.77	----	2.29	3.06	2.5	7.84	6.04	0.70	14.58	----	13.88	----	0.60	4.94	4.0
3127	25.6	0.42	----	3.82	4.24	3.3	4.48	3.75	1.84	10.07	10.0	8.23	6.0	6.88	6.88	6.0
3375	25.6	1.03	0.36	2.27	3.66	3.3	5.14	3.91	1.22	10.27	9.0	9.05	8.0	7.73	7.73	7.0
3464	26.2	1.23	0.76	1.54	3.53	3.3	6.51	2.06	1.28	9.85	9.0	8.57	8.0	7.52	7.52	7.0
3208	26.5	----	----	2.55	2.55	2.0	6.56	3.81	1.30	11.67	9.0	10.37	8.0	4.06	4.06	3.0
3201	27.0	2.92	----	1.81	4.73	4.1	2.40	4.42	1.75	8.57	8.0	6.82	7.0	0.72	5.83	5.0
3204	27.5	----	0.24	2.83	3.07	2.5	2.19	3.88	1.81	7.88	6.0	6.07	5.0	3.94	3.94	3.0
3221	28.2	----	----	1.92	1.92	1.8	7.28	1.89	1.35	10.52	10.5	9.17	9.0	0.61	2.36	2.3
3265	29.8	----	0.67	2.65	3.32	3.4	7.12	2.15	1.73	11.00	9.5	9.27	8.0	6.27	6.68	7.0

Nitrogenous Superphosphates.

Station No.	Name of Brand.	Manufacturer.	Dealer.	Dealer's cash price per ton.	Valuation per ton.
3284	Clark's Cove Great Planet Manure	American Agricultural Chemical Co., N. Y.	C. C. Pierce, Thompson	$34.00	$25.72
			Phineas Platt, Milford	----	
3128	Special 10% Potash	Sanderson Fertilizer & Chemical Co., New Haven	Manufacturer	35.00	26.45
3405	Packers' Union Gardeners' Complete Manure	American Agricultural Chemical Co., N. Y.	Frank L. Mackey, Ellington	35.00	26.39
3465	Crocker's A. A. Complete Manure	American Agricultural Chemical Co., N. Y.	J. H. Day, Jr., Saybrook	35.00	26.34
3457	Mapes' Dissolved Bone	Mapes F. & P. G. Co., N. Y.	Mapes' Branch, Hartford	30.00	22.47
3385	Williams & Clark's Americus Ammoniated Bone Superphosphate	American Agricultural Chemical Co., N. Y.	H. A. Doyle & Co., Burnside	28.00	20.74
			O. R. Dimmock, Waterford	28.50	
3295	Fish and Potash	Rogers' Mfg. Co., Rockfall	Rockville Milling Co., Rockville	26.50	20.28
			Meeker Coal Co., Norwalk	27.00	
			F. S. Bidwell, Windsor Locks	29.00	
				27.50	
3403	E. Frank Coe's Gold Brand Excelsior Guano	E. Frank Coe Co., N. Y.	John Horn, Southport	32.00	23.38
			Joseph Adams, Westport	32.00	
3231	Hubbard's All Soils, All Crops Phosphate	The Rogers & Hubbard Co., Middletown	S. E. Frisbie, Milford	32.00	21.82
			A. J. Fuller, Danbury	28.00	
				30.00	
3125	Old Reliable Superphosphate	Sanderson Fertilizer & Chemical Co., New Haven	Manufacturer	30.00	21.60
3206	Essex XXX Fish and Potash	Russia Cement Co., Gloucester	W. J. Cox, East Hartford	31.00	21.51
			F. S. Bidwell & Co., Windsor Locks	29.00	
				30.00	
3270	Swift's Lowell Animal Brand for all crops	Lowell Fertilizer Co., Boston, Mass.	Standard Feed Co., Bridgeport	30.00	22.06
			C. W. Lines, New Britain	32.00	
				31.00	
3226	Bowker's Market Garden Fertilizer	Bowker Fertilizer Co., Boston, Mass.	Bowker's Branch, Southport	34.00	24.16
			Bowker's Branch, Hartford	35.00	
3209	All Round Fertilizer	Rogers Mfg. Co., Rockfall	J. E. Smith, Waterford	26.00	18.44
			F. S. Bidwell & Co., Windsor Locks	26.00	

Analyses and Valuations—*Continued.*

Station No.	Percentage difference between cost and valuation.	Nitrogen. Nitrogen as Nitrates.	Nitrogen as Ammonia.	Nitrogen Organic.	Total Nitrogen. Found.	Total Nitrogen. Guaranteed.	Phosphoric Acid. Soluble.	Reverted.	Insoluble.	Total. Found.	Total. Guaranteed.	Available. Found.	Available. Guaranteed.	Potash. Found. As Muriate.	Found. Total.	Guaranteed.
3284	32.1	1.05	0.33	1.95	3.33	*3.3*	5.12	3.72	1.54	10.38	*9.0*	8.84	*8.0*	7.48	7.48	*7.0*
3128	32.3	0.59	----	2.27	2.86	*1.7*	3.16	5.32	2.20	10.68	*9.0*	8.48	*5.0*	10.25	10.25	*10.0*
3405	32.6	0.75	----	1.99	2.74	*2.4*	4.32	3.98	1.61	9.91	*7.0*	8.30	*6.0*	2.34	9.73	*10.0*
3465	32.8	1.28	----	1.92	3.20	*3.3*	7.52	2.92	1.07	11.51	*9.0*	10.44	*8.0*	7.10	7.10	*7.0*
3457	33.5	----	----	2.60	2.60	*2.1*	1.12	13.23	2.79	17.14	----	14.35	*12.0*	----	----	----
3385	35.0	0.37	----	2.35	2.72	*2.5*	6.64	2.35	1.01	10.00	*9.0*	8.99	*9.0*	3.55	3.55	*2.0*
3295	35.6	0.09	----	3.00	3.09	*3.3*	3.20	3.24	1.70	8.14	*6.0*	6.44	*4.0*	4.27	4.27	*3.8*
3403	36.8	----	0.53	2.14	2.67	*2.4*	6.37	2.34	1.91	10.62	*9.0*	8.71	*7.5*	0.72	5.65	*6.0*
3231	37.4	1.30	----	1.14	2.44	*2.3*	8.30	3.69	0.80	12.79	*12.0*	11.99	*10.0*	3.05	3.05	*3.0*
3125	38.8	----	----	2.47	2.47	*2.5*	3.63	6.12	4.78	14.53	*10.0*	9.75	*7.0*	3.12	3.12	*2.0*
3206	39.4	0.30	----	2.47	2.77	*2.1*	4.19	5.59	3.72	13.50	*12.0*	9.78	----	2.42	2.42	*2.3*
3270	40.5	----	----	2.66	2.66	*2.5*	7.31	2.18	1.33	10.82	*10.0*	9.49	*9.0*	2.62	4.14	*4.0*
3226	40.7	0.65	----	1.85	2.50	*2.3*	4.51	3.27	1.79	9.57	*7.4*	7.78	*6.0*	9.70	9.70	*10.0*
3209	40.9	----	----	1.71	1.71	*1.7*	7.92	2.75	1.23	11.90	*10.0*	10.67	*8.0*	2.45	2.45	*2.0*

Nitrogenous Superphosphates.

Station No.	Name of Brand.	Manufacturer.	Dealer.	Dealer's cash price per ton.	*Valuation per ton.*
3365	Chittenden's Market Garden Fertilizer	National Fertilizer Co., Bridgeport	F. Hallock & Co, Derby A. H. Cashen, Meriden E. R. Aiken, Silver Mine	$32.00 34.00 32.00	$22.61
3417	Chittenden's Fish and Potash	National Fertilizer Co., Bridgeport	A. H. Cashen, Meriden G. A. Williams, East Hartford	30.00 29.00	20.31
3235	Mapes' Complete Manure, A Brand	Mapes F. & P. G. Co., N. Y.	Mapes' Branch, Hartford P. J. Bolan, Waterbury	33.00 35.00	22.90
3266	Berkshire Complete Fertilizer	Berkshire Fertilizer Co., Bridgeport	Manufacturer J. W. Palmer, Stamford	33.00 35.00 34.00	23.54
3421	Chittenden's Complete Fertilizer	National Fertilizer Co., Bridgeport	G. A. Williams, East Hartford F. Hallock & Co., Derby	36.00 36.00	24.80
3289	Darling's Farm Favorite	American Agricultural Chemical Co., N. Y.	D. E. Hickey, West Thompson Hotchkiss & Templeton, Waterbury	30.00 32.00 31.00	21.34
3219	Quinnipiac Phosphate	American Agricultural Chemical Co., N. Y.	F. S. Bidwell & Co., Windsor Locks G. M. Williams Co., New London	32.00 29.00	19.93
3379	Cecrops or Dragon's Tooth Brand	Frederick Ludlam, N. Y.	J. M. Beckwith, Chesterfield	37.00	25.35
3220	Bowker's Fisherman's Brand Fish and Potash	Bowker Fertilizer Co., Boston, Mass.	A. C. Rogers & Co., New London Bowker's Branch, Hartford G. F. Walters, Guilford	27.00 25.00 23.00	17.13
3199	Berkshire Ammoniated Bone Phosphate	Berkshire Fertilizer Co., Bridgeport	P. Schwartz, Chesterfield	26.00	17.75
3281	Armour's All Soluble	Armour Fertilizer Co., Baltimore, Md.	Ansonia Flour and Grain Co., Ansonia Meriden Feed Co., Meriden F. E. Tucker, Vernon	30.00 33.00 34.00 32.00	21.75
3229	Hubbard's Soluble Corn and General Crops	The Rogers & Hubbard Co., Middletown	A. J. Fuller, Danbury S. E. Frisbie, Milford	34.00 35.50	23.02

Analyses and Valuations—*Continued.*

Station No.	Percentage difference between cost and valuation.	Nitrogen.					Phosphoric Acid.							Potash.		
		Nitrogen as Nitrates.	Nitrogen as Ammonia.	Nitrogen Organic.	Total Nitrogen.		Soluble.	Reverted.	Insoluble.	Total.		Available.		Found.		Guaranteed.
					Found.	Guaranteed.				Found.	Guaranteed.	Found.	Guaranteed.	As Muriate.	Total.	
3365	41.5	1.25	----	1.25	2.50	*2.5*	7.84	1.96	1.07	10.87	*9.0*	9.80	*8.0*	5.97	5.97	*6.0*
3417	42.7	0.91	----	1.81	2.72	*3.0*	5.30	2.54	0.68	8.52	*6.0*	7.84	----	4.84	4.84	*4.0*
3235	44.1	0.59	----	2.23	2.82	*2.5*	4.08	7.18	2.04	13.30	*12.0*	11.26	*10.0*	3.24	3.24	*2.5*
3266	44.4	0.84	----	2.24	3.08	*2.5*	4.88	2.69	2.73	10.30	*10.0*	7.57	*8.0*	4.38	6.29	*6.0*
3421	45.1	1.34	----	2.13	3.47	*3.0*	6.82	1.77	0.92	9.51	*10.0*	8.59	*8.0*	6.41	6.41	*6.0*
3289	45.2	0.03	0.15	2.41	2.59	*2.1*	5.68	4.39	0.39	10.46	*10.0*	10.07	*8.0*	3.84	3.84	*3.0*
3219	45.5	0.59	----	2.11	2.70	*2.5*	5.52	3.45	2.07	11.04	*11.0*	8.97	*9.0*	2.44	2.44	*2.0*
3379	45.9	1.32	----	1.94	3.26	*3.0*	5.92	3.05	1.58	10.55	----	8.97	*7.0*	7.22	7.22	*7.0*
3220	45.9	----	----	2.33	2.33	*2.3*	2.48	3.26	1.67	7.41	*6.0*	5.74	*4.0*	4.22	4.22	*4.0*
3199	46.4	----	----	1.59	1.59	*0.8*	6.00	2.50	2.69	11.19	*10.0*	8.50	*8.0*	0.42	3.39	*3.0*
3281	47.1	0.88	----	1.67	2.55	*2.8*	6.43	3.00	0.80	10.23	*10.0*	9.43	*8.0*	0.93	4.64	*4.0*
3229	47.6	0.80	----	1.73	2.53	*2.5*	0.43	6.80	2.70	9.93	*8.0*	7.23	*6.0*	8.95	8.95	*8.0*

NITROGENOUS SUPERPHOSPHATES.

Station No.	Name of Brand.	Manufacturer.	Dealer.	Dealer's cash price per ton.	*Valuation per ton.*
3267	Bradley's New Method Fertilizer	American Agricultural Chemical Co., N. Y.	C. M. Beach, New Milford	$30.00	$20.13
			D. L. Clark, Milford	----	
3320	O. & W. Special Phosphate	Olds & Whipple, Hartford	----------	34.00	22.39
3236	Mapes' Cereal Brand	Mapes F. & P. G. Co., N. Y.	Mapes' Branch, Hartford	27.00	17.72
			A. N. Clark, Milford	28.00	
3342	Baker's A. A. Ammoniated Superphosphate	American Agricultural Chemical Co., N. Y.	Edward White, Rockville	30.00	20.31
			Saxton & Strong, Bristol	31.50	
				31.00	
3222	Bradley's XL Superphosphate	American Agricultural Chemical Co., N. Y.	F. S. Bidwell & Co., Windsor Locks	32.00	20.29
			P. Schwartz, Chesterfield	34.00	
			J. A. Cruff, Thompson	30.00	
			C. O. Jelliff & Co., Southport	30.00	
				31.00	
3435	Clark's Cove Bay State Fertilizer, G. G.	American Agricultural Chemical Co., N. Y.	J. M. Burke, South Manchester	30.00	19.41
3355	Bowker's Middlesex Special	Bowker Fertilizer Co., Boston	W. H. Baldwin, Meriden	32.00	17.76
				28.00	
3388*	Listers' Success Phosphate	Listers Agricultural Chemical Works, Newark, N. J.	A. W. Hutchinson, Gilead	28.00	17.74
3351	Bowker's Hill and Drill Phosphate	Bowker Fertilizer Co., Boston, Mass.	Southington Lumber Co., Southington	32.00	20.22
			Bowker's Branch, Southport	32.00	
3317	Luce Bros. Bone, Fish and Potash	Sanderson Fertilizer & Chemical Co., New Haven	A. D. Morse & Son, Guilford	25.00	15.06
			Ives Bros., West Cheshire	24.00	
3315	Chittenden's Ammoniated Bone Phosphate	National Fertilizer Co., Bridgeport	F. Hallock & Co., Derby	32.00	18.77
			G. A. Williams, East Hartford	30.00	
3335	Great Eastern General Fertilizer	American Agricultural Chemical Co., N. Y.	H. S. Harvey, Windham	26.00	16.26
			T. E. Green, Plainfield	26.00	
			J. H. Elliott, Campville	28.00	
3416	Bowker's Fish and Potash, Square Brand	Bowker Fertilizer Co., Boston	E. F. Miller, Ellington	28.00	17.42
3439	Packers' Union Universal Fertilizer	American Agricultural Chemical Co., N. Y.	G. W. Eaton, Bristol	28.00	17.37
3433	Clark's Cove K'g Phillip Alkaline Guano	American Agricultural Chemical Co., N. Y.	J. M. Burke, South Manchester	25.00	15.33

* See page 42.

ANALYSES AND VALUATIONS—*Continued.*

Station No.	Percentage difference between cost and valuation.	Nitrogen.					Phosphoric Acid.							Potash.		
					Total Nitrogen.					Total.		Available.		Found.		
		Nitrogen as Nitrates.	Nitrogen as Ammonia.	Nitrogen Organic.	Found.	Guaranteed.	Soluble.	Reverted.	Insoluble.	Found.	Guaranteed.	Found.	Guaranteed.	As Muriate.	Total.	Guaranteed.
3267	49.0	0.38	0.36	1.52	2.26	*1.7*	5.05	4.19	2.21	11.45	*9.0*	9.24	*8.0*	3.90	3.90	*3.0*
3320	51.8	2.32	----	2.40	4.72	*4.1*	3.14	1.30	0.36	4.80	----	4.44	*4.0*	0.24	3.80	*3.3*
3236	52.3	0.50	----	1.58	2.08	*1.7*	2.64	5.94	1.14	9.72	*8.0*	8.58	*6.0*	3.30	3.30	*3.0*
3342	52.6	0.84	----	1.68	2.52	*2.5*	8.27	1.66	1.53	11.46	*11.0*	9.93	*9.0*	2.60	2.60	*2.0*
3222	52.7	0.53	----	2.14	2.67	*2.5*	5.68	3.96	1.91	11.55	*11.0*	9.64	*9.0*	2.30	2.30	*2.0*
3435	54.5	0.77	----	1.72	2.49	*2.1*	6.32	3.24	2.34	11.90	*10.0*	9.56	*8.0*	1.85	1.85	*1.5*
3355	57.6	0.43	----	1.69	2.12	*2.1*	2.48	3.13	1.23	6.84	*6.0*	5.61	*4.0*	6.30	6.30	*6.0*
3388	57.8	----	0.14	1.33	1.47	*1.2*	6.96	3.71	2.57	13.24	*11.0*	10.67	*9.0*	0.43	1.75	*2.0*
3351	58.2	0.61	----	1.68	2.29	*2.3*	7.36	3.15	2.03	12.54	*11.0*	10.51	*9.0*	2.49	2.49	*2.0*
3317	59.3	----	0.12	1.93	2.05	*1.7*	0.64	2.79	4.69	8.12	*6.0*	3.43	*4.0*	4.06	4.06	*4.0*
3315	59.8	----	----	1.87	1.87	*1.8*	7.68	2.51	1.13	11.32	*10.0*	10.19	*8.0*	2.82	2.82	*2.0*
3335	59.9	----	----	1.04	1.04	*0.8*	6.21	2.64	1.70	10.55	*10.0*	8.85	*8.0*	4.30	4.30	*4.0*
3416	60.7	0.06	----	2.44	2.50	*2.3*	3.92	1.64	0.32	5.88	*8.0*	5.56	----	4.60	4.60	*4.0*
3439	61.1	----	----	1.11	1.11	*0.8*	7.62	2.23	1.31	11.16	*8.0*	9.85	*6.0*	4.32	4.32	*2.0*
3433	63.0	----	----	1.28	1.28	*1.0*	5.98	3.16	1.35	10.49	*10.0*	9.14	*8.0*	2.20	2.20	*2.0*

NITROGENOUS SUPERPHOSPHATES.

Station No.	Name of Brand.	Manufacturer.	Dealer.	Dealer's cash price per ton.	*Valuation per ton.*
3432	Chittenden's Universal Phosphate	National Fertilizer Co., Bridgeport	A. H. Cashen, Meriden	$25.00	$15.17
3234	General Crop Fish Guano	Ohio Farmers' Fertilizer Co., Columbus, Ohio	D. G. Arnold, Putnam	26.00	15.71
			A. M. Paine, South Woodstock	26.00	
3264	Swift's Lowell Bone Fertilizer	Lowell Fertilizer Co., Boston, Mass.	A. S. Bennett, Cheshire	30.00	17.81
			C. W. Lines, New Britain	30.00	
			Standard Feed Co., Bridgeport	28.00	
3437	Pacific Nobsque Guano	American Agricultural Chemical Co., N. Y.	J. A. Nichols & Co., Danielson	25.00	14.81
3290	Bowker's Farm and Garden Phosphate	Bowker Fertilizer Co., Boston, Mass.	Hubbell & Bradley, Saugatuck	28.00	16.41
			Lightbourn & Pond Co., New Haven	33.00	
3341	Read's Standard Superphosphate	American Agricultural Chemical Co., N. Y.	Lewis Ford, Norwich	30.00	16.98
			C. B. Strong, Leonard Bridge	----	
			C. W. Fulton, West Hartford	28.00	
				29.00	
3438	Pacific Soluble Guano	American Agricultural Chemical Co., N. Y.	Saxton & Strong, Bristol	33.00	18.37
3344	Quinnipiac Climax Phosphate	American Agricultural Chemical Co., N. Y.	Adams & Canfield, Winnipauk	30.00	15.56
			J. P. Lathrop, Plainfield	26.00	
				28.00	
3387	Bradley's Eclipse Phosphate for all crops	American Agricultural Chemical Co., N. Y.	W. W. Sheldon, South Woodstock	27.00	14.90
3340	Read's Fish Bone and Potash	American Agricultural Chemical Co., N. Y.	T. A. Tillinghast, Brooklyn	28.00	15.43
			M. W. Howard, Bolton Notch	28.00	
3298	Essex A1 Superphosphate	Russia Cement Co., Gloucester, Mass.	W. J. Cox, East Hartford	29.00	14.43
			C. A. Young, Danielson	24.00	
			P. J. Bolan, Waterbury	27.00	
3381	Cereal Brand of Cecrops Fertilizer	Frederick Ludlam, N. Y.	J. M. Beckwith, Chesterfield	25.00	13.20
3313	Bowker's Sure Crop Phosphate	Bowker Fertilizer Co., Boston	G. F. Walters, Guilford	26.00	13.65
			J. E. Leonard, Jewett City	27.00	

ANALYSES AND VALUATIONS—*Continued.*

Station No.	Percentage difference between cost and valuation.	Nitrogen.					Phosphoric Acid.							Potash.		
					Total Nitrogen.					Total.		Available.		Found.		
		Nitrogen as Nitrates.	Nitrogen as Ammonia.	Nitrogen Organic.	Found.	Guaranteed.	Soluble.	Reverted.	Insoluble.	Found.	Guaranteed.	Found.	Guaranteed.	As Muriate.	Total.	Guaranteed.
3432	64.7	----	----	1.07	1.07	*0.8*	7.76	2.58	1.05	11.39	*10.0*	10.34	*8.0*	1.47	1.47	*1.0*
3234	65.4	0.09	----	0.85	0.94	*0.8*	5.30	3.64	1.42	10.36	*9.0*	8.94	*8.0*	4.22	4.22	*1.0*
3264	68.4	----	----	1.92	1.92	*1.6*	6.34	1.95	1.30	9.59	*9.0*	8.29	*8.0*	3.59	3.59	*3.0*
3437	68.8	----	----	1.21	1.21	*1.1*	5.70	2.90	1.63	10.23	*10.0*	8.60	*8.0*	2.33	2.33	*2.0*
3290	70.6	0.24	----	1.46	1.70	*1.5*	5.60	3.07	1.88	10.55	*11.0*	8.67	*9.0*	2.30	2.30	*2.0*
3341	70.7	0.06	----	1.15	1.21	*0.8*	6.16	2.99	1.66	10.81	*10.0*	9.15	*8.0*	4.26	4.26	*4.0*
3438	79.6	trace	----	2.31	2.31	*2.1*	3.68	5.20	2.62	11.50	*10.0*	8.88	*8.0*	1.85	1.85	*1.5*
3344	79.9	----	----	1.54	1.54	*1.0*	5.12	3.51	1.31	9.94	*8.0*	8.63	*6.0*	2.15	2.15	*2.0*
3387	81.2	----	----	1.22	1.22	*1.0*	5.50	3.42	1.57	10.49	*10.0*	8.92	*8.0*	2.10	2.10	*2.0*
3340	81.4	----	0.38	1.54	1.92	*2.0*	1.76	3.70	1.70	7.16	*5.0*	5.46	*4.0*	4.09	4.09	*4.0*
3298	87.1	----	----	1.26	1.26	*1.0*	2.40	5.11	3.57	11.08	*9.0*	7.51	----	2.32	2.32	*2.0*
3381	89.3	----	----	0.78	0.78	*0.8*	3.92	5.32	2.92	12.16	*10.0*	9.24	*9.0*	0.96	0.96	*1.0*
3313	90.4	0.15	----	0.77	0.92	*0.8*	4.75	3.95	1.60	10.30	*11.0*	8.70	*9.0*	2.14	2.14	*2.0*

NITROGENOUS SUPERPHOSPHATES SAMPLED BY PURCHASERS. ANALYSES AND VALUATIONS.

	3227	3427	3396	3395	3397	3377	3380	3174
Nitrogen as nitrates	....	0.63	0.75	....	0.70	....	....	....
Nitrogen as ammonia	0.21	....	....	1.66	....	....	....	0.24
Nitrogen organic	1.75	3.57	2.59	3.47	2.20	3.04	3.76	3.80
Total nitrogen found	1.96	4.20	3.34	5.13	2.90	3.04	3.76	4.04
Total nitrogen guaranteed	....	....	....	*6.00*	....	*2.47*	....	....
Soluble phosphoric acid	7.44	4.91	4.16	trace	5.31	5.84	4.90	1.20
Reverted phosphoric acid	3.71	4.81	5.55	5.97	3.25	2.48	2.55	11.26
Insoluble phosphoric acid	0.44	1.47	1.10	1.04	2.03	1.02	0.99	3.79
Total phosphoric acid found	11.59	11.19	10.81	7.01	10.59	9.34	8.44	16.25
Total phosphoric acid guaranteed	....	....	....	....	....	*9.00*	....	....
Available phosphoric acid found	11.15	9.72	9.71	5.97	8.56	8.32	7.45	12.46
Available phosphoric acid guaranteed	....	....	....	*10.00*	....	*8.00*	....	....
Potash found	3.01	6.62	6.40	8.30	6.52	4.70	4.00	0.32
Potash guaranteed	....	....	....	*10.00*	....	*6.00*	....	....
Cost per ton	$20.00	35.00	33.00	40.00	33.00	30.00	33.00	....
Valuation per ton	$20.18	28.64	26.26	30.53	24.54	22.21	23.03	26.07
Per cent. difference between cost and valuation	0.9*	22.2	25.6	31.0	34.4	35.0	43.2	....

* Valuation exceeds cost.

3380. Formula A; made by Sanderson Fertilizer and Chemical Co., New Haven; sampled and sent by W. W. Thompson, Warehouse Point.

3174. Fertilizer Dust. This is understood to be sweepings from the mill room where fertilizers are screened and ground. From factory of Sanderson Fertilizer and Chemical Co.; sampled and sent by J. H. Hale, South Glastonbury.

SPECIAL MANURES.

Here are included such mixed fertilizers, chiefly nitrogenous superphosphates, as are claimed by their manufacturers to be specially adapted to the needs of particular crops.

1. *Samples Drawn by Station Agent.*

In the table on pages 58 to 71 are given analyses of eighty-six brands represented by samples drawn by the Station agents.

GUARANTEES.

Of the samples represented in the following tables, nine failed to come up to the maker's guarantee in respect to the percentage of nitrogen, four in respect to that of phosphoric acid, and eight in respect to that of potash.

The brands which thus failed fully to meet the claims of the manufacturers by more than one-tenth per cent., were the following:—

3367. Hubbard's Oat and Top Dressing Fertilizer.* Nitrogen found 8.67 per cent., guaranteed 8.8 per cent.

3426. Darling's Tobacco Grower. Nitrogen found 4.15, guaranteed 4.4.

3425. Chittenden's High Grade Tobacco Fertilizer. Nitrogen found, 5.27, guaranteed 5.7.

3294. The Rogers Mfg. Co.'s Fertilizer for Oats and Top Dressing.* Nitrogen found 5.89, guaranteed 6.3.

3293. The Rogers Mfg. Co.'s Soluble Tobacco Manure. Nitrogen found 4.86, guaranteed 5.0.

3356. Stockbridge Grass Top Dressing. Nitrogen found 4.46, guaranteed 4.8.

3286. American Farmers' Corn King. Nitrogen found 2.22, guaranteed 2.4.

* See page 57.

3436. Great Eastern Northern Corn Special. Nitrogen found 2.28, guaranteed 2.5.
3428. Pacific Potato Special. Nitrogen found 1.98, guaranteed 2.1.
3450. Rogers Mfg. Co.'s Grass and Grain Fertilizer.* Phosphoric acid found 14.12, guaranteed 16.0.
3422. Sanderson's Tobacco Formula B. Phosphoric acid found 9.79, guaranteed 10.0.
3369. Essex Tobacco Manure. Phosphoric acid found 8.38, guaranteed 8.5.
3303. Bowker's Potato Phosphate. Phosphoric acid found 10.85, guaranteed 11.0.
3450. Rogers Mfg. Co.'s Grass and Grain Fertilizer,* potash found 12.12, guaranteed 12.5.
3366. Hubbard's Grass and Grain Fertilizer.* Potash found 11.33, guaranteed 12.5.
3390. Listers' Potato Manure.* Potash found 6.52, guaranteed 7.0.
3402. Stockbridge Tobacco Fertilizer. Potash found 9.74, guaranteed 10.0.
3282. Armour's Potato Manure. Potash found 9.58, guaranteed 10.0.
3126. Sanderson's Potato Manure. Potash found 5.42, guaranteed 6.0.
3382. Listers' Corn and Potato Fertilizer.* Potash found 2.65, guaranteed 3.0.
3429. Essex Corn Fertilizer. Potash found 2.82, guaranteed 3.0.

Cost and Valuation.

The average cost per ton of the eighty-eight special manures included in the table was $32.64, the valuation, $23.80, and the percentage difference, 37.1.

In 1900 the corresponding figures were:—Average cost, $32.73; valuation, $22.49; and percentage difference, 45.5.

2. *Special Manures Sampled by Purchasers.*

In the tables on pages 70 and 71 are included two analyses of samples of special manures sent to the Station by purchasers.

Analyses Requiring Special Notice.

The manufacturers claim that at least half of the potash in Mapes' Tobacco Manure, Wrapper Brand, **3349**, and also in Mapes' Tobacco Ash Constituents, **3406**, is present as carbonate, while some lots of these brands were put out containing potash wholly in form of carbonate. In the foregoing tables, the valuations of these brands are made reckoning the potash as sulphate. If a half of it is figured as carbonate, at 7¼ cents per

* See explanations on this page and the next.

pound, the valuation of the Wrapper Brand Tobacco Manure would be $37.54 per ton, and of the Tobacco Ash Constituents, $26.25.

The manufacturers of Listers' Corn and Potato Fertilizer, **3382**, and of Listers' Potato Manure, **3390**, state that these analyses do not represent the average composition of the brands named, in that the percentage of potash found in these samples is lower than the goods were calculated to contain. An unsuccessful effort was made, after receiving this notice from the manufacturers, to secure other samples from the Connecticut market for analysis.

The following fertilizers, viz:

3450. Rogers Mfg. Co.'s Grass and Grain Manure,
3294. Rogers Mfg. Co.'s Oats and Top-Dressing Manure,
3366. Hubbard's Grass and Grain Manure,
3367. Hubbard's Oats and Top-Dressing Manure,

are mixtures of ground raw bone and chemicals.

It is quite impossible to make mixtures of dry, raw bone and chemicals which will remain uniformly mixed during transportation, or even when stored. There is a constant tendency for the dry particles to separate according to their specific gravities, so that one side or end of a package may contain considerably more of one chemical ingredient, potash or nitrogen for instance, than the other, and the contents of different packages will show similar differences.

In such cases, a deficiency of one ingredient is likely to be offset by an amount of another ingredient quite in excess of the manufacturer's claims.

Tobacco Manures claimed to contain Potash as Carbonate or Nitrate.

In a table on page 72 are analyses of a number of tobacco fertilizers which are claimed to contain potash, chiefly, or wholly, in form of nitrate or carbonate. Since potash in these forms costs considerably more than in sulphate or muriate, it should not be valued at the same rate in mixed fertilizers. It is not possible in most cases to determine by analysis whether the manufacturer's claims are well-founded, but, *assuming potash to be present in form of nitrate or carbonate* and valued at 7¼ cents per pound, the valuations are as given in the table:

Special Manures, Sampled by the Station.

Station No.	Name of Brand.	Manufacturer.	Dealer.	Dealer's cash price per ton.	*Valuation per ton.*
	Sampled by Station Agent				
3449	Mapes' Seeding Down Manure	Mapes F. & P. G. Co., New York	Mapes' Branch, Hartford	$37.00	$33.19
3450*	H. G. Grass and Grain Fertilizer	Rogers Mfg. Co., Rockfall	Manufacturer	38.00	32.98
			A. O. Smith, Norfolk	38.00	
3230	Wilcox Potato, Onion and Tobacco Manure	Wilcox Fertilizer Works, Mystic	I. W. Dennison, Mystic	32.00	27.85
			W. A. Howard, Woodstock	34.00	
				33.00	
3422	Sanderson's Tobacco Formula B. Fertilizer	Sanderson Fertilizer & Chemical Co. New Haven	C. Hendel, Hockanum	32.00	26.70
			J. H. Hackett, Wapping	33.00	
3369	Essex Special Tobacco Manure	Russia Cement Co., Gloucester, Mass.	W. J. Cox, E. Hartford	44.00	36.49
3366*	Hubbard's Grass and Grain Fertilizer	The Rogers & Hubbard Co., Middletown	S. E. Frisbie, Milford	40.00	31.49
			Manufacturer	39.75	
			John Bransfield, Portland	38.00	
			R. H. Hall, East Hampton	38.00	
3367*	Hubbard's Oat and Top Dressing Fertilizer	The Rogers & Hubbard Co., Middletown	S. E. Dowd, Clinton	48.00	39.57
			H. W. Andrews, Wallingford	49.00	
			G. A. Tucker, West Cheshire	46.00	
3460	Swift-sure Superphosphate for Potatoes	M. L. Shoemaker & Co., Phila. Pa.	E. B. Clark Co., Milford	33.00	27.12
3426	Darling's Tobacco Grower	American Agricultural Chemical Co., N. Y.	Loomis Brothers, Granby	38.00	30.31
			J. B. Pease, Melrose	36.00	
			E. F. Miller, Ellington	37.00	
3425	Chittenden's H. G. Special Tobacco Fertilizer	National Fertilizer Co., Bridgeport	Ralph Lasbury, Broad Brook	42.00	34.14
3371	Mystic Gilt Edge Potato Manure	C. M. Shay, Groton	Manufacturer	30.00	24.26
3297	Essex Complete Manure for Potatoes, Roots and Vegetables	Russia Cement Co., Gloucester, Mass.	E. N. Pierce, Plainville	40.00	31.46
			W. J. Cox, East Hartford	39.00	
3294*	H. G. Fertilizer for Oats and Top Dressing	The Rogers Mfg. Co., Rockfall	J. F. Blakeslee, No. Haven	42.00	33.62
			Wm. Orr, Southington	42.00	
			J. E. Smith, Waterford	43.00	
3390*	Listers' Potato Manure	Listers Agric. Chem. Works, Newark, N. J.	A. W. Hutchinson, Gilead	33.00	26.36

* See pages 56 and 57.

Analyses and Valuations.

Station No.	Percentage difference between cost and valuation.	Nitrogen.					Phosphoric Acid.							Potash.		
					Total Nitrogen.					Total.		Available.		Found.		
		Nitrogen as Nitrates.	Nitrogen as Ammonia.	Nitrogen Organic.	Found.	Guaranteed.	Soluble.	Reverted.	Insoluble.	Found.	Guaranteed.	Found.	Guaranteed.	As Muriate.	Total.	Guaranteed.
3449	11.5	1.71	0.18	0.53	2.42	*2.5*	none	16.24	1.73	17.97	*18.0*	16.24	----	12.71	12.71	*10.0*
3450	15.2	0.43	----	3.33	3.76	*3.0*	0.29	9.99	3.84	14.12	*16.0*	10.28	----	12.12	12.12	*12.5*
3230	18.5	0.94	0.14	2.53	3.61	*3.3*	6.40	3.06	1.16	10.62	*8.0*	9.46	*7.0*	0.73	7.16	*6.0*
3422	19.9	0.33	0.57	3.10	4.00	*3.3*	2.46	5.34	1.99	9.79	*10.0*	7.80	*6.0*	1.04	6.07	*6.0*
3369	20.6	1.91	----	3.24	5.15	*4.5*	5.41	2.61	0.36	8.38	*8.5*	8.02	----	0.54	12.95	*12.0*
3366	20.7	----	0.15	2.75	2.90	*2.5*	none	11.57	5.38	16.95	*15.0*	11.57	*6.6*	11.33	11.33	*12.5*
3367	21.3	7.64	----	1.03	8.67	*8.8*	none	7.20	1.18	8.38	*7.9*	7.20	*3.9*	9.33	9.33	*8.4*
3460	21.7	0.94	----	1.80	2.74	*2.5*	6.96	5.24	2.08	14.28	----	12.20	*8.0*	7.32	7.32	*6.5*
3426	22.1	----	2.26	1.89	4.15	*4.4*	3.30	3.19	0.14	6.63	*5.0*	6.49	*4.0*	1.42	10.78	*10.0*
3425	23.0	0.63	----	4.64	5.27	*5.7*	3.84	2.69	1.08	7.61	*7.0*	6.53	*5.0*	1.22	11.02	*10.0*
3371	23.7	0.71	----	2.29	3.00	*3.0*	6.37	3.57	1.83	11.77	*9.0*	9.94	*8.0*	5.45	5.45	*5.0*
3297	23.9	0.58	0.60	2.94	4.12	*3.7*	4.56	4.99	1.07	10.62	*9.0*	9.55	----	0.60	9.06	*8.5*
3294	24.9	4.10	0.14	1.65	5.89	*6.3*	1.49	7.70	2.00	11.19	*9.5*	9.19	*7.0*	8.45	8.45	*7.5*
3390	25.2	0.31	1.40	1.63	3.34	*3.3*	7.44	2.04	1.65	11.13	*9.0*	9.48	*8.0*	5.37	6.52	*7.0*

Special Manures, Sampled by the Station.

Station No.	Name of Brand.	Manufacturer.	Dealer.	Dealer's cash price per ton.	Valuation per ton.
	Sampled by Station Agent				
3374	Wheeler's Bermuda Onion Grower	American Agricultural Chemical Co., N. Y.	W. H. Baldwin, Cheshire	$26.00	$20.35
3312	Hubbard's Soluble Tobacco Manure	The Rogers & Hubbard Co., Middletown	H. W. Andrews, Wallingford	44.00	34.27
			F. S. Bidwell & Co., Windsor Locks	44.00	
3296	Hubbard's Soluble Potato Manure	The Rogers & Hubbard Co., Middletown	H. W. Andrews, Wallingford	39.00	29.98
			G. A. Tucker, West Cheshire	40.00	
			S. E. Frisbie, Milford	39.50	
				38.50	
3349*	Mapes' Tobacco Manure, Wrapper Brand	Mapes F. & P. G. Co., New York	Mapes' Branch, Hartford	45.00	34.96
			C. T. Abbe, Warehouse Point	46.00	
3373	Wheeler's Havana Tobacco Grower	American Agricultural Chemical Co., N. Y.	J. E. Rogers, New Britain	----	26.34
			John Bransfield, Portland	35.00	
			E. E. Pitney, Ellington	34.00	
3225	Bradley's Complete Manure for Potatoes and Vegetables	American Agricultural Chemical Co., N. Y.	J. A. Cruff, Thompson	33.00	25.56
			C. O. Jelliff & Co., Southport	34.00	
3202	Mapes' Potato Manure	Mapes F. & P. G. Co., New York	Birdsey & Raven, Meriden	38.00	28.60
			Mapes' Branch, Hartford	37.00	
3368	H. G. Complete Corn and Onion Manure	The Rogers Mfg. Co., Rockfall	J. F. Blakeslee, North Haven	35.00	25.95
			W. O. Goodsell, Bristol	34.00	
3269	Mapes' Economical Potato Manure	Mapes F. & P. G. Co., New York	Mapes' Branch, Hartford	34.00	25.93
			A. N. Clark, Milford	35.00	
3293	H. G. Soluble Tobacco Manure	The Rogers Mfg. Co., Rockfall	Manufacturer	44.00	32.96
			W. E. Bostwick, New Milford	40.00	
3402	Stockbridge Tobacco Fertilizer	Bowker Fertilizer Co., Boston	Bowker's Branch, Hartford	44.00	32.97
3406*	Mapes' Tobacco Ash Constituents	Mapes F. & P. G. Co., New York City	Mapes' Branch, Hartford	31.00	
			Spencer Brothers, Suffield	32.00	22.86
3203	Bowker's Early Potato Manure	Bowker Fertilizer Co., Boston	Bowker's Branch, Hartford	35.00	24.96
			Bowker's Branch, Southport	34.00	

* See p. 56.

Analyses and Valuations—*Continued.*

Station No.	Percentage difference between cost and valuation.	Nitrogen: Nitrogen as Nitrates.	Nitrogen: Nitrogen as Ammonia.	Nitrogen: Nitrogen Organic.	Total Nitrogen: Found.	Total Nitrogen: Guaranteed.	Phosphoric Acid: Soluble.	Phosphoric Acid: Reverted.	Phosphoric Acid: Insoluble.	Total: Found.	Total: Guaranteed.	Available: Found.	Available: Guaranteed.	Potash Found: As Muriate.	Potash Found: Total.	Potash: Guaranteed.
3374	27.8	----	----	1.01	1.01	*0.8*	8.96	1.86	1.40	12.22	*10.0*	10.82	*9.0*	6.97	6.97	*7.0*
3312	28.4	2.79	0.20	2.15	5.14	*5.0*	0.93	7.10	3.41	11.44	*10.0*	8.03	*7.0*	----	10.24	*10.0*
3296	28.4	2.70	0.22	2.13	5.05	*5.0*	1.04	7.03	3.12	11.19	*10.0*	8.07	*7.0*	1.01	6.41	*5.0*
3349	28.7	3.89	0.68	1.91	6.48	*6.2*	none	4.89	1.06	5.95	*4.5*	4.89	----	1.06	11.06	*10.5*
3373	29.0	0.71	0.36	1.70	2.77	*2.5*	5.28	2.51	1.34	9.13	*7.0*	7.79	*6.0*	5.11	10.41	*10.0*
3225	29.1	1.04	0.33	1.91	3.28	*3.3*	5.28	3.98	1.23	10.49	*9.0*	9.26	*8.0*	7.17	7.17	*7.0*
3202	29.4	1.72	0.28	1.85	3.85	*3.7*	3.04	6.25	1.20	10.49	*8.0*	9.29	*8.0*	0.94	7.93	*6.0*
3368	31.0	1.57	----	2.13	3.70	*3.6*	5.20	3.23	1.16	9.59	*8.0*	8.43	*6.0*	7.25	7.25	*7.0*
3269	31.1	1.49	0.30	1.87	3.66	*3.3*	1.04	4.68	1.38	7.10	*6.0*	5.72	*4.0*	1.06	9.15	*8.0*
3293	33.5	2.38	----	2.48	4.86	*5.0*	1.52	5.52	2.18	9.22	*8.0*	7.04	*6.0*	1.08	11.16	*11.0*
3402	33.5	2.70	----	2.77	5.47	*5.8*	3.82	3.22	0.83	7.87	*6.0*	7.04	*4.0*	1.60	9.74	*10.0*
3406	35.6	----	----	0.64	0.64	*0.5*	none	5.03	1.17	6.20	*5.7*	5.03	----	0.92	15.95	*15.0*
3203	36.2	1.30	----	2.00	3.30	*3.0*	5.76	2.48	1.23	9.47	*9.0*	8.24	*7.0*	7.58	7.58	*7.0*

Special Manures, Sampled by the Station.

Station No.	Name of Brand.	Manufacturer.	Dealer.	Dealer's cash price per ton.	Valuation per ton.
	Sampled by Station Agent				
3299	Mapes' Grass & Grain Spring Top Dressing	Mapes F. & P. G. Co., New York City	Mapes' Branch, Hartford	**$39.00**	$28.60
			Southington Lumber Co., Southington	40.00	
			J. P. Barstow, Norwich	40.00	
3292	H. G. Soluble Tobacco and Potato Manure	The Rogers Mfg. Co., Rockfall	Manufacturer	**40.00**	29.31
			W. E. Bostwick, New Milford	40.00	
3217	Essex Complete Manure for Corn, Grain and Grass	Russia Cement Co., Gloucester, Mass.	F. S. Bidwell & Co., Windsor Locks	**39.00**	28.48
			W. J. Cox, East Hartford	39.00	
3419	Packer's Union Potato Manure	American Agricultural Chemical Co., N. Y.	Rockville Milling Co., Rockville	**30.00**	21.87
3237	Swift's Lowell Potato Phosphate	Lowell Fertilizer Co., Boston	Standard Feed Co., Bridgeport	**33.00**	24.01
			C. W. Lines, New Britain	33.00	
			S. W. Bray, Milford	32.00	
			E. J. Galvin, New Milford	35.00	
3356	Stockbridge Grass Top Dressing	Bowker Fertilizer Co., Boston	Bowker's Branch, Hartford	**37.00**	26.92
3386	Armour's Fruit and Root Crop	Armour Fertilizer Co., Baltimore, Md.	F. C. Benjamin & Co., Danbury	**28.00**	20.32
3285	Stockbridge Potato and Vegetable Manure	Bowker Fertilizer Co., Boston	G. S. Jennings, Southport	35.00	26.84
			Bowker's Branch, Hartford	**37.00**	
			E. B. Clark Co., Milford	34.00	
3282	Armour's H. G. Potato	Armour Fertilizer Co., Baltimore, Md.	Ansonia Flour and Grain Co., Ansonia	30.00	23.07
			Meriden Feed Co., Meriden	**32.00**	
			F. E. Tucker, Vernon	35.00	
3268	Quinnipiac Potato Manure	American Agricultural Chemical Co., N. Y.	C. Buckingham, Southport	27.00	20.89
			G. M. Williams, New London	32.00	
				29.00	
3232	Wilcox Potato Manure	Wilcox Fertilizer Works, Mystic	W. A. Howard, Woodstock	28.00	20.64
			Olds & Whipple, Hartford	30.00	
				29.00	
3322	O. & W.'s Potato Manure	Olds & Whipple, Hartford	Manufacturers	**32.00**	22.76
			Manufacturers	32.00	

Analyses and Valuations—*Continued.*

Station No.	Percentage difference between cost and valuation.	Nitrogen. Nitrogen as Nitrates.	Nitrogen as Ammonia.	Nitrogen Organic.	Total Nitrogen. Found.	Total Nitrogen. Guaranteed.	Phosphoric Acid. Soluble.	Reverted.	Insoluble.	Total. Found.	Total. Guaranteed.	Available. Found.	Available. Guaranteed.	Potash. Found. As Muriate.	Found. Total.	Guaranteed.
3299	36.4	3.13	0.27	1.85	5.25	*4.9*	1.76	4.58	0.95	7.29	*6.0*	6.34	*5.0*	7.96	7.96	*7.0*
3292	36.5	0.35	0.18	3.12	3.65	*3.5*	1.84	6.73	1.54	10.11	*7.0*	8.57	----	1.02	9.39	*9.0*
3217	36.9	0.75	----	2.71	3.46	*3.3*	4.75	4.23	1.70	10.68	*9.5*	8.98	----	9.96	9.96	*9.5*
3419	37.2	0.54	----	1.76	2.30	*2.1*	6.85	2.28	1.56	10.69	*10.0*	9.13	*8.0*	6.13	6.13	*6.0*
3237	37.4	----	----	2.86	2.86	*2.5*	6.48	2.07	1.31	9.86	*9.0*	8.55	*8.0*	0.46	6.07	*6.0*
3356	37.4	2.45	----	2.01	4.46	*4.8*	4.18	2.69	1.38	8.25	*6.0*	6.87	*5.0*	7.62	7.62	*6.0*
3386	37.8	trace	----	1.74	1.74	*1.3*	4.21	5.08	2.61	11.90	*10.0*	9.29	*8.0*	5.80	5.80	*5.0*
3285	37.9	1.08	----	2.15	3.23	*3.0*	5.65	2.23	1.39	9.27	*8.0*	7.88	*6.0*	10.26	10.26	*10.0*
3282	38.7	----	----	1.50	1.50	*1.6*	8.40	1.55	0.63	10.58	*10.0*	9.95	*8.0*	9.04	9.58	*10.0*
3268	38.8	0.60	----	2.04	2.64	*2.5*	4.08	2.83	2.05	8.96	*8.0*	6.91	*6.0*	6.15	6.15	*5.0*
3232	40.5	0.38	----	2.53	2.91	*2.0*	2.62	4.77	3.16	10.55	*7.0*	7.39	*6.0*	3.89	5.67	*4.5*
3322	40.6	1.22	----	1.96	3.18	*2.5*	4.56	1.48	0.36	6.40	----	6.04	*5.0*	0.18	7.07	*7.0*

Special Manures, Sampled by the Station.

Station No.	Name of Brand.	Manufacturer.	Dealer.	Dealer's cash price per ton.	*Valuation per ton.*
	Sampled by Station Agent				
3126	Potato Manure	Sanderson Fertilizer & Chemical Co., New Haven	Manufacturers	**$30.00**	$21.34
3224	Bradley's Potato Fertilizer	American Agricultural Chemical Co., N. Y.	J. A. Cruff, Thompson	29.00	19.82
			C. O. Jelliff & Co., Southport	**28.00**	
3354	Bowker's Potato and Vegetable Fertilizer	Bowker Fertilizer Co., Boston	Bowker's Branch, Hartford	**32.00**	22.58
3415	Bradley's Tobacco Fertilizer	American Agricultural Chemical Co., N. Y.	C. M. Beach, New Milford	**36.00**	25.24
			D. T. Dyer, Collinsville	37.00	
			J. & H. Woodford, Avon	35.00	
3316	Bowker's Tobacco Starter	Bowker Fertilizer Co., Boston	Bowker's Branch, Hartford	**33.00**	23.10
3256	Mapes' Corn Manure	Mapes F. & P. G. Co., New York	P. J. Bolan, Waterbury	35.00	22.99
			Mapes' Branch, Hartford	**33.00**	
3383	Williams & Clark's Potato Phosphate	American Agricultural Chemical Co., N. Y.	Atwater Mills, Plantsville	37.00	21.50
			G. F. Day, South Manchester	30.00	
			D. B. Wilson, Waterbury	32.00	
				31.00	
3286	American Farmers' Corn King	American Farmers' Fertilizer Co., New York	D. C. Spencer, Saybrook	32.00	21.12
			F. H. Rolf, Guilford	29.00	
				30.50	
3228	Complete Potato and Vegetable Fertilizer	The Rogers Mfg. Co., Rockfall	J. E. Smith, Waterford	**31.00**	21.45
			Meeker Coal Co., Norwalk	31.00	
3430	Packers' Union Animal Corn Fertilizer	American Agricultural Chemical Co., N. Y.	Rockville Milling Co., Rockville	**30.00**	20.73
3314	Essex Tobacco Starter	Russia Cement Co., Gloucester, Mass.	W. J. Cox, East Hartford	**34.00**	23.48
3436	Great Eastern Northern Corn Special	American Agricultural Chemical Co., N. Y.	C. A. Sanderson, Moosup	**30.00**	20.71
3337	Baker's Complete Potato Manure	American Agricultural Chemical Co., N. Y.	Edward White, Rockville	37.00	26.03
			Saxton & Strong, Bristol	39.00	
			F. J. Hartz, Burnside	**38.00**	
3348	Wheeler's Potato Manure	American Agricultural Chemical Co., N. Y.	W. H. Baldwin, Cheshire	**29.00**	19.78
			W. O. Goodsell, Bristol	28.00	
			Balch & Platt, West Winsted	32.00	

Analyses and Valuations—*Continued.*

Station No.	Percentage difference between cost and valuation.	Nitrogen. Nitrogen as Nitrates.	Nitrogen as Ammonia.	Nitrogen Organic.	Total Nitrogen. Found.	Total Nitrogen. Guaranteed.	Phosphoric Acid. Soluble.	Reverted.	Insoluble.	Total. Found.	Total. Guaranteed.	Available. Found.	Available. Guaranteed.	Potash. Found. As Muriate.	Found. Total.	Guaranteed.
3126	40.8	0.42	....	1.51	1.93	*1.7*	4.52	5.65	2.78	12.95	*9.0*	10.17	*5.0*	5.42	5.42	*6.0*
3224	41.2	0.56	0.24	1.48	2.28	*2.1*	5.76	3.49	2.62	11.87	*10.0*	9.25	*8.0*	3.26	3.26	*3.0*
3354	41.7	0.49	....	1.93	2.42	*2.3*	6.62	4.68	0.96	12.26	*10.0*	11.30	*9.0*	4.49	4.49	*4.0*
3415	42.2	1.20	1.10	1.43	3.73	*3.3*	5.36	4.01	1.50	10.87	*9.0*	9.37	*8.0*	0.67	4.20	*4.0*
3316	42.9	0.87	....	1.71	2.58	*2.3*	7.47	2.68	2.00	12.15	*10.0*	10.15	*8.0*	0.33	4.56	*3.0*
3256	43.5	0.67	0.33	1.62	2.62	*2.5*	1.78	7.35	2.00	11.13	*10.0*	9.13	*8.0*	6.63	6.63	*6.0*
3383	44.2	0.66	....	2.09	2.75	*2.5*	3.23	4.26	2.17	9.66	*7.0*	7.49	*6.0*	5.92	5.92	*5.0*
3286	44.4	....	0.94	1.28	2.22	*2.4*	7.06	2.51	1.83	11.40	*9.5*	9.57	*8.0*	2.70	4.27	*4.0*
3228	44.5	0.35	....	2.09	2.44	*2.3*	6.37	2.82	1.75	10.94	*10.0*	9.19	*8.0*	4.91	4.91	*5.0*
3430	44.7	0.72	....	1.73	2.45	*2.5*	8.00	2.55	2.12	12.67	*11.0*	10.55	*9.0*	2.37	2.37	*2.0*
3314	44.8	1.63	....	1.35	2.98	*2.5*	5.36	5.20	2.62	13.18	*12.0*	10.56	....	0.58	3.60	*2.5*
3436	44.9	0.66	....	1.62	2.28	*2.5*	8.19	2.88	2.43	13.50	*10.0*	11.07	*8.0*	2.27	2.27	*2.0*
3337	45.9	1.20	0.30	1.76	3.26	*3.3*	4.64	2.47	1.33	8.44	*7.0*	7.11	*6.0*	10.19	10.19	*10.0*
3348	46.6	0.43	....	1.67	2.10	*2.1*	7.41	2.52	1.46	11.39	*9.0*	9.93	*8.0*	3.50	3.50	*3.0*

SPECIAL MANURES, SAMPLED BY THE STATION.

Station No.	Name of Brand.	Manufacturer.	Dealer.	Dealer's cash price per ton.	Valuation per ton.
	Sampled by Station Agent				
3384	Williams & Clark's Americus Potato Manure	American Agricultural Chemical Co., N. Y.	R. B. Witter, Brooklyn	$30.00	$19.00
			W. H. Chappell, Chesterfield	28.00	
3238	Hubbard's Potato Phosphate	The Rogers & Hubbard Co., Middletown	S. E. Frisbie, Milford	32.00	21.57
			J. H. Miner, Waterford	32.00	
			G. W. Dennison, Saybrook	32.00	
3323	Chittenden's Potato Phosphate	National Fertilizer Co., Bridgeport	E. R. Aiken, Silver Mine	32.00	21.57
			A. Y. Beach, Seymour	32.00	
			F. Hallock & Co., Derby	32.00	
			G. A. Williams, East Hartford	32.00	
3389	Quinnipiac Corn Manure	American Agricultural Chemical Co., N. Y.	C. A. Young, Danielson	28.00	18.79
3350	Stockbridge Corn Manure	Bowker Fertilizer Co., Boston	Bowker's Branch, Hartford	37.00	24.76
			C. T. Leonard, Norwalk	38.00	
3216	Essex Market Garden and Potato Manure	Russia Cement Co., Gloucester, Mass.	W. J. Cox, East Hartford	34.00	22.69
			F. S. Bidwell & Co., Windsor Locks	34.00	
3418	Read's Vegetable and Vine Fertilizer	American Agricultural Chemical Co., N. Y.	Albert Bender, Glenville	----	21.33
				32.00	
3288	American Farmers' Complete Potato Fertilizer	American Farmers' Fertilizer Co., N. Y.	D. C. Spencer, Saybrook	30.00	19.28
			F. H. Rolf, Guilford	28.00	
				29.00	
3255	Mapes' Corn Manure	Mapes F. & P. G. Co., New York	A. E. Plant,* Branford	35.00	23.13
3291	Great Eastern Vegetable, Vine and Tobacco	American Agricultural Chemical Co., N. Y.	Thomas Richmond, New Milford	33.00	21.06
			C. A. Sanderson, So. Killingly	31.00	
				32.00	
3343	Darling's Potato Manure	American Agricultural Chemical Co., N. Y.	D. E. Hickey, West Thompson	30.00	21.01
			M. D. Stanley, New Britain	34.00	
				32.00	

* Purchaser, not a dealer.

ANALYSES AND VALUATIONS—*Continued.*

Station No.	Percentage difference between cost and valuation.	Nitrogen.					Phosphoric Acid.							Potash.		
					Total Nitrogen.					Total.		Available.		Found.		
		Nitrogen as Nitrates.	Nitrogen as Ammonia.	Nitrogen Organic.	Found.	Guaranteed.	Soluble.	Reverted.	Insoluble.	Found.	Guaranteed.	Found.	Guaranteed.	As Muriate.	Total.	Guaranteed.
3384	47.4	0.64	----	1.51	2.15	*2.1*	6.16	3.01	2.09	11.26	*10.0*	9.17	*8.0*	3.14	3.14	*3.0*
3238	48.4	1.20	----	0.95	2.15	*2.0*	7.68	2.99	0.72	11.39	*10.0*	10.67	*9.0*	5.31	5.31	*5.0*
3323	48.4	0.67	----	1.44	2.11	*2.1*	7.39	2.17	1.25	10.81	*10.0*	9.56	*8.0*	6.16	6.16	*6.0*
3389	49.0	----	0.22	2.26	2.48	*2.0*	6.08	2.91	0.22	9.21	*10.0*	8.99	*8.0*	2.40	2.40	*1.5*
3350	49.4	1.13	----	2.18	3.31	*3.0*	4.90	3.01	1.43	9.34	*9.0*	7.91	*7.0*	7.57	7.57	*7.0*
3216	49.8	0.62	----	1.94	2.56	*2.0*	4.56	5.09	2.57	12.22	*10.0*	9.65	----	5.37	5.37	*5.0*
3418	50.0	0.40	0.50	1.35	2.25	*2.0*	6.72	2.65	0.74	10.11	*9.0*	9.37	*8.0*	5.47	5.65	*5.0*
3288	50.4	----	----	1.70	1.70	*1.6*	5.71	2.08	1.80	9.59	*8.5*	7.79	*7.0*	3.40	6.05	*6.0*
3255	51.3	1.02	----	1.42	2.44		3.09	6.20	1.84	11.13	----	9.29	----	7.44	7.44	----
3291	51.9	0.46	----	1.60	2.06	*2.1*	7.10	1.73	1.72	10.55	*9.0*	8.83	*8.0*	6.23	6.23	*6.0*
3343	52.3	----	0.13	2.35	2.48	*2.5*	4.18	4.61	0.10	8.89	*7.0*	8.79	*6.0*	5.52	5.52	*5.0*

Special Manures, Sampled by the Station.

Station No.	Name of Brand.	Manufacturer.	Dealer.	Dealer's cash price per ton.	Valuation per ton.
	Sampled by Station Agent				
3407	Crocker's Potato, Hop and Tobacco Phosphate	American Agricultural Chemical Co., N. Y.	F. M. Loomis, North Granby	$30.00	$19.59
			W. A. Thrall, Windsor	31.00	
			F. P. Williams, So. Coventry	30.00	
3223	Bradley's Potato Manure	American Agricultural Chemical Co., N. Y.	F. S. Bidwell & Co., Windsor Locks	32.00	21.40
			P. Schwartz, Chesterfield	34.00	
				33.00	
3336	Mapes' Fruit and Vine Manure	Mapes F. & P. G. Co., New York	P. J. Bolan, Waterbury	40.00	25.02
			Mapes' Branch, Hartford	**39.00**	
3434	Clark's Cove Potato Fertilizer	American Agricultural Chemical Co., N. Y.	J. M. Burke, South Manchester	30.00	19.19
3382*	Listers' Spl. Corn and Potato Fertilizer	Listers Agric. Chem. Works, Newark, N. J.	A. I. Martin, Wallingford	30.00	19.09
3345	Read's Practical Potato Special	American Agricultural Chemical Co., N. Y.	T. A. Tillinghast, Brooklyn	28.00	18.40
			P. McEnerny's Sons, Derby	30.00	
			C. B. Strong, Leonard Bridge	26.50	
				29.00	
3428	Pacific Potato Special	American Agricultural Chemical Co., N. Y.	J. A. Nichols & Co., Danielson	30.00	19.00
3376	Williams & Clark's Americus Corn Phosphate	American Agricultural Chemical Co, N, Y.	Lewis Ford, Norwich	30.00	17.62
			W. H. Chappell, Chesterfield	**28.00**	
3404	Crocker's Ammoniated Corn Phosphate	American Agricultural Chemical Co., N. Y.	F. P. Williams, South Coventry	29.00	18.25
3233	Quinnipiac Potato Phosphate	American Agricultural Chemical Co., N. Y.	R. B. Witter, Brooklyn	30.00	19.34
			G. M. Williams Co., New London	32.00	
				31.00	
3429	Essex Corn Fertilizer	Russia Cement Co., Gloucester, Mass.	W. J. Cox, East Hartford	33.00	19.90
3338	Berkshire Potato and Vegetable Phosphate	Berkshire Fertilizer Co., Bridgeport	F. C. Benjamin, Danbury	32.00	18.60
			J. W. Palmer, Stamford	32.00	
			Manufacturer	30.00	
				31.00	

* See page 56.

Analyses and Valuations—*Continued.*

Station No.	Percentage difference between cost and valuation.	Nitrogen: Nitrogen as Nitrates.	Nitrogen: Nitrogen as Ammonia.	Nitrogen: Nitrogen Organic.	Nitrogen: Total Nitrogen, Found.	Nitrogen: Total Nitrogen, Guaranteed.	Phosphoric Acid: Soluble.	Phosphoric Acid: Reverted.	Phosphoric Acid: Insoluble.	Phosphoric Acid: Total, Found.	Phosphoric Acid: Total, Guaranteed.	Phosphoric Acid: Available, Found.	Phosphoric Acid: Available, Guaranteed.	Potash: Found, As Muriate.	Potash: Found, Total.	Potash: Guaranteed.
3407	53.1	0.09	....	1.98	2.07	*2.1*	6.96	2.76	1.47	11.19	*9.0*	9.72	*8.0*	3.49	3.49	*3.0*
3223	54.2	0.59	....	2.23	2.82	*2.5*	3.44	3.90	1.93	9.27	*8.0*	7.34	*6.0*	5.75	5.75	*5.0*
3336	55.9	0.70	....	1.55	2.25	*1.7*	1.28	5.86	0.63	7.77	*7.0*	7.14	*5.0*	1.04	11.46	*10.0*
3434	56.3	0.37	....	1.86	2.23	*2.1*	6.14	2.82	1.40	10.36	*10.0*	8.96	*8.0*	3.48	3.48	*3.0*
3382	57.2	---	0.19	1.58	1.77	*1.7*	6.80	3.85	2.02	12.67	*9.0*	10.65	*8.0*	2.21	2.65	*3.0*
3345	57.6	....	....	1.20	1.20	*0.8*	3.60	3.45	1.27	8.32	*5.0*	7.05	*4.0*	8.64	8.64	*8.0*
3428	57.9	0.66	....	1.32	1.98	*2.1*	6.90	2.56	2.14	11.60	*10.0*	9.46	*8.0*	3.37	3.37	*3.0*
3376	58.9	0.60	....	1.55	2.15	*2.1*	5.02	4.22	1.70	10.94	*10.0*	9.24	*8.0*	1.74	1.74	*1.5*
3404	58.9	0.37	....	1.92	2.29	*2.1*	5.12	3.99	2.28	11.39	*10.0*	9.11	*8.0*	1.70	1.70	*1.5*
3233	60.3	0.65	....	1.49	2.14	*2.1*	6.59	2.51	2.54	11.64	*10.0*	9.10	*8.0*	3.39	3.39	*3.0*
3429	65.8	0.40	---	1.90	2.30	*2.0*	4.08	5.52	3.13	12.73	*11.0*	9.60	....	2.82	2.82	*3.0*
3338	66.7	....	....	1.83	1.83	*1.7*	4.56	2.60	2.50	9.66	*8.0*	7.16	*6.0*	0.40	4.90	*4.0*

SPECIAL MANURES, SAMPLED BY THE STATION.

Station No.	Name of Brand.	Manufacturer.	Dealer.	Dealer's cash price per ton.	Valuation per ton.
	Sampled by Station Agent				
3200	Bradley's Corn Phosphate	American Agricultural Chemical Co., N. Y.	P. Schwartz, Chesterfield	$32.00	$17.98
			J. A. Cruff, Thompson	28.00	
				30.00	
3431	Packers' Union Wheat, Oats and Clover	American Agricultural Chemical Co., N. Y.	Rockville Milling Co., Rockville	22.00	13.12
3461	Swift's Lowell Potato Manure	Lowell Fertilizer Co., Boston, Mass.	A. S. Bennett, Cheshire	30.00	17.77
			W. H. Scott & Co., Pequabuck	30.00	
			Standard Feed Co., Bridgeport	30.00	
3372	Wheeler' Corn Fertilizer	American Agricultural Chemical Co., N. Y.	W. O. Goodsell, Bristol	29.00	18.00
			John Bransfield, Portland	32.00	
				30.50	
3239	Hubbard's Corn Phosphate	The Rogers & Hubbard Co., Middletown	A. J. Fuller, Danbury	32.00	17.09
			S. E. Frisbie, Milford	30.00	
			F. S. Bidwell & Co., Windsor Locks	26.00	
				29.00	
3339	Great Eastern Grass and Oats Fertilizer	American Agricultural Chemical Co., N. Y.	Thos. Richmond, New Milford	25.00	13.61
			H. S. Harvey, Windham	24.00	
3462	Wheeler's Grass and Oats	American Agricultural Chemical Co., N. Y.	Wm. B. Ives, Wallingford	24.00	13.61
3352	Bowker's Corn Phosphate	Bowker Fertilizer Co., Boston	G. F. Walters, Guilford	30.00	16.18
			S. E. Brown, Collinsville	34.00	
3303	Bowker's Potato Phosphate	Bowker Fertilizer Co., Boston	G. F. Walters, Guilford	32.00	16.60
			Lightbourn & Pond Co., New Haven	33.00	
			A. C. Rogers & Co., New London	35.00	
3370	Essex Odorless Lawn Dressing	Russia Cement Co., Gloucester, Mass.	W. J. Cox, East Hartford	----	29.42
	Sampled by Purchasers.				
3334	Sanderson's Formula B for Tobacco	Sanderson Fertilizer & Chemical Co, New Haven	Manufacturer	35.00	26.23
3398	Read's Potato Manure	American Agricultural Chemical Co, N. Y.	Manufacturer	31.00	24.15

ANALYSES AND VALUATIONS—*Continued.*

Station No.	Percentage difference between cost and valuation.	Nitrogen. Nitrogen as Nitrates.	Nitrogen as Ammonia.	Nitrogen Organic.	Total Nitrogen. Found.	Total Nitrogen. Guaranteed.	Phosphoric Acid. Soluble.	Reverted.	Insoluble.	Total. Found.	Total. Guaranteed.	Available. Found.	Available. Guaranteed.	Potash. Found. As Muriate.	Found. Total.	Guaranteed.
3200	66.8	0.50	----	1.81	2.31	*2.0*	5.81	2.84	2.16	10.81	*10.0*	8.65	*8.0*	1.84	1.84	*1.5*
3431	67.7	----	----	----	----	----	6.88	4.01	1.07	11.96	*12.0*	10.89	*11.0*	2.59	2.59	*2.0*
3461	68.8	----	----	2.02	2.02	*1.6*	5.36	1.92	1.01	8.29	*8.0*	7.28	*7.0*	4.49	4.49	*4.0*
3372	69.4	----	----	1.87	1.87	*1.7*	7.20	2.63	1.04	10.87	*9.0*	9.83	*8.0*	2.39	2.39	*2.0*
3239	69.7	0.38	----	0.76	1.14	*1.0*	7.12	3.27	0.94	11.33	*10.0*	10.39	*8.0*	3.72	3.72	*3.0*
3339	76.3	----	----	----	----	----	8.40	3.05	1.34	12.79	*12.0*	11.45	*11.0*	2.26	2.26	*2.0*
3462	76.3	----	----	----	----	----	9.04	3.02	0.44	12.50	*12.0*	12.06	*11.0*	1.96	1.96	*2.0*
3352	85.4	0.26	----	1.36	1.62	*1.5*	5.36	3.75	1.42	10.53	*10.0*	9.11	*8.0*	2.10	2.10	*2.0*
3303	92.8	0.23	----	1.47	1.70	*1.5*	5.34	3.56	1.95	10.85	*11.0*	8.90	*9.0*	2.28	2.28	*2.0*
3370		----	4.00	0.22	4.22	*3.1*	3.68	3.26	3.01	9.95	*8.0*	6.94	----	0.88	7.84	*7.0*
3334	33.4	1.05	----	2.95	4.00	*3.3*	2.50	4.79	2.24	9.53	*8.0*	7.29	*6.0*	0.85	6.27	*6.0*
3398	28.3	0.64	0.84	1.29	2.77	*2.5*	3.36	3.77	1.16	8.29	----	7.13	*6.0*	9.70	9.70	*10.0*

3136, 3278, 3279, 3309, and **3332,** Bowker's Tobacco Ash Elements; made by Bowker Fertilizer Co., Boston, Mass.

3136. Sampled by O. J. Hazard, Suffield, from stock of Seth Viets, West Suffield.

3278. Sampled by A. F. Austin, Suffield, from stock of Seth Viets, West Suffield.

3279. Sampled by Station Agent from stock of Bowker's Branch, Hartford.

3309. Sampled by E. N. Austin, Suffield, from stock of Bowker Fertilizer Co.

3332. Sampled by T. C. Austin & Sons, from stock of Seth Viets, West Suffield.

3357. Bowker's Tobacco Ash Fertilizer; made by Bowker Fertilizer Co., Boston; sampled by Station agent, from stock of Bowker's Branch, Hartford.

3301. Mapes' Tobacco Starter Improved. Made by Mapes F. & P. G. Co., New York City; sampled by Station agent from stock of Manchester Elevator Co., Manchester, and of John Bransfield, Portland.

3319. O. & W. Complete Tobacco Fertilizer; made by Olds & Whipple, Hartford; sampled by Station agent, from stock of manufacturer.

3408. Carbonate of Potash Tobacco Starter; made by A. Pouleur, Windsor; sampled by Station agent, from stock of manufacturer.

ANALYSES OF BRANDS CLAIMED TO CONTAIN POTASH IN FORM OF CARBONATE OR NITRATE.

	3136	3278	3279	3309	3332	3357	3301	3319	3408
Nitrogen as nitrates	----	----	----	----	----	3.35	2.12	----	1.01
" " ammonia	----	----	----	----	----	----	0.32	----	----
" organic	----	----	----	----	----	0.52	2.09	5.07	2.51
" total	----	----	----	----	----	3.87	4.53	5.07	3.52
" guaranteed	----	----	----	----	----	*3.0*	*4.12*	*5.5*	*2.5*
Phosphoric acid, soluble	0.76	1.36	1.12	0.88	0.48	0.27	2.48	none	none
" " reverted	6.58	6.81	6.43	7.39	7.81	4.77	4.96	2.28	9.02
" " insoluble	3.12	0.72	1.23	2.28	3.48	5.96	1.77	0.53	1.73
" " total	10.46	8.89	8.78	10.55	11.77	11.00	9.21	2.81	10.75
" " guaranteed	----	----	----	----	----	----	*8.0*	----	*8.0*
Available phos. acid found	7.34	8.17	7.55	8.27	8.29	5.04	7.44	2.28	9.02
" phos. acid guarant'd	*6.0*	*6.0*	*6.0*	*6.0*	*6.0*	*5.0*	*6.0*	*3.0*	----
Potash as muriate	0.78	0.17	0.33	0.38	0.40	0.63	0 33	0.42	1.05
" total	14.86	16.25	15.77	15.14	15.00	13.73	2.19	5.47	15.65
" guaranteed	*15.0*	*15.0*	*15.0*	*15.0*	*15.0*	*13.0*	*1.0*	*5.5*	*14.0*
Cost per ton	$30.00	30.00	30.00	30.00	30.00	40.00	36.00	32.00	50.00
Valuation per ton*	29.03	31.23	30.07	30.16	30.41	37 51	24.32	26.16	41.73

* Assuming all potash, other than muriate, to be in form of nitrate or carbonate, valued at 7¼ cents per pound. See page 57.

In a following table, pages 74 and 75, the different brands of Tobacco Starters, Tobacco Manures, Potato Manures and Corn Manures are tabulated by themselves.

This table serves to show the ideas of different manufacturers as to what is required to make a "special" corn, tobacco, or potato fertilizer.

It is quite clear at a glance that these ideas are not by any means unanimous. Thus, we have tobacco manures containing no nitrates, others in which more than one-half of the nitrogen is in that form. Most of them contain relatively little muriate; in others a half, and in still others, all of the potash is in that form.

The Special Potato Manures contain all the way from 1.5 to 5.1 per cent. of nitrogen and from 2¼ to 10¼ per cent. of potash. In some cases the latter is chiefly in form of sulphate; in other cases it is all as muriate.

HOME MIXTURES.

In a following table, pages 76 and 77, are given analyses of thirteen home-mixed fertilizers. The samples analyzed were, for the most part, drawn and sent by the persons who made the mixtures. With the analyses are given, wherever it is known, the formulas by which the fertilizers were made.

The average cost of these fertilizers per ton, calculated from the table, is $27.82, and the valuation, $27.12. It is not known in all cases whether "cost" covers more than cost of the raw materials. Assuming that it does not, in any case, and allowing $3.00 per ton (an excessive amount) for the cost of mixing and bagging, the average cost of the goods mixed has been $30.82, and the percentage difference between cost and valuation, 14.0 per cent., much lower than in the average of factory-mixed goods.

The mechanical condition of these mixtures is also, in most cases, all that could be desired. The statement made by interested parties, that a proper mixture of the ingredients in a fertilizer can only be made by the use of mixing machinery, is absurd.

Percentage Composition of Tobacco, Potato and Corn Manures.

	Nitrogen as Nitrates.	Nitrogen as Ammonia.	Nitrogen Organic.	Total Nitrogen.	Soluble Phosphoric Acid.	Reverted Phosphoric Acid.	Insoluble Phosphoric Acid.	Total Phosphoric Acid.	Potash as Muriate.	Total Potash.	Cost.	Percentage difference between cost and valuation.
Tobacco Starters.												
Bowker's	0.87	---	1.71	2.58	7.47	2.68	2.00	12.15	0.33	4.56	$33.00	42.9
Russia Cement Co.'s	1.63	---	1.35	2.98	5.36	5.20	2.62	13.18	0.58	3.60	34.00	44.8
Mapes'	2.12	0.32	2.09	4.53	2.48	4.96	1.77	9.21	0.33	2.19	36.00	53.3
Tobacco Manures.												
Sanderson's	0.33	0.57	3.10	4.00	2.46	5.24	1.99	9.79	1.04	6.07	32.00	19.9
Russia Cement Co.'s	1.91	---	3.24	5.15	5.41	2.61	0.36	8.38	0.54	12.95	44.00	20.6
Darling's	---	2.26	1.89	4.15	3.30	3.19	0.14	6.63	1.42	10.78	37.00	22.1
National Fertilizer Co.'s	0.63	---	4.64	5.27	3.84	2.69	1.08	7.61	1.22	11.02	42.00	23.0
Hubbard's	2.79	0.20	2.15	5.14	0.93	7.10	3.41	11.44	----	10.24	44.00	28.4
Mapes'	3.89	0.68	1.91	6.48	---	4.89	1.06	5.95	1.06	11.06	45.00	28.7
Wheeler's	0.71	0.36	1.70	2.77	5.28	2.51	1.34	9.13	5.11	10.41	34.00	29.0
Rogers Mfg. Co.'s	2.38	---	2.48	4.86	1.52	5.52	2.18	9.22	1.08	11.16	44.00	33.5
Stockbridge's	2.70	---	2.77	5.47	3.82	3.22	0.83	7.87	1.60	9.74	44.00	33.5
Rogers Mfg. Co.'s	0.35	0.18	3.12	3.65	1.84	6.73	1.54	10.11	1.02	9.39	40.00	36.5
Bradley's	1.20	1.10	1.43	3.73	5.36	4.01	1.50	10.87	4.20	4.20	36.00	45.7
Potato Manures.												
Shoemaker's	0.94	---	1.80	2.74	6.96	5.24	2.08	14.28	7.32	7.32	33.00	21.7
Shay's	0.71	---	2.29	3.00	6.37	3.57	1.83	11.77	5.45	5.45	30.00	23.7
Russia Cement Co.'s	0.58	0.60	2.94	4.12	4.56	4.99	1.07	10.62	0.60	9.06	39.00	23.9
Listers'	0.31	1.40	1.63	3.34	7.44	2.04	1.65	11.13	5.37	6.52	33.00	25.2
Hubbard's	2.70	0.22	2.13	5.05	1.04	7.03	3.12	11.19	1.01	6.41	38.50	28.4
Bradley's	1.04	0.33	1.91	3.28	5.28	3.98	1.23	10.49	7.17	7.17	33.00	29.1
Mapes'	1.72	0.28	1.85	3.85	3.04	6.25	1.20	10.49	0.94	7.93	37.00	29.4
Mapes'	1.49	0.30	1.87	3.66	1.04	4.68	1.38	7.10	1.06	9.15	34.00	31.1
Bowker's	1.30	---	2.00	3.30	5.76	2.48	1.23	9.47	7.58	7.58	34.00	36.2
Packers' Union's	0.54	---	1.76	2.30	6.85	2.28	1.56	10.69	6.13	6.13	30.00	37.2
Lowell's	---	---	2.86	2.86	6.48	2.07	1.31	9.86	0.46	6.07	33.00	37.4
Stockbridge's	1.08	---	2.15	3.23	5.65	2.23	1.39	9.27	10.26	10.26	37.00	37.9
Armour's	---	---	1.50	1.50	8.40	1.55	0.63	10.58	9.04	9.58	32.00	38.7
Quinnipiac's	0.60	---	2.04	2.64	4.08	2.83	2.05	8.96	6.15	6.15	29.00	38.8
Wilcox's	0.38	---	2.53	2.91	2.62	4.77	3.16	10.55	3.89	5.67	29.00	40.5
Olds & Whipple's	1.22	---	1.96	3.18	4.56	1.48	0.36	6.40	0.18	7.07	32.00	40.6
Sanderson's	0.42	---	1.51	1.93	4.52	5.65	2.78	12.95	5.42	5.42	30.00	40.8
Bradley's	0.56	0.24	1.48	2.28	5.76	3.49	2.62	11.87	3.26	3.26	28.00	41.2
Bowker's	0.49	---	1.93	2.42	6.62	4.68	0.96	12.26	4.49	4.49	32.00	41.7
Williams & Clark's	0.66	---	2.09	2.75	3.23	4.26	2.17	9.66	5.92	5.92	31.00	44.2
Rogers Mfg. Co.'s	0.35	---	2.09	2.44	6.37	2.82	1.75	10.94	4.91	4.91	31.00	44.5
Baker's	1.20	0.30	1.76	3.26	4.64	2.47	1.33	8.44	10.19	10.19	38.00	45.9
Wheeler's	0.43	---	1.67	2.10	7.41	2.52	1.46	11.39	3.50	3.50	29.00	46.6
Williams & Clark's	0.64	---	1.51	2.15	6.16	3.01	2.09	11.26	3.14	3.14	28.00	47.4
Hubbard's	1.20	---	0.95	2.15	7.68	2.99	0.72	11.39	5.31	5.31	32.00	48.4
National Fertilizer Co.'s	0.67	---	1.44	2.11	7.39	2.17	1.25	10.81	6.16	6.16	32.00	48.4
American Farmers'	---	---	1.70	1.70	5.71	2.08	1.80	9.59	3.40	6.05	29.00	50.4
Darling's	---	0.13	2.35	2.48	4.18	4.61	0.10	8.89	5.52	5.52	32.00	52.3
Bradley's	0.59	---	2.23	2.82	3.44	3.90	1.93	9.27	5.75	5.75	33.00	54.2

Composition of Tobacco, Potato and Corn Manures—*Continued.*

	Nitrogen as Nitrates.	Nitrogen as Ammonia.	Nitrogen, Organic.	Total Nitrogen.	Soluble Phosphoric Acid.	Reverted Phosphoric Acid.	Insoluble Phosphoric Acid.	Total Phosphoric Acid.	Potash as Muriate.	Total Potash.	Cost.	Percentage difference between cost and valuation.
Potato Manures continued.												
Clark's Cove's	0.37	---	1.86	2.23	6.14	2.82	1.40	10.36	3.48	3.48	$30.00	56.3
Read's	---	---	1.20	1.20	3.60	3.45	1.27	8.32	8.64	8.64	29.00	57.6
Pacific's	0.66	---	1.32	1.98	6.90	2.56	2.14	11.60	3.37	3.37	30.00	57.9
Quinnipiac's	0.65	---	1.49	2.14	6.59	2.51	2.54	11.64	3.39	3.39	31.00	60.3
Berkshire's	---	---	1.83	1.83	4.56	2.60	2.50	9.66	0.40	4.90	31.00	66.7
Lowell's	---	---	2.02	2.02	5.36	1.92	1.01	8.29	4.49	4.49	30.00	68.8
Bowker's	0.23	---	1.47	1.70	5.34	3.56	1.95	10.85	2.28	2.28	32.00	92.8
Corn Manures.												
Mapes'	0.67	0.33	1.62	2.62	1.78	7.35	2.00	11.13	6.63	6.63	33.00	43.5
American Farmers'	---	0.94	1.28	2.22	7.06	2.51	1.83	11.40	2.70	4.27	30.50	44.4
Packers' Union's	0.72	---	1.73	2.45	8.00	2.55	2.12	12.67	2.37	2.37	30.00	44.7
Great Eastern's	0.66	---	1.62	2.28	8.19	2.88	2.43	13.50	2.27	2.27	30.00	44.9
Quinnipiac's	--	0.22	2.26	2.48	6.08	2.91	0.22	9.21	2.40	2.40	28.00	49.0
Stockbridge's	1.13	---	2.18	3.31	4.90	3.01	1.43	9.34	7.57	7.57	37.00	49.4
Mapes'	1.02	---	1.42	2.44	3.09	6.20	1.84	11.13	7.44	7.44	35.00	51.3
Williams & Clark's	0.60	---	1.55	2.15	5.02	4.22	1.70	10.94	1.74	1.74	28.00	58.9
Crocker's	0.37	---	1.92	2.29	5.12	3.99	2.28	11.39	1.70	1.70	29.00	58.9
Russia Cement Co.'s	0.40	---	1.90	2.30	4.08	5.52	3.13	12.73	2.82	2.82	33.00	65.8
Bradley's	0.50	---	1.81	2.31	5.81	2.84	2.16	10.81	1.84	1.84	30.00	66.8
Wheeler's	---	---	1.87	1.87	7.20	2.63	1.04	10.87	2.39	2.39	30.50	69.4
Hubbard's	0.38	---	0.76	1.14	7.12	3.27	0.94	11.33	3.72	3.72	29.00	69.7
Bowker's	0.26	---	1.36	1.62	5.36	3.75	1.42	10.53	2.10	2.10	30.00	85.4

MISCELLANEOUS FERTILIZERS AND MANURES.

COTTON HULL ASHES.

In the table, pages 78 and 79, are given analyses of twenty-six samples of cotton hull ashes, which are extensively used as a source of potash for fertilizing tobacco in the Connecticut River Valley, where "Connecticut Havana Wrapper Leaf" is raised, and which have proved to be an invaluable fertilizer.

The analyses show the usual wide range of composition.

The highest percentage of water-soluble potash is 31.04, the lowest 15.02, and the average of twenty-six samples 24.09 per cent., a considerably higher average than last year.

Allowing 4½, 4 and 2 cents per pound for water-soluble, citrate-soluble and insoluble phosphoric acid, the cost of water-soluble potash in cotton hull ashes has ranged from 9 to 5.3 cents per pound and has averaged 7.2 cents, three-tenths of a cent less per pound than last year.

Home Mixtures. Formulas, Analyses and Valuations.

Station No.	Made by	Formulas. Pounds per ton: Nitrate of Soda.	Sulphate of Ammonia.	Dried Blood.	Cotton Seed Meal.	Tankage.	Pulverized Bone and Meat.	Ground Bone.	Dry Ground Fish.	Acid Phosphate.
3250	J. E. Griffiths, Sterling	670	---	21	---	---	---	---	---	1224
3251	" " "	156	---	260	---	---	---	---	---	1292
3089	S. D. Woodruff & Sons, Orange	100	---	---	---	800	---	---	---	800
3254	E. R. Kelsey, for A. E. Plant, Branford	---	---	---	---	---	---	---	---	----
3401	W. B. Ives, Wallingford	----	---	---	---	---	---	700	---	600
3400	Connecticut School for Boys, Meriden	100	---	---	---	750	---	---	---	750
3399	" " " "	500	---	---	---	500	---	---	---	400
3263	J. G. Schwink, Meriden	100	---	---	---	750	---	---	---	750
3420	F. H. Woodruff, Milford	150	---	---	---	800	---	---	---	800
3253		1000	---	---	---	---	---	400	---	400
3333	C. H. Wells, Suffield	----	100	---	300	---	640	---	60	----
3139	Barnes Bros., Yalesville	----	---	---	---	---	---	---	---	----
3138	" " "	150	---	---	---	---	---	---	850	800

Station No.	Of Mixture: Dissolved Bone Black.	High Grade Sulphate of Potash.	Double Sulphate Potash and Magnesia.	Muriate of Potash.	Kainit.	Analyses: Nitrogen as Nitrates.	Organic Nitrogen.	Total Nitrogen.	Soluble Phosphoric Acid.	Reverted Phosphoric Acid.	Insoluble Phosphoric Acid.	Total Phosphoric Acid.	Potash.	Cost (Unmixed) and Valuation: Cost per ton.	Valuation per ton.	Percentage difference between Cost and Valuation.
3250	---	---	---	85	---	5.19	0.25	5.44	6.34	2.00	0.36	8.70	3.00	$23.06	$26.16	11.8*
3251	---	292	---	---	---	0.99	2.24	3.23	8.40	0.54	0.40	9.34	7.49	24.48	26.42	7.3*
3089	---	---	---	300	---	1.75	1.15	2.90	3.22	6.91	2.54	12.67	8.69	26.00	26.43	1.6*
3254	---	---	---	---	---	----	3.00	3.50†	2.32	2.86	0.67	5.85	10.98	26.00	25.74	1.0
3401	---	---	---	700	---	----	1.39	1.39	3.20	7.50	1.41	12.11	16.96	30.00	29.38	2.1
3400	---	---	200	200	---	0.75	2.24	2.99	4.64	3.38	1.33	9.35	7.76	25.00	24.24	3.1
3399	---	---	---	250	350	3.49	1.46	4.95	2.72	2.24	0.62	5.58	8.88	28.50	26.98	5.6
3263	---	---	200	200	---	0.90	1.99	2.89	4.22	2.69	1.79	8.70	8.04	25.00	23.28	7.4
3420	---	---	---	250	---	0.71	2.51	3.22	3.28	3.96	1.52	8.76	7.74	26.00	24.05	8.1
3253	---	---	---	200	---	7.52	0.62	8.14	2.88	0.94	3.66	7.48	5.80	36.00	33.16	8.6
3333	450	450	---	---	---	0.73	3.09	3.82	1.23	5.06	2.28	8.57	13.93	35.96	32.49	10.7
3139	---	---	---	---	---	----	3.43	3.43	4.03	4.23	1.53	9.79	9.58	----	27.57	---
3138	---	---	---	200	---	1.09	4.02	5.11	3.68	4.11	1.70	9.49	4.13	----	27.48	---

* Valuation exceeds cost.
† 0.50 per cent. of nitrogen as ammonia.

Solubility of the Potash.

In each sample of cotton hull ashes were determined both the total percentage of potash present and also the potash soluble in boiling water. The percentage of potash insoluble in water was found to range from 4.73 to 0.26 per cent., and on the average the samples contained, in addition to the water-soluble potash, the percentage of which is given in the following table, 2.26 per cent. of potash insoluble in water, but soluble in strong acid.

The Percentages of Chlorine and Sulphuric Acid Normally Present in Cotton Hull Ashes.

In view of the fact that both muriate and sulphate of potash have been used in the preparation of spurious cotton hull ashes, both chlorine and sulphuric acid were determined in sixteen of the samples whose analyses appear in the table. The percentage of chlorine was found to range from almost nothing to 2.26, and to average 0.85. The percentage of sulphuric acid ranged from nothing to 3.65, and averaged 2.82. These figures agree substantially with others obtained in previous years and no

doubt fairly represent the percentages which are found in genuine cotton hull ashes. If so-called cotton hull ashes contain very much larger percentages of chlorine or of sulphuric acid than are given above, it is quite certain that they are spurious and have been prepared by the use of muriate or sulphate of potash.

Spurious Cotton Hull Ashes.

3346. Sampled by G. A. Douglass, Thompsonville, from stock of H. K. Brainard, Thompsonville; sold to H. K. Brainard by Olds & Whipple, Hartford.

Of this sample Messrs. Olds & Whipple wrote:

"Regarding the ashes shipped to Thompsonville, Conn., to H. K. Brainard, sold by him to Mr. Douglass, would say this car contained 18 tons and the ashes were purchased by us from a broker in Houston. In this connection would say we have used unusual care this season to have nearly all cars of ashes we have purchased, analyzed, to see if they were up to guarantee and pure ashes. This car in question was received by us via boat at Hartford and rushed off to Thompsonville at the first possible moment, as the car was overdue and Mr. Brain-

Cotton Hull Ashes.

Station No.	Dealer or Purchaser.	Sampled by
3108	The Bissell, Graves Co., Suffield	Dealers
3066	Olds & Whipple, Hartford	E. P. Brewer, Silver Lane
3185	Loomis Brothers, Granby	Alfred H. Griffin, Granby
3018	Spencer Bros., Suffield	C. D. Woodworth, Thompsonville
3109	The Bissell, Graves Co., Suffield	Dealers
3095	Olds & Whipple, Hartford	Geo. Watson, Warehouse Point
3077	C. M. Beach, New Milford	E. A. Wildman, New Milford
3150	W. S. Pinney, Suffield	W. H. Prout, Suffield
3324	Olds & Whipple, Hartford	Seth Alden, Thompsonville
3273	The Sanderson Fertilizer & Chemical Co., New Haven	A. C. Russell & Son, Suffield
3142	J. C. Eddy, Simsbury	M. Doughney, Windsor Locks
3306	Arthur Sikes, Suffield	Wm. C. Vietts, Thompsonville
3211		Willard E. Treat, Silver Lane
3272	Arthur Sikes, Suffield	A. C. Russell & Son, Suffield
3474	Olds & Whipple, Hartford	Olin Wheeler, Buckland
3327	Arthur Sikes, Mapleton	Edward Austin, Mapleton
3325	" " "	E. B. Loomis, Suffield
3331	" " "	Chas. H. Wells, Suffield
3107	W. S. Pinney, Suffield	Dexter A. Woodworth, Suffield
3328	Arthur Sikes, Suffield	Ralph E. Moody, Thompsonville
3135	J. C. Eddy, Simsbury	E. S. Seymour, Windsor Locks
3363	Loomis Bros., Granby	D. A. Merriam, Granby
*3318	Olds & Whipple, Hartford	Station Agent
3362	A. N. Graves, Suffield	E. N. Austin, Suffield
3079	Arthur Sikes, Mapleton	The Bissell, Graves Co., Suffield
3987	Olds & Whipple, Hartford	Olin Wheeler, Buckland

ard's customers were in a great hurry for same and car was not sampled at Hartford or analyzed by us. We regret exceedingly this car should be anything but pure ashes. Regarding any future shipments of these goods, we shall take special care to try and determine that they are strictly pure ashes, but we do not think there is another car that could have passed us with this exception, but what were as represented."

3391. Sampled and sent by W. W. Thompson, Warehouse Point, from stock of Arthur Sikes, Suffield, who bought them of J. C. Eddy, Simsbury, agent for Olds & Whipple, of Hartford. Messrs. Olds & Whipple wrote that these ashes, sent by Mr. Thompson, were from a few tons left over of the same lot and from the same source as those represented by sample **3346**.

*"Vegetable Potash and Phosphoric Acid."

Percentage Composition.

Station No.	Soluble Phosphoric Acid.	Reverted Phosphoric Acid.	Insoluble Phosphoric Acid.	Total Phosphoric Acid.	Potash Soluble in Water.	Cost per ton.	Potash costs cents per pound.
3108	1.48	5.99	0.27	7.74	31.04	$40.00	5.3
3066	1.33	5.48	0.35	7.16	29.34	43.00	6.2
3185	1.44	10.39	0.54	12.37	21.10	39.00	6.6
3018	0.43	8.04	0.65	9.12	23.68	40.00	6.8
3109	0.36	4.99	0.96	6.31	22.34	36.00	6.9
3095	1.70	9.24	0.70	11.64	23.01	42.00	6.9
3077	1.15	7.34	0.80	9.29	19.50	35.00	6.9
3150	0.60	6.23	0.40	7.23	27.91	45.00	6.9
3324	0.64	6.25	0.89	7.78	25.39	42.00	7.0
3273	0.24	6.35	0.64	7.23	26.38	43.00	7.0
3142	0.16	5.57	0.54	6.27	27.00	43.00	7.0
3306	none	5.77	0.63	6.40	26.74	43.00	7.0
3211	none	5.21	0.57	5.78	27.10	43.00	7.0
3272	trace	5.50	0.64	6.14	26.62	43.00	7.1
3474	0.48	6.66	0.92	8.06	21.84	38.00	7.1
3327	none	5.64	0.72	6.36	26.19	43.00	7.2
3325	none	5.07	0.94	6.01	25.95	43.00	7.3
3331	0.08	5.49	0.63	6.20	25.68	43.00	7.3
3107	0.03	5.09	0.80	5.92	25.99	45.00	7.7
3328	none	5.26	0.75	6.01	24.59	43.00	7.7
3135	0.08	6.07	0.76	6.91	24.00	43.00	7.7
3363	0.88	4.96	0.94	6.78	21.43	39.00	7.8
3318	0.82	6.72	2.32	9.86	15.02	32.00	8.1
3362	none	2.19	0.37	2.56	24.89	43.00	8.2
3079	0.62	6.28	1.01	7.91	17.68	38.50	9.0
3987	1.04	4.81	0.86	6.71	18.65	....	...

3414. Sampled and sent by Geo. Poole, Thompsonville, from stock bought of G. S. Parsons, who, in turn, bought it of S. D. Viets, 18 Harrison Avenue, Springfield, Mass.

Analyses.

	3346	3391	3414
Phosphoric acid water-soluble	none	0.48	none
" " citrate-soluble	2.95	5.68	4.71
" " insoluble	0.77	0.36	1.37
" " total	3.72	6.52	6.08
Potash soluble in acid	27.60	25.82	23 00
" " " water	26.01	24.92	21.00
Chlorine	1.10	1.82	1.92
Sulphuric acid	16.41	16.65	12 36

Regarding the percentages of potash alone, it is seen that one of these samples has the same as genuine ashes of average quality, and two of them have a considerably higher percentage. The percentages of chlorine are not unusually large, and prove that no considerable quantity of muriate of potash is in the materials. But the percentages of sulphuric acid demonstrate that these are not genuine ashes. As has been said above, cotton hull ashes contain on the average 2.82 per cent. of sulphuric acid and may contain as much as 3.65 per cent. In sample **3346**, even allowing 3.65 per cent. of sulphuric acid as belonging to genuine ashes, there yet remains an excess of about 12¾ per cent. of sulphuric acid, indicating an admixture of *at least* 30 per cent. of potash salts.

By this fraud the purchaser is given sulphate of potash, instead of carbonate of potash, and actual potash in form of sulphate is sold to him for 7.3 cents per pound, whereas the market price is only five cents per pound.

It should be said that we see no reason to believe that the Connecticut dealers knew of the fraud which was being practiced, any more than did the purchaser of the ashes before he received the report of this Station on them. The mixing was probably done at the South. These spurious ashes are not different in appearance from the genuine.

To illustrate more clearly the differences between the composition of genuine cotton hull ashes and the spurious article, there is given an analysis of a sample of genuine cotton hull ashes, taken from the Report of this Station for 1890, page 68, and with it the detailed analysis of one of these "ashes" just referred to.

	Genuine Ashes.	Spurious Ashes.
Potash	27.85	27.60
Soda	1.30	1.54
Lime	5.23	9.68
Magnesia	11.24	5.19
Oxide of iron and alumina	1.64	2.20
Phosphoric acid	9.81	3.72
Sulphuric acid	2.41	16.41
Carbonic acid	11.59	4.58
Chlorine	0.21	1.10
Silica and sand	9.50	21.64
Water and charcoal by difference	19.22	6.34
	100.00	100.00

The particularly striking differences are these: The spurious article contains much more lime and less magnesia than the genuine; much less phosphoric acid and a large excess of sulphuric acid, as well as of sand.

TOBACCO STEMS.

Four samples of stems have been analyzed with the following results:—

3067. Ground Tobacco Stems; sold by Olds & Whipple, Hartford; sampled and sent by E. P. Brewer, Silver Lane.

3082. Broken Tobacco Stems, **3083**, Whole Tobacco Stems; sent by A. E. Hayes, Windsorville.

3134. Ground Tobacco Stems; sampled and sent by W. I. Lobdell, Stratford.

Analyses.

	3067	3082	3083	3134
Nitrogen	2.79	1.27	2.13	2.76
Phosphoric acid	1.39	0.30	0.45	0.88
Potash	10.40	5.46	5.08	9.49
Cost per ton	$22.00	11.50	13.00	20.00
Potash costs cents per pound	**5.7**	**6.6**	**5.7**	**5.5**

Allowing 16 cents and 4 cents per pound for nitrogen and phosphoric acid respectively, the potash in these samples ranges in cost from 5.5 cents to 6.6 cents per pound.

Wood Ashes.

In the table on page 82 are given twenty-four analyses of "Canada Hard Wood Ashes." Three of the samples, at least, **3098**, **3307** and **3046**, are not genuine hard wood ashes free from admixture with sand or other adulterants. **3046** certainly contains a large amount of sand and soil which were introduced either by carelessness or fraud. Samples **2847** and **3149** also contain much more sand than they should.

The total percentage of potash in these 24 samples ranges from 8.37 to 2.34, the average being 5.2. The average percentage of water-soluble potash is 4.6. The average percentages of phosphoric acid and of lime are 1.4 and 35.9 respectively. These are about the same average figures as were found last

Wood Ashes and Lime-Kiln Ashes.

Analyses and Valuations.

Station No.	Dealer or Purchaser.	Sampled or sent by	Potash Soluble in Acid.	Potash Soluble in Water.	Phosphoric Acid.	Lime, Calcium Oxide.	Magnesia.	Carbonic Acid.	Sand and Soil.	Charcoal.	Cost per ton.
	Wood Ashes.										
3063	E. N. Austin, Suffield	E. N. Austin, Suffield	3.40	2.96	1.88	30.40	3.42	22.48	3.37	5.73	$9.00
3096	" " "	" " "	4.42	3.82	1.97	32.98	3.02	24.02	3.24	4.69	9.00
3098	" " "	" " "	2.34	1.74	0.83	50.48	1.27	26.28	1.50	0.84	7.50
3103	" " "	Joseph Amstead, Windsor Locks	3.28	3.18	0.77	45.65	1.35	32.08	2.71	0.91	---
3307	" " "	E. N. Austin, Suffield	2.54	2.54	0.83	45.92	1.46	28.64	1.28	1.90	7.50
2847	Bowker Fertilizer Co., Boston	J. Norris Barnes, Yalesville	3.46	2.73	1.19	36.06	2.40	22.27	14.39	1.70	9.00
2848	" " " "	" " "	4.73	4.25	1.27	36.94	2.08	21.32	10.18	1.04	9.00
3100	" " " "	E. N. Austin, Suffield	6.16	4.98	1.33	34.84	2.47	24.09	8.41	1.49	9.50
3140	" " " "	Barnes Bros., Yalesville	8.03	6.20	2.20	35.64	2.98	20.81	8.10	1.36	---
3141	" " " "	Walter Fawthrop, Cromwell	6.88	5.02	1.41	31.84	2.52	19.71	5.24	1.52	9.00
3167	" " " "	Lightbourn & Pond Co., New Haven	6.89	5.88	2.17	31.80	2.34	20.05	6.25	1.42	18.00*
3276	" " " Hartford	Conn. Valley Orchard Co., Berlin	6.89	6.28	1.41	35.76	3.49	21.98	5.66	0.93	9.00
3410	" " " Boston	J. Norris Barnes, Yalesville	6.80	6.25	1.47	35.36	3.36	25.23	6.28	1.59	---
3411	" " " "	" " "	6.32	6.28	1.28	35.12	3.62	21.46	5.50	0.74	---
4272	Simeon Pease, Greenfield Hill	D. A. St. John, New Canaan	4.43	4.03	1.31	36.02	3.22	21.39	9.25	2.76	9.25
3184	E. B. Clark & Sons, Milford	Geo. F. Platt, Milford	8.37	8.12	1.51	29.78	2.70	17.46	7.04	2.18	9.00
3277	" " " "	" " "	6.63	6.45	1.43	29.20	2.30	17.54	8.73	1.82	9.00
3194	Conn. Valley Orchard Co., Deep River	Station Agent	3.74	3.39	1.09	34.94	3.10	21.31	3.83	1.13	10.00
3149	John Joynt, Lucknow, Canada	A. Pouleur, Windsor	6.08	5.64	1.47	33.26	2.48	16.87	13.03	3.54	10.00
3392	F. B. Miller, Bloomfield	George Mexcur, Bloomfield	4.29	3.51	1.25	40.02	2.30	23.98	3.66	1.35	11.00
3364		C. Z. Morse, Shelton	5.05	4.54	1.62	30.74	2.76	20.18	8.15	1.28	---
3143	Geo. L. Munroe, Oswego, N. Y.	A. Welton, Plymouth	6.23	5.48	1.51	37.62	2.48	20.35	5.36	1.14	9.00
3046	Hollister Sage, South Britain	Newton M. Curtis, Sandy Hook	2.47	2.06	0.94	35.88	3.46	21.24	22.46	3.10	---
4501	W. B. Mallette, Bridgeport	W. B. Mallette, Bridgeport	4.35	3.77	1.31	31.24	2.54	20.16	10.65	1.91	---
	Lime-Kiln Ashes.										
3028		J. H. Hale, South Glastonbury	0.91	0.39	0.42	44.50	1.31	9.84	15.40	7.38	---
3409	Chas. Barnes' Sons, Canaan	George Mexcur, Bloomfield	1.53	1.00	1.47	30.67	8.57	21.61	7.30	3.88	5.67

* Probably in small lots.

year. A ton of Canada ashes, therefore, contains, on the average, 92 pounds of quickly available potash, 28 pounds of phosphoric acid, and 718 pounds of lime, and costs $9.00 per ton. The potash is present chiefly in form of carbonate, which at this writing costs, in forms used as fertilizers, not far from 7¼ cents per pound.

Allowing 7¼ cents per pound for the water-soluble potash and 4 cents per pound for the phosphoric acid contained in these ashes, the lime in them costs 17 cents per 100 pounds.

It needs to be remembered that wood ashes are distinctively a lime fertilizer, containing nearly eight times as much lime as potash.

Following are analyses of two samples of ashes sent by E. N. Austin, Suffield, who stated that the ashes were bought by Patrick Havey from the Bowker Fertilizer Co. The Bowker Fertilizer Co. states that the analyses are not representative of the ashes which it sells and that no ashes have been sold by the company to Mr. Havey. The Station has been unable to get a statement regarding the matter from Mr. Havey:

Analyses.

	3192	3308
Potash soluble in acid	4.44	4.98
Potash soluble in water	3.87	4.93
Phosphoric acid	1.28	1.31
Lime	28.74	31.04
Magnesia	2.26	2.47
Carbonic acid	19.54	22.57
Sand and soil	13.35	14.39
Charcoal	1.40	1.69

Lime-Kiln Ashes.

The table, page 82, contains two analyses of this material, which consists of the ashes of fuel used in lime-burning, unavoidably mixed with much of the lime from the kiln itself.

The two samples were quite damp and on that account contained scarcely more lime than wood ashes, with the small percentage of potash which is usually found in kiln ashes.

Lime Refuse.

This is understood to be a waste product from soap factories.

3175. Sampled and sent by J. H. Hale, South Glastonbury; made by J. B. Williams Soap Co., Glastonbury.

1842 and **1843.** Sampled and sent by the J. T. Robertson Co., soapmakers, Manchester.

Analyses.

	3175	1842	1843
Moisture	39.75	48.80	52.20
Insoluble in acid	0.58	----	----
Lime	32.83	33.14	28.22
Magnesia	none	----	----
Carbonic acid and combined water	26.16	----	----

This material could be used for liming land, although the high percentage of water makes it expensive to transport and inconvenient to spread on the land.

Chimney Soot.

Two samples of this material were sent by the Elm City Nursery Co. for examination. They were found to contain:

	3152	3153
Nitrogen as ammonia	0.92	0.80
" organic	1.33	0.94
" total	2.25	1.74

Neither had more than a trace of either phosphoric acid or potash.

Wool Waste.

A sample of Wool Waste, **3037**, from the factory of the J. J. Regan Manufacturing Co., Rockville; sampled and sent by Fred. Trinks, Rockville, was found to contain:

Nitrogen	4.53 per cent.
Phosphoric acid	none
Potash	0.36

Wool waste, untreated, is very slow in its action as a fertilizer, though if applied *in large quantities,* it sometimes produces marked effects quite promptly.

Experiments made by the New Jersey Station on wheat, clover and grass indicated that, where wool waste could be bought for about $1.00 per ton, it could be used to profit as a fertilizer at the rate of one ton or more per acre. Wool waste, of course, is not a material of uniform quality and composition. We have seen samples full of weed seeds, which of course, should never be used. Other samples contain much oil and are, on that account, less suited for use as fertilizers.

Carbonizing Dust.

This material, stated to be a waste product from a Rockville mill, and to contain a large amount of oil of vitriol, was sent by Fred. Trinks, of Rockville, and was analyzed with the following results:

Analysis of Carbonizing Dust.

	4201
Water	7.30
Nitrogen	2.13
Other organic matter	45.96
Sand	31.50
Oxide of iron	1.72
Lime	1.47
Magnesia	0.10
Potash	0.13
Sulphuric acid, free	5.50
Sulphuric acid, combined	2.45
Phosphoric acid	0.45
Undetermined	1.29
	100.00

GARBAGE TANKAGE.

Two samples of this material have been analyzed, both of them made by the Bridgeport Reduction Co. from various refuse materials.

3104. A large sample sent by the Ansonia Flour and Grain Co. Aside from the chemical ingredients named below, there were also found in this sample the following treasures:—Bones, nails, cartridge shells, clam shells, cinders, glass, cloth, nutshells, seeds, sheet iron and feathers.

1844. Sampled and sent by G. P. Jennings, Green's Farms.

ANALYSES.

	3104	1844
Water	14.88	19.50
Organic matter	31.83	24.44
Mineral matter	53.29	56.06
	100.00	100.00
Sand and soil	10.38	8.43
Nitrogen	0.99	0.90
Phosphoric acid	5.03	4.17
Potash soluble in water	----	1.47
" " " acid	2.36	1.72
Cost per ton	$8.00	3.50

Observations made in former years have shown that the nitrogen of this "garbage tankage" is not in forms which are readily soluble.

The following analyses were made on samples which were stated to represent Bridgeport city garbage, which had been rendered and dried in a newly devised and constructed Hogel machine, operated at Messrs. Plumb and Winton's rendering establishment in Bridgeport.

4199 and **4200** were sent by Frank Staples, Bridgeport, **4499** and **4500** were sent by Albert Sneider, Bridgeport, **4559** and **4560** were taken in the presence of a Station agent at the factory:

	4199	4200	4499	4500	4559	4560
Moisture	----	----	----	----	2.32	2.15
Nitrogen	4.60	4.62	2.26	3.73	2.15	1.82
Phosphoric acid	17.02	15.10	21.47	23.05	3.67	3.22

No tests have been made to determine the solubility of the nitrogen in this material and it is evident that in the trial runs, represented by the foregoing samples, the quality of the garbage rendered was not at all uniform.

DRIED MUCK.

3988. A sample of air-dry "muck;" sent by Adams and Canfield, Norwalk, had the following composition:—

Moisture	3.45
Organic matter	10.12
Mineral matter	86.43
	100.00
Nitrogen	0.39
Phosphoric acid	0.22
Potash	0.25
Sand	79.05

As the analysis shows, about four-fifths of this "muck" consist of fine sand and soil.

FRESH MUCK.

Two samples of this material; sent by E. C. Sherman, Manchester Green, had the following composition:—

	3145		3146	
	As received.	Water-free.	As received.	Water-free.
Water	75.97	----	76.13	----
Organic matter	5.01	20.84	4.77	20.03
Mineral matter	19.02	79.16	19.10	79.97
	100.00	100.00	100.00	100.00
Nitrogen	0.17	0.71	0.17	0.71
Phosphoric acid	0.03	0.13	0.01	0.04
Potash	0.20	0.83	0.18	0.76
Sand and soil	13.47	56.04	13.81	58.00

More than half the dry weight of these "mucks," which are nearly alike in composition, is made up of sand. Only about one-fifth part of the water-free substance is organic, vegetable matter.

REVIEW OF THE FERTILIZER MARKET,

FOR THE YEAR ENDING OCTOBER 31, 1901.

BY E. H. JENKINS.

NITROGEN

Nitric Nitrogen.

The *wholesale* New York quotation of nitrogen in form of nitrate, which was 11.6 cents per pound in November, 1900, rose in May, 1901, to 11.9 and since then has ranged between that figure and 12.2, which was the October quotation.

The average of the monthly quotations for a number of years —from November 1st to November 1st—has been as follows:

Year	1901	1900	1899	1898	1897	1896	1895	1894
Average quotation, cents per pound for nitrogen, *wholesale*	11.9	11.8	10.5	11.0	11.4	11.1	11.4	13.0

Nitrate nitrogen has been sold to farmers in this State during the past season for from 13.5 to 15.1 cents per pound, or from $42.50 to $47.00 per ton for nitrate of soda.

Ammonic Nitrogen.

The *wholesale* New York quotation of nitrogen in this form was 13.4 cents per pound in November, 1900. With slight fluctuations, it has remained at nearly the same price through the year, being quoted in October, 1901, at 13.5.

The average monthly quotations for a number of years have been as follows:

Year	1901	1900	1899	1898	1897	1896	1895	1894
Average quotation, cents per pound for nitrogen, *wholesale*	13.3	13.9	14.0	11.9	10.5	11.1	14.3	17.3

Scarcely any sulphate of ammonia is used by farmers for home mixing, as the present price is almost prohibitive for use as a fertilizer.

Organic Nitrogen.

The *wholesale* New York quotation of nitrogen in form of red blood, which was 14.4 cents per pound in November, 1900,

dropped as low as 13.5 in September, 1901, while the October quotation was 14.0.

The quotations of low grade blood and concentrated tankage show corresponding fluctuations and, in general, the quotations for this year have been slightly higher than in the previous year.

Low grade tankage, bone, fish and, especially, cotton seed meals are the nitrogenous matters most popular with those who buy fertilizing materials for use directly or after mixing at home.

The retail cost of nitrogen in cotton seed meal has been a half-cent higher per pound than last year.

Dry Ground Fish has been, during the past season, one of the cheapest sources of available organic nitrogen.

Phosphatic Materials.

The *wholesale* New York quotations of ground bone, bone meal and Charleston rock have remained practically the same during the year, with possibly a slight downward tendency.

The wholesale quotation of available phosphoric acid in form of acid phosphate fell from 3.30 cents per pound in October, 1900, to 3.12 in December, 1900, at which figure it has since remained.

The prices which have been generally paid for available phosphoric acid by farmers in this State are out of all proportion to the wholesale price of the article, and those who have to make purchases of this material will do well to get quotations from a number of manufacturers and brokers before placing their orders.

Potash.

The *wholesale* quotations of potash salts, which are regulated within narrow limits by the German Kali Works, show little fluctuation.

Muriate of Potash.

Potash in this form has been quoted *at wholesale* in New York at 3.36 cents per pound through the entire year.

At retail in this State, potash in this form has cost from 3.6 to 4.9 cents per pound. See p. 29.

Double Sulphate of Potash and Magnesia.

At *wholesale,* in New York, potash in this form was quoted at 4.04 cents per pound in November, 1900, and remained at that point till March, 1901, since which time it has been quoted at 4.27 cents.

At retail in this State, it has cost about 5.4 cents per pound.

High Grade Sulphate of Potash.

Potash in this form was quoted *at wholesale* in New York, in November, 1900, at 4.21 cents per pound. It rose in March, 1901, to 4.32 and has remained at that figure ever since.

Potash in this form has sold at retail in this State for about 4.9 cents per pound during the present season.

There are two other forms of potash, much used on tobacco lands, which are worth the attention of all farmers. Cotton hull ashes, when of good quality, contain over twenty per cent. of potash, *chiefly in form of carbonate,* and eight to ten per cent. of phosphoric acid. At present prices, actual potash costs more in this material than in the Stassfurt Salts, but as the ashes are strongly alkaline, their use may be found very profitable on lands which have been dressed for some time with chemical fertilizers, and on meadows having acid soils.

The second form of potash fertilizers is tobacco stems, which contain eight per cent. or more of potash, together with two per cent. of nitrogen and one per cent. of phosphoric acid.

EXPLANATIONS OF MARKET QUOTATIONS.

The following explanations will help in the examination of the market quotations, and will also show the basis on which they have been interpreted in this review:

Phosphate rock, kainit, bone, fish-scrap, tankage and some other articles are commonly quoted and sold by the ton. The seller usually has an analysis of his stock, and purchasers often control this by analysis at the time of the purchase.

Sulphate of ammonia, nitrate of soda and the potash salts are quoted and sold by the pound, and generally their wholesale and retail rates do not differ very widely.

Blood, azotin and concentrated tankage are quoted at so much "per unit of ammonia." To reduce ammonia to nitrogen, multiply the per cent. of ammonia by the decimal .824 (or multiply the per cent. of ammonia by 14 and divide that product by 17). A "unit of ammonia" is one per cent., or 20 pounds per ton. To illustrate: if a lot of tankage has 7.0 per cent. of nitrogen, equivalent to 8.5 per cent. of ammonia, it is said to contain 8½ units of ammonia, and if quoted at $2.25 per unit, a ton of it will cost $8\frac{1}{2} \times 2.25 = \$19.13$.

The term "ammonia" is *properly* used only in those cases where the nitrogen actually exists in the form of ammonia, but it is a usage of the trade to reckon all nitrogen, in whatever form it occurs, as ammonia.

To facilitate finding the actual cost of nitrogen per pound from the cost per unit of ammonia in the market reports, the following table is given:

Ammonia at	$3.00	per unit	is equivalent	to nitrogen	at	18.2 cts.	per lb.
"	2.90	"	"	"		17.6	"
"	2.80	"	"	"		17.0	"
"	2.70	"	"	"		16.4	"
"	2.60	"	"	"		15.8	"
"	2.50	"	"	"		15.2	"
"	2.40	"	"	"		14.6	"
"	2.30	"	"	"		14.0	"
"	2.20	"	"	"		13.4	"
"	2.10	"	"	"		12.8	"
"	2.00	"	"	"		12.2	"
"	1.90	"	"	"		11.6	"
"	1.80	"	"	"		11.0	"
"	1.70	"	"	"		10.3	"
"	1.60	"	"	"		9.7	"
"	1.50	"	"	"		9.1	"

Commercial Sulphate of Ammonia contains about 20.8 per cent. of nitrogen, though it varies somewhat in quality. With that per cent. of nitrogen (equivalent to 25.25 per cent. of ammonia),

if quoted at	3.0	cents per pound, Nitrogen costs	14.4	cents per lb.
"	2.9	" " "	13.9	"
"	2.8	" " "	13.4	"
"	2.7	" " "	12.9	"
"	2.6	" " "	12.5	"
"	2.5	" " "	12.0	"
"	2.4	" " "	11.5	"

Commercial Nitrate of Soda averages 93.7 per cent. of pure sodium nitrate, or 15.7 per cent. of nitrogen.

If quoted at	2.5	cents per pound, Nitrogen costs	15.9	cents per lb.
"	2.4	" " "	15.3	"
"	2.3	" " "	14.7	"
"	2.2	" " "	14.0	"
"	2.1	" " "	13.3	"
"	2.0	" " "	12.7	"
"	1.9	" " "	12.1	"
"	1.8	" " "	11.5	"
"	1.7	" " "	10.8	"
"	1.6	" " "	10.2	"
"	1.5	" " "	9.6	"

Commercial Muriate of Potash usually contains 50½ per cent. of "actual potash," or potassium oxide.

If quoted at	2.20	cents per pound, Potassium Oxide costs	4.35	cents per lb.
"	2.15	" " "	4.25	"
"	2.10	" " "	4.15	"
"	2.05	" " "	4.06	"
"	2.00	" " "	3.96	"
"	1.95	" " "	3.86	"
"	1.90	" " "	3.76	"
"	1.85	" " "	3.66	"
"	1.80	" " "	3.56	"
"	1.75	" " "	3.46	"
"	1.70	" " "	3.36	"

High Grade Sulphate of Potash, as it is found in the Connecticut market, contains about 49.2 per cent. of actual potash.

If quoted at	2.50	cents per pound, Potassium Oxide costs	5.1	cents per lb.
"	2.45	" " "	5.0	"
"	2.40	" " "	4.9	"
"	2.35	" " "	4.8	"
"	2.30	" " "	4.7	"
"	2.25	" " "	4.6	"
"	2.20	" " "	4.5	"
"	2.15	" " "	4.4	"
"	2.10	" " "	4.3	"
"	2.05	" " "	4.2	"
"	2.00	" " "	4.1	"

The Double Sulphate of Potash and Magnesia has about 26½ per cent. of potassium oxide.

If quoted at	1.00	cents per pound, Potassium Oxide costs	3.77	cents per lb.
"	1.05	" " "	3.96	"
"	1.10	" " "	4.15	"
"	1.15	" " "	4.34	"
"	1.20	" " "	4.53	"
"	1.25	" " "	4.72	"
"	1.30	" " "	4.90	"

The following table shows the fluctuations in the wholesale prices of a number of fertilizing materials in the New York market, since November, 1897. The price given for each month is the average of the four weekly quotations for that month. Sulphate of ammonia is assumed to contain 20.8 per cent. and nitrate of soda 16.0* per cent. of nitrogen; muriate of potash 50½ per cent., high grade sulphate 49.2 per cent., and double manure salt 26.5 per cent. of actual potash.

* 15.7 in 1900 and 1901.

Wholesale Prices of Fertilizing Materials.

		Cost of Nitrogen at wholesale in					Cost of Potash at wholesale in			
		Dried Blood.								
		Red. Cents per pound.	Black or low grade. Cents per pound.	Concentrated Tankage. Cents per pound.	Nitrate of Soda. Cents per pound.	Sulphate of Ammonia. Cents per pound.	Muriate of Potash. Cents per pound.	Double Manure Salt. Cents per pound.	High Grade Sulphate of Potash. Cents per pound.	Available Phosphoric Acid in Dissolved South Carolina Rock. Cents per pound.
1897.	November	11.9	10.3	11.7	10.1	10.9	3.64	4.09	4.10	2.53
	December	11.7	10.5	11.7	10.3	11.3	3.64	4.09	4.10	2.55
1898.	January	11.7	10.5	11.7	11.3	11.5	3.64	4.09	4.10	2.53
	February	11.6	10.4	11.6	10.3	12.4	3.64	4.09	4.10	2.48
	March	10.0	10.2	11.4	11.1	12.1	3.64	4.09	4.10	2.36
	April	10.8	10.5	11.5	11.9	11.4	3.64	4.09	4.10	2.36
	May	10.9	10.6	11.7	17.1	11.5	3.64	4.09	4.10	2.50
	June	11.1	10.8	11.7	11.5	12.1	3.64	4.09	4.10	2.56
	July	10.8	10.3	11.7	9.9	12.1	3.64	4.09	4.10	3.13
	August	10.8	10.5	11.7	9.2	12.3	3.64	4.09	4.10	3.13
	September	10.8	10.5	11.7	9.1	12.6	3.64	4.09	4.10	3.13
	October	10.8	10.5	11.7	9.6	12.3	3.64	4.09	4.10	3.13
	November	10.8	10.5	11.7	9.9	12.6	3.64	4.11	4.09	3.13
	December	10.7	10.5	11.7	10.4	12.7	3.64	4.11	4.09	3.13
1899.	January	10.8	10.5	11.7	10.2	13.1	3.64	4.11	4.09	3.13
	February	10.8	10.5	11.7	10.5	12.9	3.58	3.98	4.06	3.13
	March	10.8	10.5	11.7	10.6	13.1	3.52	3.85	4.03	3.13
	April	11.0	10.7	11.1	10.7	13.6	3.56	3.90	4.06	3.13
	May	11.1	10.7	10.8	10.6	14.6	3.58	3.91	4.07	3.13
	June	12.0	11.4	11.1	10.3	15.3	3.58	3.91	4.07	3.13
	July	11.8	11.4	11.1	10.4	15.2	3.58	3.91	4.07	3.13
	August	11.7	11.4	11.1	10.4	15.1	3.58	3.91	4.07	3.13
	September	11.4	11.4	11.1	10.5	14.8	3.58	3.91	4.07	3.13
	October	11.1	11.1	10.9	10.9	14.3	3.58	3.91	4.07	3.60
	November	11.0	10.8	10.8	11.1	13.8	3.58	3.91	4.10	3.09
	December	11.7	11.1	10.8	11.5	14.1	3.58	3.94	4.10	3.09
1900.	January	13.4	11.5	----	11.9	14.3	3.58	3.94	4.10	3.05
	February	15.2	----	----	12.6	14.0	3.59	3.94	4.00	3.05
	March	14.9	----	----	13.6	15.0	3.66	4.04	4.21	3.17
	April	15.0	----	----	13.3	14.5	3.66	4.04	4.21	3.17
	May	13.9	----	----	11.5	14.0	3.66	4.04	4.21	3.17
	June	12.8	----	----	10.8	13.8	3.66	4.04	4.21	3.15
	July	12.6	----	----	11.1	13.5	3.66	4.04	4.21	3.20
	August	13.6	13.7	----	11.3	13.7	3.66	4.04	4.21	3.30
	September	13.6	13.3	----	11.4	13.4	3.66	4.04	4.21	3.30
	October	14.0	13.6	----	11.5	13.4	3.66	4.04	4.21	3.30
	November	14.4	13.8	----	11.6	13.4	3.66	4.04	4.21	3.26
	December	14.2	13.7	----	11.6	13.5	3.66	4.04	4.21	3.12
1901.	January	14.0	13.6	----	11.7	13.4	3.66	4.04	4.21	3.12
	February	14.3	----	----	11.7	13.4	3.66	4.04	4.21	3.12
	March	14.5	----	----	11.6	13.3	3.66	4.27	4.32	3.12
	April	14.3	----	----	11.7	12.9	3.66	4.27	4.32	3.12
	May	14.2	----	----	11.9	13.3	3.66	4.27	4.32	3.12
	June	14.0	----	----	12.1	13.1	3.66	4.27	4.32	3.12
	July	13.9	----	----	12.2	13.1	3.66	4.27	4.32	3.12
	August	13.7	----	----	12.4	13.1	3.66	4.27	4.32	3.12
	September	13.5	----	----	12.3	13.4	3.66	4.27	4.32	3.12
	October	14.0	----	----	12.2	13.5	3.66	4.27	4.32	3.12

SIXTH

REPORT ON FOOD PRODUCTS.

To His Excellency, GEORGE P. MCLEAN, *Governor of Connecticut:*

As required by law, I herewith submit to you the Sixth Report of the Connecticut Agricultural Experiment Station on Food Products, for the year ending July 31st, 1901.

Very respectfully,

E. H. JENKINS, *Director.*

LAWS REGULATING THE SALE OF FOODS AND FEEDS.

THE CONNECTICUT FOOD LAW.

PUBLIC ACTS, JANUARY SESSION, 1895, ENTITLED

An Act regulating the Manufacture and Sale of Food Products, amended by Chapter XXII, Public Acts, January Session, 1897, entitled An Act amending an Act Regulating the Manufacture and Sale of Food Products.

Be it enacted by the Senate and House of Representatives in General Assembly convened:

SECTION 1. It shall be unlawful for any person, persons, or corporation within this State to manufacture for sale, offer, or expose for sale, have in his or their possession for sale, or to sell, any article of food which is adulterated or misbranded within the meaning of this act.

SEC. 2. The term food, as used in this act, shall include every article used for food or drink by man, horses, or cattle. The term misbranded, as used in this act, shall include every article of food and every article which enters into the composition of food, the package or label of which shall bear any statement purporting to name any ingredient or substance as not being contained in such article, which statement shall be untrue in any particular; or any statement purporting to name the substance or substances of which such article is made, which statement shall not give fully the names of all substances contained in such article in any measurable quantity.

SEC. 3. For the purposes of this act, an article shall be deemed adulterated:

First, if any substance or substances be mixed or packed with it so as to reduce or lower or injuriously affect its quality or strength;

Second, if any inferior substance or substances be substituted wholly or in part for the article;

Third, if any valuable constituent of the article has been wholly or in part abstracted;

Fourth, if it be an imitation of or sold under the name of another article;

Fifth, if it is colored, coated, polished, or powdered whereby damage is concealed, or if it is made to appear better or of greater value than it is;

Sixth, if it contains poisonous ingredients which may render such article injurious to the health of a party consuming it, or if it contain any antiseptic or preservative not evident and not known to the purchaser or consumer;

Seventh, if it consists, in whole or in part, of a diseased, filthy, decomposed, or putrid substance, either animal or vegetable, unfit for food, whether manufactured or not, or if it is in any part the product of a diseased animal, or of any animal that has died otherwise than by slaughter;

Provided, that an article of food product shall not be deemed adulterated or misbranded within the meaning of this act in the following cases:

(*a*) In the case of mixtures or compounds which may be now or from time to time hereafter known as articles of food under their own distinctive names, and not included in definition fourth of this section;

(*b*) In the case of articles labeled, branded, or tagged, so as plainly and correctly to show that they are mixtures, compounds, combinations, or blends:

(*c*) When any matter or ingredient is added to a food because the same is required for the protection or preparation thereof as an article of commerce in a fit state for carriage or consumption and not fraudulently to increase the bulk, weight, or measure of the food or to conceal the inferior quality thereof;

(*d*) When a food is unavoidably mixed with some extraneous matter in the process of collection or preparation.

SEC. 4. The Connecticut Agricultural Experiment Station shall make analyses of food products on sale in Connecticut, or kept in Connecticut for export, to be sold without the State, suspected of being adulterated. Samples of food products for analysis shall be taken by the duly authorized agents of the Station, or by the Dairy Commissioner or his Deputy, at such times and places and to such an extent as in the judgment of the officers of said Experiment Station and of the Dairy Commissioner shall seem expedient. The Dairy Commissioner or his Deputy shall have full access at all reasonable hours to any place wherein it is suspected that there is kept for sale or for export, as above specified, any article of food adulterated with any deleterious or foreign ingredient or ingredients, and said Dairy Commissioner or his Deputy, upon tendering the market price of such article, may take from any person, firm, or corporation samples of the same. The said Experiment Station may adopt or fix standards of purity, quality, or strength, when such standards are not specified by law.

SEC. 5. Whenever said Experiment Station shall find by its analysis that adulterated food products have been on sale in the State, or kept in the State for export, for sale without the State, it shall forthwith transmit the facts so found to the Dairy Commissioner, who shall make complaint to the proper prosecuting officer, to the end that violators of the law relating to the adulteration of food products shall be prosecuted.

SEC. 6. The said Station shall make an annual report to the governor upon adulterated food products, in addition to the reports required by law, which shall not exceed one hundred and fifty pages, and said report may be included in the report which said Station is already authorized by law to make, and such annual reports shall be submitted to the general assembly at its regular session.

SEC. 7. To carry out the provisions of this act, the additional sum of twenty-five hundred dollars is hereby annually appropriated to said Connecticut Agricultural Experiment Station, which sum shall be paid in equal quarterly installments to the treasurer of the board of control of said Station, upon the order of the comptroller, who is hereby directed to draw his order for the same.

SEC. 8. Any person who, either by himself, his agent, or attorney, with the intent that the same may be sold as unadulterated, adulterates any food products for man, or horses, or cattle, or, knowing that the same has been adulterated, offers for sale or sells the same as unadulterated, or without disclosing or informing the purchaser that the same has been adulterated, shall be fined not more than five hundred dollars, or imprisoned not more than one year.

SEC. 9. No action shall be maintained in any court in this State on account of any sale or other contract made in violation of this act.

SEC. 10. All acts and parts of acts inconsistent herewith are hereby repealed.

Approved, June 26, 1895.

The General Assembly in 1899 also passed an act regulating the Sale of Concentrated Commercial Feeding Stuffs, which, as regards these materials, places on the Station further duties than those imposed by the Pure Food Law just cited. The text of this Act is as follows:

CHAPTER CCXIX.

Public Acts, January Session, 1899.

An Act concerning the Regulation of the Sale of Concentrated Commercial Feeding Stuffs.

Be it enacted by the Senate and House of Representatives in General Assembly convened:

Section 1. Every lot or parcel of concentrated commercial feeding stuff, as defined in section three of this act, used for feeding domestic animals, sold, offered, or exposed for sale within this State, shall have affixed thereto, in a conspicuous place on the outside thereof, a legible and plainly printed statement, clearly and truly certifying the number of net pounds of feeding stuff contained therein, the name, brand, or trademark under which the article is sold, the name and address of the manufacturer or importer, and a statement of the percentage it contains of crude fat and of crude protein, allowing one per cent. of nitrogen to equal six and one-fourth per cent. of protein, both constituents to be determined by the methods adopted at the time by the Association of Official Agricultural Chemists of the United States.

Sec. 2. The term concentrated commercial feeding stuff as herein used shall not include hays and straws, the whole seeds nor the unmixed meals made directly from the seed of wheat, rye, barley, oats, Indian corn, buckwheat, or broom corn.

Sec. 3. The term concentrated commercial feeding stuff as herein used shall include linseed meals, cottonseed meals, pea meals, cocoanut meals, gluten meals, gluten feeds, maize feeds, starch feeds, sugar feeds, dried brewers grains, malt sprouts, hominy feeds, cerealine feeds, rice meals, oat feeds, corn and oat chop, corn and oat feeds, ground beef, or fish scraps, mixed feeds, provenders, bran, middlings, and mixed feeds made wholly or in part from wheat, rye or buckwheat, and all materials of a similar nature not included in section two of this act.

Sec. 4. Each and every manufacturer, importer, agent, or seller of any concentrated commercial feeding stuff shall, upon request, file with the Connecticut Agricultural Experiment Station a certified copy of the statement named in section one of this act.

Sec. 5. Each and every manufacturer, importer, agent, or person selling, offering, or exposing for sale in this State any concentrated commercial feeding stuff, as defined in section three of this act, without the statement required by section one of this act, and stating that said feeding stuff contains substantially a larger percentage of either of the constituents mentioned in section one than is contained therein, or in relation to which the provisions of all of the foregoing sections have not been fully complied with, shall be fined not exceeding one hundred dollars for the first offense and not exceeding two hundred dollars for each subsequent offense.

Sec. 6. The Connecticut Agricultural Experiment Station is hereby authorized to have collected a sample, not exceeding two pounds in weight, for analysis from any lot, parcel, or package of concentrated commercial feeding stuff as defined by section three of this act, or unmixed meals, brans, or middlings named in section two of this act, which may be in the possession of any manufacturer, importer, agent, or dealer, but said sample shall be taken in the presence of said party or parties in interest or their representatives, and taken from a number of parcels or packages which shall be not less than five per cent. of the whole lot inspected, and shall be thoroughly mixed, divided into two samples, placed in glass vessels, carefully sealed, and a label placed on each stating the name or brand of the feeding stuff or material sampled, the name of the party from whose stock the sample was taken, and the time and place of taking the same, and said label shall be signed by said chemist or his deputy, and by the party or parties in interest or their representatives present at the taking and sealing of said sample; one of said samples shall be retained by said chemist or his deputy and the other by the party whose stock is sampled. Said Connecticut Agricultural Experiment Station shall cause at least one sample of each brand of feeding stuff collected as herein provided to be analyzed annually by or under the direction of said chemist. Said analysis shall include determinations of crude fat and crude protein and such other determinations as may at any time be deemed advisable. Said Connecticut Agricultural Experiment Station shall cause the analysis so made to be published in Station bulletins, together with such other additional information in relation to the character, composition, and use thereof as may seem to be of importance, and issue the same annually, or more frequently, if deemed advisable.

Sec. 7. It shall be the duty of the Dairy Commissioner to attend to the enforcement of this act, and when any evidence is submitted by the Connecticut Agricultural Experiment Station that the provisions of this act have been violated, he shall make complaint to the proper prosecuting officer, to the end that the violator may be prosecuted.

Sec. 8. The term importer for all the purposes of this act is intended to apply to such person or persons as shall bring into or offer for sale within this State, concentrated commercial feeding stuffs manufactured without this State.

Sec. 9. This bill shall not apply to feed ground from whole grain and sold directly from manufacturer to consumer.

Sec. 10. All acts or parts of acts inconsistent herewith are hereby repealed.

Sec. 11. This act shall take effect on and after July first, 1899.

Approved, June 20, 1899.

DUTIES OF THE STATION UNDER THE FOOD LAW AND THE LAW REGULATING THE SALE OF COMMERCIAL FEEDING STUFFS.

The fourth, fifth, and sixth sections of the Food Law lay certain duties upon this Station as follows:

1st. To make analyses of food products suspected of being adulterated.

2d. Whenever it shall find by its analyses that adulterated food products have been on sale, it shall forthwith transmit the facts so found to the Dairy Commissioner.

3d. The Station shall make an annual report.

The law also provides that the Station may adopt or fix standards of purity, quality, or strength, when such standards are not specified or fixed by statute.

The sixth section of the law, regulating the Sale of Commercial Feeding Stuffs, requires the Station,

1st. To determine crude fat and crude protein annually in at least one sample of each brand of feeding stuff which it may have collected.

2d. To publish these analyses in Station Bulletins, at least annually, with such additional information as to the character, composition and use of commercial feeds as may seem to be of importance.

The Station is also authorized to collect samples of commercial feeding stuffs for analysis from any manufacturers, importers, agents or dealers, and they are required to give the Station, if requested by it, a certified copy of the statement described in section one of the law.

SAMPLES EXAMINED BY THE STATION.

During the year ending July 31, 1901, authorized agents of the Station have visited forty-three towns and villages of this State and purchased samples of food products for examination at this Station.

These places were distributed as follows:

	No. of Places.
Litchfield County	5
Hartford County	10
Windham County	3
Tolland County	1
New London County	5
Middlesex County	1
New Haven County	10
Fairfield County	8
	43

In all there have been bought by the Station 1,154 samples of food products for examination. A considerable number in addition have been examined, which were submitted by grocers or purchasers. The total number of examinations of food products made in our laboratory, within the twelve months covered by this report, is as follows:

Milk		434
Cream		15
Coffee		57
Jellies, Jams and Preserves		66
Catsup, Chili Sauce and other Sauces		106
Cordials		29
Vanilla Extract		69
Vanilla "Crystals"		2
Lemon Extract		73
Orange Extract		9
Other Flavoring Extracts		25
Tea Fruit		1
Egg Powder		1
Preservatives		2
Pepper		76
Cayenne		20
Mustard		32
Ginger		32
Cinnamon		33
Cloves		18
Allspice		16
Cream of Tartar		43
Macaroni, Spaghetti, Vermicelli and Noodles		83
Miscellaneous		14
For the Dairy Commissioner:		
Butter	35	
Molasses	231	
Vinegar	164	
		430
		1,686

The State Dairy Commissioner is charged by special statutes with the enforcement of laws regulating the sale of butter, vinegar, molasses and concentrated commercial feeds.

From the time when the office of Dairy Commissioner was established, 1886, this Station has done at its own cost all the chemical work desired by the Commissioner and has given needful expert evidence in court.

Under the amendment to the Food Law, passed at the session of the General Assembly in 1899, the Commissioner is also empowered to collect samples of food products, the Station is required to report to him all cases of adulteration, and he is required to make complaint to the prosecuting officer.

During the twelve months ending July 31st, 1901, the Station has received from the Commissioner and examined 430 samples, as appears in the preceding statement.

In the following pages the results of the work of this year are presented by members of the Station staff.

MILK AND CREAM.

By A. L. Winton, I. F. Harris and M. Silverman.

MILK BOUGHT OF MILKMEN.

In the report of this Station for 1900 were published analyses of 246 samples of milk bought, during August of that year, by agents of the Station, from milk wagons, in seventeen of the cities and larger villages of the State.

Fifty-four of these samples contained less than twelve per cent. of solids, 11 less than three per cent. of fat,* 7 had been treated with boric acid (borax) and 14 with formaldehyde. Of the whole number, seven had certainly been adulterated by skimming or watering, in addition to the twenty-one adulterated with chemical preservatives.

During August of the present year, 375 samples have been collected and examined, the plan of the investigation being essentially the same as was followed in 1900.

Collection of samples. The agents were provided with bicycles, carrying in the frame a case containing 18 cans for samples. This case is similar in construction to those used by bicycle tourists for carrying traveling necessities, but is divided into compartments for the cans and the whole of one side opens so that any one of the cans can be removed without disturbing the others.

*Several states have adopted 12 per cent. of solids and 3 per cent. of fat as the minimum percentages in pure milk. Connecticut has adopted no standard for milk.

The cans are of tin, 2¼ inches square and 3¼ inches high, not including the screw cap. Filled to the brim, they have a capacity of 280 cc., or a little more than half a pint. The screw cap is 1½ inches in diameter, thus allowing easy access to the interior for washing, and is lined with a disk of thick paraffined paper, insuring a water-tight joint. They were made to order by S. A. Ilsley & Co., Brooklyn, but cans like these, except that the caps are of smaller diameter, are kept in stock by the manufacturers. The general appearance of the bicycle and its attachment, as well as the arrangement of the sampling cans, is shown in the Report for 1900, Plate I.

The sampling agent, between the hours of four and seven A. M., rode from street to street and bought a pint of milk of each milkman whom he met, without making known the object of his errand. He also noted the name of the milkman or his dairy as given on the wagon, or if there was nothing on the wagon, he asked the driver for the name of the man who carried on the business. The agent thoroughly mixed the sample of milk and filled one of the tin cans with it. He also filled out a numbered blank describing the sample and attached a duplicate number to the can.

The samples thus collected were brought as soon as possible to the Station laboratory, where they were examined.

Examination of samples. Determinations of specific gravity, fat and total solids, and tests for boric acid and formaldehyde were made in each sample immediately after its arrival. A summary of the results obtained will be found in Table I; the names of the dealers and the analyses in Table II. Percentages of fat below 3.0 and of total solids below 12.00,—the legal standards adopted in several states,—are printed in heavy-faced type. This indicates that the samples are of inferior quality in those respects, but not necessarily that they have been adulterated. It is well known that genuine milk has a very wide range of composition, caused by differences of breed, feed, period of lactation and many other things, and it is also true that milk which has not been skimmed or watered is sometimes so poor as to be unfit for sale as whole milk. Laws regulating the sale of milk should be so devised as to exclude the sale of milk, as of standard quality, which is inferior, even if it has not been adulterated.

Again it should be noted that the pint samples were taken from milk cans by the milkmen and not by our agent. Milkmen do not always mix the contents of their cans before dipping and the result of this carelessness is that some customers get more than their share of cream, while others get an inferior milk. The results given in the table represent the exact quality of the samples and not necessarily that of the whole contents of the milk can. They also represent what a customer, who paid the price of whole milk, received for his money.

The names of persons from whose carts milk was sold which was unquestionably adulterated, are also printed in Table III, page 117.

Whole milk generally has a specific gravity at 60° F. between 1.029 and 1.033. Exceptionally rich milk with a high percentage of fat may, however, have a specific gravity lower than 1.029, and by that test alone would be unjustly condemned. Addition of water to milk lowers and skimming raises the specific gravity. Low percentages of fat and solids and low specific gravity indicate that the milk has been watered, but when a deficiency of fat and solids is associated with a high specific gravity, the milk has probably been skimmed. Samples which have been both skimmed and watered and which are very deficient in fat and solids may have a normal specific gravity, as the two operations have opposite effects on this physical property of milk.

There are then two reasons why a sample should not be judged by its specific gravity alone; first, exceptionally rich milk might be condemned and, second, milk which has been both skimmed and watered might pass as genuine. Taken in connection with the results of chemical analysis, the determination of specific gravity is, however, of great value.

The addition of borax or formaldehyde to milk is regarded by most physicians as a serious menace to the health, particularly of infants and invalids, and can not be too strongly condemned.

This form of adulteration is dangerous not only because of the physiological action of the chemicals themselves, but because their use becomes a substitute for the cleanliness and sanitary precautions which are so essential to the healthfulness of the product.

TABLE I.—SUMMARY OF ANALYSES OF MILK BOUGHT OF MILKMEN.

Place.	Total number of samples.	Below three per cent. of fat.	Below twelve per cent. of solids.	Both solids and fat below the percentages named.	Contain'g boric acid (borax).	Contain'g formaldehyde.
Ansonia	4	0	1	0	0	0
Bridgeport	35	4	12	4	0	2
Bristol	11	0	0	0	0	1
Danbury	8	0	4	0	0	0
Danielson	8	1	2	1	0	0
Derby	6	0	1	0	0	0
Greenwich	3	1	1	1	0	0
Hartford	36	2	5	2	1	0
Meriden	8	0	0	0	0	0
Middletown	18	1	4	1	0	0
New Britain	17	1	5	1	0	0
New Haven	55	5	23	5	0	0
New London	18	1	2	1	0	0
Norwalk	6	0	2	0	0	0
Norwich	12	0	3	0	0	0
Plainville	2	0	0	0	0	0
Plantsville	2	0	1	0	0	0
Putnam	15	1	4	1	0	0
Rockville	12	1	5	1	0	0
Southington	6	0	1	0	0	0
South Norwalk	7	0	3	0	0	2
Stamford	13	0	1	0	1	2
Torrington	8	0	1	0	0	0
Wallingford	10	2	3	2	0	0
Waterbury	35	2	19	2	0	0
West Haven	5	1	3	1	0	0
Willimantic	14	0	3	0	0	0
Windsor Locks	1	0	0	0	0	0
Total for 1901	375	23	109	23	2	7
Total for 1900	246	11	54	17	7	14

METHODS OF ANALYSIS.

Specific Gravity is determined by a delicate Quevenne lactometer and calculated to a temperature of 60° F. (15.5° C.).

Total Solids. Evaporate four grams of the milk to apparent dryness in a flat-bottomed aluminum dish, 3¼ inches in diameter, on the water bath and dry the residue to constant weight at 100° C. in a drying oven.

Fat is determined by the Babcock test.

Boric Acid. Thoroughly mix 10 cc. of milk with 7 drops of concentrated hydrochloric acid. Moisten a piece of delicate turmeric paper with the liquid and dry on watch glass over a water bath. In the presence of boric acid the paper acquires a red color which changes to blue-black on addition of ammonia.

Formaldehyde. 1. To a portion of the milk add an equal volume of 90 per cent. sulphuric acid containing a trace of a ferric salt, in such a way that the milk and acid do not mix. Formaldehyde causes the formation of a violet ring at the juncture of the liquids.

2. Slowly heat in a test tube, with a constant shaking, 10 cc. of milk, 5 cc. of concentrated hydrochloric acid and one or two drops of ferric chloride. Discontinue the heating before the solution reaches the boiling point. In the presence of formaldehyde a violet color gradually appears in the liquid. If the heating has been cautiously conducted, the color becomes very intense and remains permanent for several days.

3. Rimini test.* Acidify 100 to 200 cc. of milk with 50 per cent. citric acid solution, add a piece of paraffine and boil the mixture until 20 cc. of distillate are obtained. Proceeding in this manner, frothing is in a measure overcome. Mix the distillate with 1 cc. phenylhydrazine hydrochloride solution (4:100), 4 drops of freshly prepared sodium nitroprusside solution (1:200) and finally add concentrated sodium hydrate solution drop by drop to the mixture. Formaldehyde is indicated by the appearance of a blue or, in dilute solutions, a green coloration, which changes to red on standing. When formaldehyde is absent, only the red color appears.

In the following table are given the names of dealers from whom the samples of milk were bought. The name which was painted on the milk cart was copied, but where no name appeared, it was obtained from the driver. All names obtained in this way are marked with an asterisk. The table also gives the specific gravity of the milk at 60° F., the first two figures, which are the same in all cases, being omitted. Thus 25.3 signifies a specific gravity of 1.0253. Next follow the percentages of fat and total solids. Percentages of solids below 12.0 and of fat below 3.0 are given in full-faced type. Lastly the table shows which of the samples were adulterated with borax or formaldehyde.

The price paid was 3 cents per pint in all cases but four.

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*Anal. di Farmacol, 1898, 97. (Abstract Zeitschr. Unters. Nahr. Genuss, *1*, 858.)

TABLE II.—MILK BOUGHT OF MILKMEN.

Station No.	Sampled Aug.	Dealer.	Specific gravity at 60° F.	Fat.	Total solids.	Preservative.
		Ansonia.		%	%	
3596	10	Matthew Ellis*	25.3	4.7	12.22	None.
3598	10	J. T. Judson*	29.6	3.9	12.41	"
3595	10	W. J. Peck*	30.4	3.5	12.06	"
3597	10	G. R. Wheeler	29.4	3.6	**11.90**	"
		Bridgeport.				
3869	23	Banny's Imperial Farm Dairy	28.3	4.4	12.80	"
3829	23	Herman Boyson*	29.6	3.2	**11.55**	"
3833	23	Arthur Buckley*	28.4	3.2	**11.35**	"
3830	23	E. C. Burroughs	30.4	3.3	**11.97**	"
3870	23	F. Campbell, Valley Farm	30.6	3.5	12.07	"
3838	23	D. B. Curtiss & Son	28.6	3.9	12.04	
3871	23	A. S. Edwards	30.2	4.7	13.67	Formaldehyde.
3847	23	A. S. Edwards	30.5	4.7	13.70	"
3845	23	Dwight Fuller,* Trumbull	26.6	**2.9**	**11.02**	None.
3863	23	R. C. Galloway, Round Hill Farm	29.6	4.7	13.40	"
3846	23	A. O. Gregory	27.1	3.8	**11.45**	"
3832	23	J. E. Hammond, Hemlock Farm Dairy	26.3	4.3	12.27	"
3868	23	G. W. Hawkins, Park City Dairy	29.0	4.3	12.77	"
3874	23	T. J. Hayes*	30.0	4.1	12.60	"
3873	23	R. Howard*	30.6	4.1	12.95	"
3841	23	Geo. Jennings*	30.5	**2.9**	**11.40**	"
3867	23	L. A. Jennings*	30.9	4.6	13.32	"
3861	23	J. Kent*	26.8	4.9	**11.80**	"
3862	23	Lakeside Farm	31.3	3.2	**11.91**	"
3843	23	Albert Leonard*	29.2	3.9	12.30	"
3872	23	J. L. Linch*	28.7	3.8	12.12	"
3839	23	G. Machalowski, White Plain Dairy	27.5	3.0	**10.70**	"
3865	23	Ambrose Marsh, Acme Dairy Farm	30.9	3.4	12.39	"
3842	23	Geo. L. McClellan, Nichols	31.5	4.2	13.45	"
3831	23	J. E. McDonald*	30.0	4.4	13.20	"
3876	23	Alfred Miller*	33.6	**1.2**	**10.10**	"
3866	23	Mitchel Dairy	29.9	4.6	13.17	"
3836	23	Nichols Bros.*	25.8	3.4	**10.90**	"
3875	23	H. W. Parks, Favorite	28.6	4.2	12.60	"
3844	23	E. S. Price	18.4	**2.5**	**7.70**	"
3864	23	The Rogers Farm Dairy, 266 State St.	30.5	4.1	12.90	"
3834	23	Edward Sherman*	29.3	4.1	12.41	"
3837	23	Geo. Sherman*	30.6	3.9	12.65	"
3840	23	D. S. Walker, Long Hill*	30.4	3.8	12.32	"
3835	23	Wooster*	31.4	3.5	12.50	"
		Bristol.				
3813	21	Chauncey Abbott*	30.0	4.2	12.97	"
3807	21	Chauncey Abbott*	29.5	4.2	13.00	"
3814	21	A. Brewer, Hillside Farm	29.3	4.1	12.70	"
3816	21	Geo. B. Evans, 118 Wolcott St.	27.9	5.0	13.42	"
3811	21	T. Holt, Maple View Farm	27.9	4.2	12.22	"
3815	21	Manchester Bros.	29.9	5.0	13.97	"

* Statement of Driver.

TABLE II.—MILK BOUGHT OF MILKMEN—*Continued.*

Station No.	Sampled Aug.	Dealer.	Specific gravity at 60° F.	Fat.	Total solids.	Preservative.
		Bristol.		%	%	
3812	21	N. J. Potter	29.0	4.0	12.37	None.
3810	21	N. J. Potter*	29.3	4.8	13.52	"
3806	21	O. Roberts*	29.1	3.8	12.37	"
3808	21	G. A. Root & Son	28.8	4.4	12.85	Formaldehyde.
3809	21	J. L. Wilcox, Clover Hill Stock Farm	28.6	4.9	13.65	None.
		Danbury.				
3566	7	Bailey's Cash Route	26.9	3.7	**10.92**	"
3560	7	Danbury Milk Sterilizing Co.	29.1	3.7	**11.91**	"
3565	7	Grover Lent*	30.1	4.2	12.83	"
3561	7	Andrew Misico*	30.0	4.1	12.81	"
3562	7	L. C. Nicholson*	28.0	3.6	**11.55**	"
3564	7	Robinson Bros., Pembroke Dairy	31.2	4.2	13.09	"
3563	7	William Ubrent*	30.1	3.6	12.14	"
3559	7	Worden*	27.0	3.0	**10.60**	"
		Danielson.				
3801	20	J. E. Allen	30.1	5.0	13.72	"
3803	20	Alfred Ennis*	30.4	4.6	13.27	"
3804	20	Hugh Gorman*	27.4	3.8	**11.50**	"
3805	20	Grasmere Farm	29.4	4.9	13.25	"
3800	20	Calvin Long*	29.1	4.1	12.54	"
3799	20	R. C. Rawson*	29.8	4.2	12.77	"
3802	20	John Weaver*	30.6	**2.8**	**11.25**	"
3798	20	Chas. Young*	30.5	4.5	13.27	"
		Derby.				
3603	10	F. E. Blakeman, Oronoque	29.5	4.2	12.54	"
3602	10	D. H. Clark	30.5	4.0	12.67	"
3600	10	C. W. Dimon	28.1	4.3	12.56	"
3601	10	H. C. Hubbell*	30.6	3.8	12.65	"
3599	10	C. R. Quick	28.4	4.0	12.49	"
3604	10	M. E. T.	29.0	3.5	**11.94**	"
		Greenwich.				
3707	19	T. Brennan	29.6	4.1	12.45	"
3709	19	Jacob Fisher, Meadow Brook Dairy	32.3	**2.0**	**10.75**	"
3708	19	P. L. Jones, Round Hill Dairy	30.1	3.9	12.15	"
		Hartford.				
3661	12	J. F. Anglum	27.2	**2.8**	**10.28**	"
3671	12	E. Barnard	31.7	3.5	12.42	"
3620	12	L. H. Barnard	29.6	4.7	13.34	"
3655	12	W. G. Beerwort	29.7	4.2	13.25	"
3664	12	R. Boyle, Windsor	29.3	4.8	13.14	"
3612	12	A. G. Brewer	28.0	4.0	12.36	"
3663	12	H. Chinn, No. 1	28.1	4.0	12.21	"
3617	12	C. J. Christensen	29.3	3.9	12.36	"

* Statement of Driver.

TABLE II.—MILK BOUGHT OF MILKMEN—*Continued.*

Station No.	Sampled Aug.	Dealer.	Specific gravity at 60° F.	Fat.	Total solids.	Preservative.
		Hartford.		%	%	
3658	12	T. M. Daly	30.0	4.0	12.35	None.
3609	12	H. I. Epstein	30.8	4.7	13.74	"
3669	12	H. I. Epstein	26.6	5.2	13.37	"
3607	12	N. Faverson	30.1	3.5	12.06	"
3614	12	C. P. Graugard	27.4	4.1	12.17	"
3666	12	P. Guilmartin, Bloomfield	26.6	4.7	12.92	"
3613	12	E. F. Hathaway	29.9	4.0	12.73	"
3605	12	H. Henderson, Bloomfield	29.8	4.3	12.92	"
3611	12	H. W. Holcomb	30.4	3.5	12.14	"
3657	12	E. A. Isaacson	29.0	4.6	13.17	"
3610	12	Louis Katz	30.0	3.8	12.25	"
3670	12	F. E. McKenney	28.6	4.0	12.46	"
3621	12	M. F. McLaughlin	27.6	3.2	**11.61**	"
3618	12	E. J. McNamara, Rocky Hill	30.9	4.0	12.95	"
3665	12	E. J. McNamara, Rocky Hill	31.9	3.2	12.15	"
3659	12	L. C. Noyes	29.9	4.9	13.50	"
3606	12	E. G. Pinney, Bloomfield	26.7	3.7	**11.77**	"
3616	12	T. Ricco,* Newington	29.0	3.7	**11.95**	"
3660	12	R. Romano	30.8	4.0	12.83	"
3608	12	Ch. Rosen	32.9	**2.5**	**11.45**	"
3662	12	L. W. Seymour	29.7	3.9	12.47	Borax.
3622	12	S. A. Shepard	30.1	4.2	13.07	None.
3668	12	E. T. Slocum	30.3	5.2	14.15	"
3619	12	Spring Brook Farm	30.6	4.2	13.32	"
3623	12	L. Stetson, Wethersfield	29.5	4.3	13.05	"
3615	12	W. H. Strong	28.9	3.7	12.25	"
3656	12	J. W. Woolley, Wethersfield	30.6	4.4	13.35	"
3667	12	Geo. L. Yates, Elmwood	29.1	3.7	12.30	"
		Meriden.				
3512	7	D. Higgins	31.0	3.4	12.35	"
3514	7	J. D. Higgins, Milk Depot	31.3	4.0	12.93	"
3519	7	R. A. Johnson*	32.0	4.5	13.90	"
3516	7	E. O. Manley*	30.8	4.8	13.70	"
3517	7	A. Pisoll	30.8	3.6	12.35	"
3513	7	J. C. Richmond, Central Dairy Farm	30.4	4.0	12.69	"
3515	7	Martin Rakowsky*	30.3	3.7	12.35	"
3518	7	L. B. Yale, Clover Hill	29.6	3.8	12.34	"
		Middletown.				
3695	14	F. B. Ashton	28.9	4.1	12.35	"
3685	14	T. Coleman	29.3	4.2	12.80	"
3684	14	Daniel Bros., Millbrook Farm	28.5	4.5	12.92	"
3689	14	C. T. Davis	28.9	**2.1**	**10.42**	"
3686	14	A. E. Fontain*	28.9	4.0	12.22	"
3691	14	W. C. Fowler	29.9	3.8	12.52	"
3693	14	Jno. Griffin*	24.9	3.0	**10.00**	"
3690	14	J. Higginson	29.4	4.4	13.16	"

* Statement of Driver.

TABLE II.—MILK BOUGHT OF MILKMEN—*Continued.*

Station No.	Sampled Aug.	Dealer.	Specific gravity at 60° F.	Fat.	Total solids.	Preservative.
		Middletown.		%	%	
3694	14	F. Johns*	28.8	4.8	13.40	None.
3680	14	H. C. Johnson & Son	30.1	3.9	12.35	"
3682	14	Lee Bros.	27.9	5.3	13.37	"
3688	14	S. J. Pedden*	28.5	4.5	13.05	"
3681	14	J. Ripps*	25.9	3.7	11.17	"
3687	14	E. J. Roberts, Maple Shade Dairy	30.0	4.8	13.70	"
3678	14	F. S. Scovill	25.9	4.5	12.12	"
3683	14	C. S. Shamlen*	29.6	3.4	11.62	"
3679	14	W. G. Sohnson & Son	28.6	3.6	12.07	"
3692	14	L. M. Tucker*	29.6	4.8	13.82	"
		New Britain.				
3635	9	Anderson & Smeburg	30.8	4.7	13.38	"
3637	9	A. E. Atwater	27.4	4.9	13.14	"
3649	9	J. E. Avery*	29.6	5.4	14.30	"
3638	9	Ed. Blinn*	31.2	3.0	11.16	"
3645	9	F. J. Elton*	29.1	5.4	14.49	"
3641	9	J. Flood & Sons, Farmington	28.4	4.1	12.40	"
3643	9	A. W. Hall	31.0	3.7	12.45	"
3644	9	H. E. Hanson	30 5	2.9	11.28	"
3646	9	J. L. Johnson, Springdale Dairy	30.5	4.5	13.52	"
3651	9	J. Monsees	29.1	3.7	11.90	"
3636	0	I. J. Newton, West Hartford	29.5	4.0	12.42	"
3639	9	M. Nott*	29.1	4.7	13.44	"
3640	9	S. Rosenberry*	31.4	3.8	12.28	"
3642	9	D. Solomon*	29.0	3.5	11.60	"
3648	9	T. H. Stanley, Cedar Hill Farm	30.1	4.5	13.18	"
3647	9	T. H. Stanley, Cedar Hill Farm	30.6	4.4	13.30	"
3650	9	Jacob Young*	25.1	3.7	10.84	"
		New Haven.				
3498	5	Allen & Huston	31.3	3.6	12.40	"
3496	5	J. E. Allen	29.8	3.4	11.95	"
3486	2	W. M. Andrew	30.0	4.0	12.16	"
3510	5	J. J. Barry*	30.5	4.6	13.29	"
3544	5	Wm. Brennan, Foxen	31.3	3.7	12.55	"
3507	5	I. J. Buchholz	30.3	4.3	12.96	"
3481	2	S. L. Burges*	29.5	3.2	11.29	"
3531	5	A. W. Cole	29.4	4.1	12.36	"
3542	5	Ed. Conden*	31.6	4.0	13.05	"
3499	5	F. H. Cowles	25.3	3.8	11.09	"
3480	2	Coyne,* Woodbridge	30.6	2.3	10.59	"
3505	5	W. L. Crawford	28.9	3.7	11.75	"
3536	5	W. H. Davis	28.7	3.4	11.38	"
3494	5	S. R. Dickinson, Mapledale Dairy	29.8	3.1	11.11	"
3506	5	J. A. Downes	30.4	3.1	11.49	"
3534	5	J. F. Dunn	29.7	3.0	11.30	"
3537	5	H. J. Fabrique	28.8	4.1	12.15	"

* Statement of Driver.

TABLE II.—MILK BOUGHT OF MILKMEN—*Continued.*

Station No.	Sampled Aug.	Dealer.	Specific gravity at 60° F.	Fat.	Total solids.	Preservative.
		New Haven.		%	%	
3489	2	I. Green	29.5	3.3	11.65	None.
3526	5	C. E. Hall	29.4	3.6	11.99	"
3541	5	L. G. Hemingway	29.7	3.7	11.95	"
3497	5	L. G. Hemingway	29.8	3.5	11.88	"
3545	5	W. R. Hoggett	26.9	3.8	11.59	"
3539	5	B. N. Hosley	31.3	4.5	13.63	"
3483	2	B. N. Hosley	31.5	3.9	12.63	"
3488	2	Huchisky*	32.7	4.1	13.51	"
3495	5	H. D. Johnson	31.3	4.0	12.90	"
3501	5	J. W. Johnson	30.5	3.7	12.47	"
3491	2	V. Konetsky*	30.1	3.5	12.22	"
3479	2	C. M. Leek*	28.5	4.0	12.19	"
3492	2	Martin Meyer	29.6	3.6	11.87	"
3529	5	R. B. Miller	31.3	3.4	12.12	"
3482	2	R. B. Miller	31.4	2.9	11.66	"
3504	5	J. F. Moran*	30.0	3.8	12.39	"
3485	2	Martin Meyer	30.5	3.8	12.50	"
3502	5	R. H. Nesbit Co., Hamden	30.0	3.4	11.85	"
3543	5	New England Dairy Co.	29.7	2.9	11.35	"
3477	2	New England Dairy Co.	30.0	3.7	12.13	"
3538	5	R. N. Noble	31.7	2.6	11.38	"
3528	5	Number 47	30.2	2.9	11.17	"
3540	5	L. C. Palmer	30.0	3.8	12.33	"
3533	5	John Palmer	31.7	3.4	12.19	"
3532	5	Palmer	28.8	3.9	12.35	"
3535	5	E. N. Pettit	30.1	4.0	12.49	"
3508	5	H. E. Russell	30.3	3.5	11.84	"
3487	2	W. C. Russell, Tyler City	31.7	3.9	13.17	"
3493	5	W. G. Schilf	31.7	4.0	12.66	"
3503	5	J. F. Shepard*	30.4	4.8	13.47	"
3476	2	F. L. Smith, North Haven	30.3	4.1	12.91	"
3527	5	J. B. Turner	30.0	3.7	12.26	"
3500	5	E. W. Tuttle, Clover Dairy	29.9	3.4	11.76	"
3490	2	Max Walley	31.2	4.1	12.80	"
3478	2	M. C. Warner	28.9	4.0	12.25	"
3509	5	H. Weinstein*	29.5	3.8	12.15	"
3530	5	D. H. Wetmore	29.1	3.7	11.92	"
3484	2	163 Woodgard*	29.8	3.9	12.70	"
		New London.				
3755	14	C. P. Alexander*	28.2	3.6	11.97	"
3739	14	A. N. Anderson*	30.4	4.6	13.25	"
3751	14	E. J. Bishop	28.6	4.3	12.65	"
3747	14	Jerry Coffin*	30.0	4.7	13.57	"
3746	14	F. E. Comstock	29.0	4.0	12.52	"
3742	14	F. L. Dimmock*	30.1	3.7	12.30	"
3744	14	W. L. Fitch*	30.0	4.5	13.20	"
3748	14	Four Wind Farm	30.4	4.4	13.22	"

* Statement of Driver.

TABLE II.—MILK BOUGHT OF MILKMEN—*Continued.*

Station No.	Sampled Aug.	Dealer.	Specific gravity at 60° F.	Fat.	Total solids.	Preservative.
		New London.		%	%	
3753	14	Otto Lawson*	29.3	4.8	13.42	None.
3749	14	Marooney Bros.	27.5	4.4	12.87	"
3750	14	C. G. Newbury's Dairy	29.5	4.0	13.80	"
3745	14	C. G. Newbury*	28.4	5.2	14.02	"
3754	14	N. A. Richards, Quaker Hill	29.3	**2.3**	**10.52**	"
3752	14	W. F. Scott, Waterford	27.8	5.3	13.60	"
3741	14	H. S. Smith	30.1	4.4	13.20	"
3740	14	Willis G. Steward	29.3	3.6	12.06	"
3756	14	Stony Brook Dairy	30.2	4.1	12.77	"
3743	14	C. A. Whipple*	28.1	5.0	13.80	"
		Norwalk.				
3554	6	W. R. Godfrey*	31.5	4.6	13.67	"
3553	6	Jos. T. Guyer, Crystal Dairy	27.8	3.3	**11.08**	"
3557	6	W. I. Hawkhurst	24.7	3.8	**10.78**	"
3556	6	David Jenks	28.8	4.2	12.59	"
3555	6	R. Loudon, Sear Hill Farm	30.3	4.6	13.30	"
3558	6	F. R. Waters	29.9	4.1	12.89	"
		Norwich.				
3738	13	Robert Beacon*	29.5	3.5	**11.77**	"
3736	13	Mrs. H. F. Davis	29.8	4.0	12.45	"
3732	13	Geo. DeWolf*	29.8	3.5	12.01	"
3730	13	J. Gallivan*	26.0	3.0	**10.37**	"
3733	13	J. F. Lester, Sunny Side Farm	29.0	4.0	12.52	"
3728	13	J. F. Lester	29.1	3.9	12.53	"
3734	13	J. G. Lyman*	28.0	4.1	12.52	"
3731	13	Patrick McKeon*	28.0	4.2	12.42	"
3729	13	C. Palmer	30.1	5.2	14.57	"
3737	13	Jno. Stoff*	29.0	3.2	**11.57**	"
3735	13	C. H. Wheeler*	30.4	3.4	12.17	"
3727	13	N. W. Wheeler*	30.8	3.8	12.80	"
		Plainville.				
3817	21	James Burns*	29.9	5.3	13.95	"
3818	21	Arthur Gridley*	29.6	5.3	14.07	"
		Plantsville.				
3711	21	H. A. Andrews*	30.1	4.5	13.15	"
3710	21	Bingham, Willow Shade Dairy	28.6	4.1	**11.97**	"
		Putnam.				
3791	19	W. I. Bartholomew*	31.3	**2.7**	**11.47**	"
3797	19	H. E. Brown, Elverton Dairy	29.4	3.5	**11.97**	"
3786	19	Bugbee, Rockhill Dairy	30.3	3.8	12.35	"
3792	19	H. E. Hurlbutt	29.3	4.3	12.67	"
3788	19	Albert Lippett*	26.6	4.1	**11.95**	"
3794	19	Perry Moffitt*	29.4	4.7	13.32	"

* Statement of Driver.

TABLE II.—MILK BOUGHT OF MILKMEN—*Continued.*

Station No.	Sampled Aug.	Dealer.	Specific gravity at 60° F.	Fat.	Total solids.	Preservative.
		Putnam.		%	%	
3784	19	F. Montville*	30.6	3.6	12.17	None.
3783	19	G. Putney*	30.8	4.2	13.07	"
3790	19	Peter Rivers*	30.1	3.4	**11.72**	"
3789	19	E. E. Sanderson*	29.7	3.8	12.42	"
3796	19	C. B. Thurber*	28.6	4.6	12.97	"
3795	19	J. Togood*	27.1	4.7	12.95	"
3785	19	F. G. Tripp*	30.4	4.4	13.30	"
3787	19	Z. White*	29.8	3.6	12.27	"
3793	19	Arthur Williams*	29.4	5.3	13.62	"
		Rockville.				
3773	16	Fred. Ginter*	25.1	3.6	**10.77**	"
3782	16	A. A. Hincks	28.0	4.7	13.02	"
3776	16	Chas, Lamphere*	30.4	4.4	13.15	"
3779	16	C. Lanz*	25.0	4.3	**11.77**	"
3777	16	Marti & Lanz	29.1	3.4	**11.75**	"
3780	16	Geo. W. Simpkins	29.9	4.8	13.37	"
3775	16	C. T. Slater	30.0	4.0	12.65	"
3774	16	C. T. Slater*	30.0	4.0	12.65	"
3772	16	M. Sparrow*	27.6	3.1	**10.92**	"
3778	16	William Vinter*	25.0	5.7	13.30	"
3771	16	William Vinter*	28.0	**2.6**	**10.45**	"
3781	16	C. T. Wooster*	29.9	4.9	13.75	"
		Southington.				
3712	21	C. E. Crissey	30.1	4.1	12.75	"
3715	21	J. Delahunty	28.9	5.2	13.70	"
3714	21	M. Eagan*	29.4	3.9	12.05	"
3713	21	N. C. Newell*	29.8	3.9	12.42	"
3716	21	William Orr	29.2	3.7	**11.87**	"
3717	21	Parkin Bros.	27.8	4.5	12.35	"
		South Norwalk.				
3552	6	William E. Barnes	31.3	4.4	13.51	"
3551	6	William E. Barnes*	30.4	4.5	13.59	"
3548	6	Birge's Dairy, Westport	30.3	4.2	12.70	"
3550	6	Chas. H. Hawxhurst	26.3	3.6	**11.11**	Formaldehyde.
3546	6	Hillside Dairy	26.2	3.5	**11.04**	"
3549	6	Keeler*	27.3	3.8	12.00	None.
3547	6	Jos. C. Miller	27.5	4.0	**11.89**	"
		Stamford.				
1994	2	Bedell & Tompkins, Long Ridge Dairy	30.4	4.2	12.81	Formaldehyde.
1991	2	J. H. Bedell, Long Ridge Dairy	29.9	4.6	12.76	"
1997	2	Bouton's Noroton Dairy	30.4	4.2	13.00	None.
2544	2	G. C. Chard, Riverside Dairy	27.8	3.3	**11.23**	"
1992	2	H. P. Howard	29.3	4.6	13.07	
1989	2	Mt. Pleasant Dairy	29.6	3.8	12.19	"

* Statement of Driver.

TABLE II.—MILK BOUGHT OF MILKMEN—*Continued.*

Station No.	Sampled Aug.	Dealer.	Specific gravity at 60° F.	Fat.	Total solids.	Preservative.
		Stamford.		%	%	
1998	2	W. F. Olmstead	29.2	4.2	12.90	None.
1996	2	Rock Hill Dairy	29.5	3.8	13.00	"
2543	2	Sarr's Milk Wagon	29.9	3.8	12.59	"
1993	2	F. X. Simmell, White Clover Dairy	30.3	4.1	12.80	"
1995	2	Emmett L. Weed	29.5	4.8	13.42	"
1999	2	Geo. W. Weed	30.1	4.1	12.99	"
1990	2	Westover Dairy	30.3	3.6	12.24	Borax.
		Torrington.				
3592	9	Tom Conden*	30.1	4.7	13.15	None.
3591	9	Dennis Crowe*	30.1	4.7	13.35	"
3594	9	Geo. Hewitt*	29.1	4.1	12.50	"
3588	9	Joe Snyder*	30.7	3.8	12.25	"
3587	9	Clark Weed*	29.6	3.9	12.14	"
3593	9	Geo. Weigold	29.1	4.8	12.85	"
3590	9	Geo. Weigold	30.7	3.6	12.34	"
3589	9	A. & E. Whiting	28.6	3.2	11.12	"
		Wallingford.				
3699	16	A. A. Blacksly	29.4	3.6	11.89	"
3701	16	A. B. Doolittle, Belle Dairy Farm	29.6	2.7	10.95	"
3704	16	C. C. Fenn, Park Hill Dairy Farm	29.4	4.2	12.57	"
3702	16	T. F. Greenschlitt*	29.9	2.9	11.05	"
3705	16	G. Pagmore*	29.6	5.6	14.00	"
3703	16	B. R. Tyler*	29.3	4.1	12.47	"
3697	16	E. R. Warner	29.9	3.9	12.50	"
3698	16	J. D. Williams	29.4	4.7	13.25	"
3700	16	G. A. Williams*	29.6	4.5	12.60	"
3706	16	H. S. Williams	30.4	4.2	12.62	"
		Waterbury.				
3631	8	G. L. Atwood*	30.3	3.5	11.91	"
3627	8	F. M. Berger, Cherry Hill	27.0	4.0	11.64	"
3573	8	S. P. Bronson	30.8	3.9	12.87	"
3629	8	S. P. Bronson	30.5	4.5	13.20	"
3567	8	Buckingham Bros., Mt. Fair Dairy	30.8	3.6	12.56	"
3568	8	Geo. Cullon, Oakville*	31.8	2.0	10.48	"
3630	8	T. B. Egelsten*	27.8	3.7	11.32	"
3586	8	W. A. Faber	30.3	4.2	13.01	"
3583	8	Myer Greenblack*	28.9	3.8	12.12	"
3579	8	D. M. Hard	27.3	3.5	11.42	"
3523	8	L. H. L'Hommedieu, Oakville	27.4	4.0	11.71	"
3582	8	C. A. Kernathan	28.4	3.6	11.79	"
3581	8	J. Kramer*	30.0	4.5	13.50	"
3585	8	J. N. Lewin, Watertown Road	27.0	3.8	11.64	"
3574	8	Lockwood Bros.	30.1	4.1	13.05	"
3584	8	C. L. Mack, Oak Grove Farm	30.3	3.6	12.24	"
3577	8	C. L. Mack	29.8	4.2	12.67	"

* Statement of Driver.

TABLE II.—MILK BOUGHT OF MILKMEN—*Continued.*

Station No.	Sampled Aug.	Dealer.	Specific gravity at 60° F.	Fat.	Total solids.	Preservative.
		Waterbury.		%	%	
3633	8	C. B. Matoon*	30.0	4.3	12.62	None.
3520	8	Wm. Messick*	28.0	3.5	11.05	"
3524	8	J. F. Mintie*	24.4	3.8	10.99	"
3572	8	E. H. Oviatt	30.4	4.3	12.94	"
3626	8	E. H. Oviatt	31.8	3.3	12.45	"
3576	8	W. H. Platt	29.9	2.8	11.07	"
3522	8	W. H. Platt*	29.7	3.7	11.92	"
3578	8	N. Rasmussen, Hellman's Farm	29.1	3.6	12.06	"
3570	8	Geo. Rasmussen	28.3	3.3	11.22	"
3521	8	Geo. Rasmussen	28.1	3.3	11.01	"
3575	8	C. C. Rogers	28.1	3.6	11.70	"
3569	8	D. M. Rogers	27.1	3.1	10.36	"
3632	8	D. M. Rogers	27.6	3.1	10.81	"
3525	8	J. N. Rose*	30.4	4.1	12.56	"
3634	8	E. M. Scott*	30.8	4.0	12.37	"
3571	8	Stiles & Sanford*	28.0	4.2	12.41	"
3628	8	W. S. Strong*	27.6	3.3	11.06	"
3580	8	Jno. R. Wood	28.8	3.7	11.84	"
		West Haven.				
3672	13	J. Johnson*	30.6	3.9	12.32	"
3675	13	J. H. Mills	31.0	2.8	11.40	"
3673	13	New England Dairy Co.	29.7	3.7	12.15	"
3674	13	M. Rockefeller, Sound View Farm	30.7	3.3	11.90	"
3676	13	A. J. Thompson	28.0	3.5	11.50	"
		Willimantic.				
3758	15	G. H. Andrews, Crystal Spring Dairy	29.0	3.2	11.45	"
3763	15	A. M. Anthony	28.9	4.0	12.44	"
3757	15	Boutelle & Kent	24.1	3.4	10.22	"
3765	15	S. P. Brown*	29.9	3.8	12.35	"
3761	15	O. Chappell & Son	29.9	4.9	13.77	"
3766	15	E. W. Ellison, Rock Maple Farm	30.3	3.8	12.77	"
3760	15	J. H. Griggs, Pleasant Valley Dairy Farm	29.8	3.6	12.07	"
3762	15	C. H. Hoxie	30.4	3.5	12.30	"
3764	15	Grant A. Jacobs	29.7	3.9	12.39	"
3759	15	Arnold Potter*	28.4	3.6	11.90	"
3770	15	F. Rosebrooks	28.8	5.0	13.64	"
3768	15	J. H. Stearns, Mountain Milk Farm	28.9	3.8	12.30	"
3767	15	W. H. Terry, Glen View Farm	27.9	5.2	13.65	"
3769	15	G. A. Tracy, Breeze Hill Stock Farm	28.9	3.9	12.07	"
		Windsor Locks.				
3696	15	P. Gantley	30.5	3.6	12.52	"

* Statement of Driver.

The General Quality of the Milk Supply in August, 1901.

Exclusive of the samples which were certainly adulterated by skimming or watering, the average percentage of total solids, in the samples examined in August, 1901, was 12.50 and the average percentage of fat, 4.0. The corresponding averages found in August, 1900, were almost identical, viz., 12.53 per cent. of solids and 3.99 per cent. of fat.

Thirty-two of the samples analyzed in 1901, or 8.5 per cent. of the whole number, were adulterated; nine of them by the addition of a chemical preservative, either formaldehyde or borax, and twenty-three by skimming or watering. Besides these there are a number of quite inferior quality which may or may not have been adulterated.

In Table III are given the names of those persons from whose carts milk was delivered, which was, in our opinion, adulterated.

Formaldehyde in Milk Shipped to Boston.

About the middle of August, Mr. W. E. Davis of Willimantic, agent for the Elm Farm Milk Co. of Dorchester, Mass., complained to Dairy Commissioner Noble that Mrs. Mary A. Poole of Ashford had been selling his company milk containing formaldehyde, and that, as a consequence, one of the milkmen who retailed milk for the company had been arrested in Boston.

On August 21, by request of Mr. Noble, an agent of the Station, in the presence of Mr. Davis and a representative of Mrs. Poole, drew samples from seven cans of the milk in question, four from the night's and three from the morning's milking, as they were being delivered for shipment.

Examination of the samples at the Station laboratory showed that all but two, which were sour, contained formaldehyde.

In the trial Mrs. Poole admitted that she had used this preservative, not knowing that the use of preservatives is illegal, and was fined by the trial justice.

Milk Sampled and Sent by Individuals.

Forty-two samples have been tested by the Station chemists, which had not apparently been adulterated. The percentage of butter-fat in these ranged from 3.0 to 6.7 and that of total solids from 11.48 to 12.87.

Table III.—Adulterated Milk.

Station No.	Sampled Aug.	Dealer.	Specific gravity at 60° F.	Fat.	Total solids.	Preservative.
		Bridgeport.		%	%	
3871	23	A. S. Edwards	30.2	4.7	13.67	Formaldehyde.
3847	23	A. S. Edwards	30.5	4.7	13.70	"
3876	23	Alfred Miller*	33.6	1.2	10.10	None.
3844	23	E. S. Price	18.4	2.5	7.70	"
		Bristol.				
3808	21	G. A. Root & Son	28.8	4.4	12.85	Formaldehyde.
		Danbury.				
3559	7	Worden*	27.0	3.0	10.60	None.
		Greenwich.				
3709	19	Jacob Fisher, Meadow Brook Dairy	32.3	2.0	10.75	"
		Hartford.				
3661	12	J. F. Anglum	27.2	2.8	10.28	"
3608	12	Ch. Rosen	32.9	2.5	11.45	"
3662	12	L. W. Seymour	29.7	3.9	12.47	Borax.
		Middletown.				
3689	14	C. T. Davis	28.9	2.1	10.42	None.
3693	14	Jno. Griffin*	24.9	3.0	10.00	"
		New Britain.				
3650	9	Jacob Young*	25.1	3.7	10.84	"
		New Haven.				
3480	2	Coyne (Woodbridge)*	30.6	2.3	10.59	"
3538	5	R. N. Noble	31.7	2.6	11.38	"
		New London.				
3754	14	N. A. Richards (Quaker Hill)	29.3	2.3	10.52	"
		Norwalk.				
3557	6	W. I. Hawxhurst	24.7	3.8	10.78	"
		Norwich.				
3730	13	J. Gallivan*	26.0	3.0	10.37	"
		Rockville.				
3771	16	Wm. Vinter*	28.0	2.6	10.45	"
		South Norwalk.				
3550	6	Chas. H. Hawxhurst	26.3	3.6	11.11	Formaldehyde.
3546	6	Hillside Dairy	26.2	3.5	11.04	"
		Stamford.				
1994	2	Bedell & Tompkins' Long Ridge Dairy	30.4	4.2	12.81	"
1991	2	J. H. Bedell, Long Ridge Dairy	29.9	4.6	12.76	"
1990	2	Westover Dairy	30.3	3.6	12.24	Borax.
		Wallingford.				
3701	16	A. B. Doolittle, Belle Dairy Farm	29.6	2.7	10.95	None.
3702	16	T. F. Greenschlitt*	29.9	2.9	11.05	"
		Waterbury.				
3568	8	Geo. Cullon (Oakville)*	31.8	2.0	10.48	"
3576	8	W. H. Platt	29.9	2.8	11.07	"
3569	8	D. M. Rogers	27.1	3.1	10.36	"
3632	8	D. M. Rogers	27.6	3.1	10.81	"
		West Haven.				
3675	13	J. H. Mills	31.0	2.8	11.40	"

* Statement of Driver.

Two samples of milk, sent by a purchaser, were stated to represent milk delivered by his milkman, and which was used for the food of an infant less than one year old. The infant was unwell and in the care of a physician at whose suggestion the milk was tested. One sample contained 1.8 per cent. of fat; the other, in a full quart bottle, just as it was delivered at the door, had a specific gravity of 1.0195, 8.12 per cent. of solids and 2.7 per cent. of fat. This was clearly milk to which a relatively large amount of water had been added. The milk supply was immediately changed and this was soon followed by the complete recovery of the child. A week later another customer of the same milkman sent a sample of milk to the Station having a specific gravity of 1.0214, 8.95 per cent. of solids and 3.0 per cent. of fat.

The owner of the milk route just referred to next appeared with a sample of milk, which he stated was sold to him at wholesale and which he delivered on his milk route in the city. This had a specific gravity of 1.021, 2.60 per cent. of fat and 8.72 per cent. of solids. The owner of the milk route owned no cows, but bought all his milk from farmers.

Six samples of milk were received in January last from I. J. True, Westerly, R. I. These samples were in sealed glass bottles, and it was stated had been taken with great care and represented milk from Connecticut herds which had been sold to Mr. True, and which he suspected of adulteration.

The results of the analyses were as follows:

	3030	3031	3032	3033	3034	3035
Specific gravity at 60° F.	20.8	21.8	26.2	27.0	26.7	17.4
Solids, per cent.	8.57	8.97	12.09	10.87	11.63	8.49
Fat, "	2.80	2.90	4.2	3.40	3.80	3 50

Certificates with affidavits were sent Mr. True declaring samples **3030, 3031,** and **3035** to be adulterated by watering. He was also advised that **3033** was probably adulterated in the same way. Mr. True immediately brought civil suits against the persons who sold him the milk declared to be adulterated, which were promptly settled by the defendants, for sums ranging from $25 to $100.

Cream Sampled and Sent by Individuals.

Fifteen samples sent in this way contained percentages of butter-fat ranging from 13.50 to 31.0. One sample contained formaldehyde. No antiseptics were found in any others.

COFFEE.

By A. L. Winton.

Seven samples of coffee beans and fifty of ground coffee have been examined. Five samples, all of ground coffee, were found adulterated as follows:

2012. "Royal Worcester Coffee. Nutmeg Coffee and Spice Mills, Hartford. A beautiful piece of imported china packed in each pound package." Bought of Moulthrop & Gray, 268 Water St., Naugatuck. Price 25 cents per pound package. *Contained a large amount of chicory and ground peas.*

2035. "W. S. Quinby Co.'s Golden Dome Coffee, Boston. Weight and fine quality guaranteed. Arabian Mocha and old government Java coffee, perfectly blended. In purity, strength and flavor this coffee has no equal." Bought of H. I. Palmer, 231 Main St., Norwich. Price 35 cents per pound. *Contained chicory.*

2008. "Silver Spoon Brand Coffee, West, Stone & Co., Springfield, Mass." One silver spoon with each pound. Bought of I. Raichie & Co., 40 Union St., Rockville. Price 25 cents per pound package. *Contained a large amount of ground peas.*

2935. "Monte Carlo Blend Coffee, Mocha and Java flavor. Imported, roasted and packed expressly for Mammoth Market Company, Waterbury, Conn. Absolute purity and full weight guaranteed. Is a high grade blend of fine drinking coffees, with a distinct Mocha and Java flavor." Bought of Mammoth Market, 153 Bank St., Waterbury. Price 23 cents per pound can. *Contained pellets made of pea hulls and other materials and chicory.*

2936. "W. S. Quinby Co.'s King Philip Blended Coffee, Boston. One of the very best blends of fine Central American coffees ever put upon the market." Bought of Mammoth Market, 153 Bank St., Waterbury. Price 25 cents per pound can. *Contained chicory.*

During the first year of the enforcement of the Connecticut food law, about nine-tenths of the samples of ground coffee collected were found adulterated, but the market has since gradually improved, nine-tenths of the samples examined

TABLE V.—COFFEE NOT FOUND ADULTERATED.

Station No.	Brand.	Dealer.	Price per pound, cents.
	Unground Coffee.	*Danielson :*	
2003	Sold in bulk	Reeves & Greiner, 226 Main St.	26
		Meriden :	
2006	Sold in bulk	Grant's Tea Store, E. Main St.	18
		Middletown :	
2005	Sold in bulk	New England Tea Co., 442 Main St.	20
		New Haven :	
2002	Red Cross, Baker & Young	J. L. Stoddard & Son, 100 Franklin St.	20
		Norwich :	
2001	Fresh Roasted	Jas. Connor & Son, 72 Water St.	20
		Willimantic :	
2004	Sold in bulk	Frank Larrabee, 16 Church St.	18
		Windsor Locks :	
2009	Gates' brand, Java and Mocha	Geo. W. Gates, Main St.	25
	Ground Coffee.	*Ansonia :*	
1923	Royal Arms, International Coffee Co.	Ansonia Market, 290 Main St.	38
1922	Ceylon Java and Mocha, Crescent Mills	Ansonia Market, 290 Main St.	30
1925	Fifth ave. Mocha and Java, O'Donahue Coffee Co.	W. H. Bronson, 234 Main St.	30
1924	Best Value, O'Donahue Coffee Co.	W. H. Bronson, 234 Main St.	25
1928	Our Jewel, Ericsson's Mills	17 High St.	25
1920	Manado Special Blend, Bryan, Miner & Read	454 Main St.	25
1926	Empress Java and Mocha, Blue Label, Eugene Rosette & Co.	D. W. Welch, 188 Main St.	30
		Bridgeport :	
2029	Seaside Brand Mocha and Java	Coe & White Co., 562 Main St.	25
2031	Gold Eagle	S. M. Phillips, 252 State St.	25
2030	Venetian Pulverized	C. Russell & Co., 335 Main St.	35
		Danbury :	
2988	Capital Mills, Lincoln, Seyms & Co.	105 White St.	30
		Meriden :	
2026	Union Club, Lincoln, Seyms & Co.	L. C. Brown, 4 E. Main St.	35
2025	Public Market Special Mocha and Java	Public Market, 45 W. Main St.	25
2027	Red Cross Brand, C. A. Cross & Co.	Public Meat Market, 25 E. Main St.	35
2007	Luxury, The Williams & Carleton Co.	H. F. Rudolph & Co., 46 E. Main St.	25
2028	Luxury, The Williams & Carleton Co.	do.	25
2024	The Silver Quarter, Swain, Earle & Co.	103 W. Main St.	25

TABLE V.—COFFEE NOT FOUND ADULTERATED—*Continued.*

Station No.	Brand.	Dealer.	Price per pound, cents.
	Ground Coffee.	*Middletown :*	
3011	Our Special, Winslow, Rand & Watson	W. F. Ackley & Co., 508 Main St.	25
3010	Arrawana Brand Java and Mocha	W. F. Ackley & Co., 508 Main St.	25
3012	Chapman's Jar-mar-mo Blend	R. A. Chapman, 334 Main St.	25
3009	Flag Brand, Deland, Potter & Co.	150 Main St.	20
		New Haven :	
2015	Hermitage, Stoddard, Gilbert & Co.	S. S. Adams, 412 State St.	25
2016	Faultless Mocha and Java	S. S. Adams, 412 State St.	25
2017	Victor, Shopleigh Coffee Co.	S. S. Adams, 412 State St.	25
2013	Seal Brand Java and Mocha, Chase & Sanborn	Bronson & Platt, 356 State St.	35
2023	Gold Star Mocha and Java, Wm. Boardman & Sons Co.	G. W. Cooper, 3 Atwater Block	25
2018	National Java and Mocha	New Haven Public Market	20
2021	Semper-Idem, Loudon & Johnson	L. C. Pfaff, 7–9 Church St.	35
2020	Old Colony, Loudon & Johnson	L. C. Pfaff, 7–9 Church St.	32
2019	Our Winner Mocha and Java	J. V, Rattlesdorfer, 95 Green St.	23
2339	Old Government Java and Mocha, C. H. Russell	Russell Bros., 418 State St.	23
2022	Gold Star, Wm. Boardman & Sons Co.	Voelker Bros., 123 Shelton Ave.	20
		New London :	
2032	White Squadron Mocha and Java, Ross W. Weir & Co.	Keefe & Davis, 125 Bank St.	33
2033	Luder, H. P. Heine	The Washington, 25 Washington St.	30
2034	Star Java, Brownell & Field Co.	The Washington, 25 Washington St.	35
		New Milford :	
2011	National Blended Java & Mocha, John G. Turnbull & Co.	A. G. Ferris	25
		Norwich :	
2036	Gilt Edge, The L. A. Gallup Co.	C. W. Hill, 19 Franklin St.	35
2037	Union Club, Lincoln, Seyms & Co.	A. T. Otis, 261 Main St.	35
		Stamford :	
3002	Our Best Java and Mocha	Geo. A. Ferris, 184 Main St.	35
		Waterbury :	
2939	Sold in bulk	640 Bank St.	30
		Willimantic :	
3014	Our Special	Purington & Reade, 717 Main St.	25
2042	Azalea, Potter & Wrightington	Purington & Reade	35
2039	Yale Mocha and Java, Howard W. Spurr Coffee Co.	Burt Thompson	25
2038	Princeton Mocha and Java, Howard W. Spurr Coffee Co.	Burt Thompson	25
2040	Autocrat, Brownell & Field Co.	Willimantic Cash Store	25

during the past year having been found pure. This is clearly shown on Table IV, which follows:

TABLE IV.—SHOWING THE GRADUAL DECREASE IN THE ADULTERATION OF GROUND COFFEE IN THE PAST SIX YEARS.

Year.	Number of samples examined.	Number of adulterated samples.	Percentage of adulterated samples in whole number examined.
1896	65	58	89.2
1897	45	39	86.6
1898	22	9	40.9
1899	80	14	17.5
1900	55	7	12.7
1901	50	5	10.0

The samples not found adulterated are described in Table V.

JELLIES, JAMS AND PRESERVES.

BY A. L. WINTON, A. W. OGDEN AND C. LANGLEY.

Pure Fruit Jelly is a clear, gelantinous product made entirely from the fruit specified and cane sugar.

Pure Jams, Preserves and Marmalades are made by boiling down the fruit specified with enough cane sugar to prevent fermentation. Unlike jellies, they contain the fruit pulp and, in the case of most small fruits, the seeds and skins.

Compound and Adulterated Jellies. All fruit products containing ingredients other than those named above, should be labeled as imitations or compounds, otherwise they are to be regarded as adulterated. The ingredients used in compound and adulterated fruit products may be divided into six classes: (1) Foreign gelatinous matter (starch paste, apple jelly, gelatine, etc.). (2) Sweetening matters (glucose, saccharin, etc.). (3) Coal-tar and other dyes. (4) Artificial flavors. (5) "Fruit acids" (Citric and tartaric acids). (6) Chemical preservatives (salicylic acid, benzoic acid, etc.).

The various foreign gelantinous substances, some artificial flavors and vegetable dyes, citric and tartaric acids, and pure glucose are harmless in food, although they are obviously adulterants when present in imitation products not labeled as "compounds"; but chemical preservatives, many coal-tar dyes, saccharin, glucose containing sulphurous acid, and fruit flavors consisting of nauseating ethers, are either decidedly injurious to health or, at least, are not so wholesome as the ingredients of pure fruit products.

Gelatinous Substances. Many of the jellies purporting to be made from currants, strawberries, raspberries and some

other fruits, contain none whatever of these fruits, but consist chiefly of apple jelly mixed with artificial flavors, colors and preservatives. The cheap jams and preserves usually contain a certain amount of the fruits specified on their labels, but many of them also contain a large proportion of apple jelly. When made entirely from ripe fruit, apple jelly is free from any appreciable amount of starchy matter, but when made wholly or in part from green apples, it may contain, as has been shown by Dr. W. D. Bigelow and his associates in the Chemical Bureau of the Department of Agriculture, a small amount of starch in a gelatinous condition. The large amount of starch present in jellies from certain factories, however, is undoubtedly derived from starch or flour or, at least, from some source other than apple jelly. Whatever its source, a considerable amount of starch paste in jelly is a proof of adulteration.

Sweetening Materials.—Glucose Sirup, being composed chiefly of sugars and dextrines similar to cane sugar in nutritive value, is, when pure, a wholesome product, although inferior to cane sugar in sweetening power. It has, however, been overlooked that much of the glucose sirup now on the market contains, in addition to the substances named, sulphurous acid, which is added in the form of bisulphite of soda during the process of manufacture, as a bleaching agent. Oftentimes, the amount present is sufficient to give the sirup a disagreeable taste. Since sulphites, bisulphites and sulphurous acid are all powerful antiseptics and preservatives, the sale of food products containing them is, in this State, illegal.

It is a significant fact that all the samples of fruit products examined during the year, which contained glucose, also contained, without any exception, a considerable amount of sulphurous acid, whereas none which were sweetened entirely with cane sugar gave any test for this substance.

Saccharin, in moderate amount, is a valuable addition to the dietary of diabetics, but for persons in good health is an undesirable substitute for sugar, because, although it has a very sweet taste, it has no value whatever as a food.

Coal-tar Dyes are considered on pages 179 to 182 of this Report.

Artificial Flavors, used in imitation jellies and jams, are prepared entirely from chemicals, chiefly the so-called "fruit ethers." These mixtures have a sickening taste and odor and are decidedly unwholesome. They are further discussed under the head of flavoring extracts, on page 177.

Chemical Preservatives. Salicylic acid and benzoic acid, added either as free acids or as soda salts of these acids (benzoate and salicylate of soda), are the preservatives most commonly used in commercial jellies and jams, as well as catsups and other fruit products. They serve chiefly, so it is stated, to prevent fermentation and molding during the delays incident to the process of manufacture, but they also prevent spoiling during transportation and storage as well as after the package is opened for consumption.

The use of chemical preservatives in food products has been discussed in previous reports, especially in the Report of this Station for 1899, p. 139. In most cases the use of these preservatives in food is illegal in Connecticut.

EXAMINATION OF SAMPLES SOLD IN CONNECTICUT.

The samples collected during the past year are tabulated on pages 125 to 131 under the following heads:

Table VII—Jellies, Jams and Preserves not found adulterated.
Table VIII—Adulterated Jellies, Jams and Preserves.
Table IX—Jellies, Jams and Preserves, labeled "Compound."

In Table VI is a summary of the examinations made in 1898, and also of those made during the past year.

It will be observed that while the percentage of samples not found adulterated was about the same in both years, the percentage of adulterated samples in 1901 was less than in 1898, due to the labeling, in compliance with the law, of "compounds," which would otherwise be classed as adulterated.

Of the adulterated samples found during the present year, 9 contained starch paste, 30 glucose, and also sulphurous acid, 21 coal-tar dyes,* 7 salicylic acid, and 6 benzoic acid.

*The names of coal-tar dyes in the table are marked with an asterisk. Magenta and acid magenta are names of individual dyes; tropeolin, ponceau, eosin and Bordeaux are names of groups, the individual colors of which are designated in the trade by letters (tropeolin OO, eosin A, etc.), or special names. The tropeolins are orange or orange red colors; the ponceaus are scarlets; the eosins are fluorescent reds and the Bordeaux colors are wine reds. In the last group are here included not only Bordeaux B, Bordeaux S, etc., but azorubin S and other azo-dyes, the colors of which, after being fixed on wools, are changed to blue or purple by sulphuric acid, but are restored by dilution.

TABLE VI.—SUMMARY OF ANALYSES MADE IN 1898 AND IN 1901, OF JELLIES, JAMS, ETC.

	Pure or not found adulterated.	Adulterated.	Marked "Compound."	Total.
Examined in 1898.				
Jellies, number of samples	20	43	7	70
Jams, etc., " " "	3	44	2	49
Total " " "	23	87	9	119
Per cent. of samples	**19**	**73**	**8**	**100**
Examined in 1901.				
Jellies, number of samples	10	18	10	38
Jams, etc., " " "	2	16	10	28
Total " " "	12	34	20	66
Per cent. of samples	**19**	**51**	**30**	**100**

TABLE VII.—JELLIES, JAMS AND PRESERVES NOT FOUND ADULTERATED, 1901.

Station No.	Brand.	Dealer.	Price per package, cents.	Quantity in packages, pound.
	Blackberry Jam or Preserve.			
2530	Bishop & Co., Los Angeles, Cal.	*Hartford.*—Hills & Co., 370 Asylum St.	35	1
	Currant Jelly.			
2941	Home Made, No Label	*Danbury.*—C. S. Loper, 17 West St.	15	⅔
2940	Alvin Hill Fruit Farm, Highland, N. Y.	Village Store Co., 238 Main St.	7	¾
2521	Home Made, No Label	*Hartford.*—Allen Bros., 466 Main St.	20	¾
2522	Mrs. Palmer's	H. Griswood, 547 Main St.	25	¾
2525	Home Made, No Label	Newton D. Burnett, 319 Asylum St.	15	⅔
2526	Mrs. Palmer's	Newton, Robertson & Co., 338 Asylum St.	30	¾
2537	E. T. Cowdrey & Co., Boston	*New Britain.*—H. A. Hall, 212 Main St.	25	⅔
2923	Home Made, No Label	*Norwich.*—A. T. Otis, 261 Main St.	25	⅔
	Raspberry Jam or Preserve.			
2535	Cross & Blackwell, London	*New Britain.*—Hermann, 73 Arch St.	25	1
	Grape Jelly.			
2518	F. R. Adams & Co., Boston	*New Haven.*—Johnson & Bro., 411 State St.	25	⅔
2918	Steele Bros., New Britain	*New London.*—Daboll & Freeman, 148 State St.	25	¾

TABLE VIII.—ADULTERATED JELLIES, JAMS AND PRESERVES, 1901.

Station No.	Brand.	Dealer.	Price per package, cents.	Quantity in package, pounds.	Gelatinous matter.	Sugar.	Color.	Preservative.
	Blackberry Jam.							
2325	American Pres. Co., Phila.	*New Haven.*—F. J. Markle, 105 Broadway	14	1	—	Glucose	Ponceau*	—
	Cherry Preserves.							
2536	Alden & Nicholson Co., Rochester	*New Britain.*—73 Arch St.	12	2/3	—	Glucose	—	Salicylic Acid
	Currant Jelly.							
2540	Marlier-Job, Bar-le-Duc	*Meriden.*—H. E. Bushnell, 75 W. Main St.	25	1/3	—	Glucose	—	—
2932	Austin Nichols & Co., New York	*Middletown.*—L. B. Chaffee, 230 Main St.	25	3/4	—	Glucose	—	Benzoic Acid
2505	Columbia Pres. Co., Boston	*New Haven.*—S. S. Adams. 412 State St.	17	5	Starch paste	Glucose	Magenta*	—
2501	E. T. Cowdrey & Co., Boston	Bronson & Platt, 356 State St.	15	1/2	—	—	—	Salicylic Acid
2517	Cruikshank Bros. Co., Allegheny	E. E. Nichols, 378 State St.	20	1/2	—	—	Ponceau*	—
2922	Manufacturer not stated	*Norwich.*—Henry Norman, 36 Franklin St.	10	1/2	Starch paste	Glucose	—	—
2924	Francis Leggett & Co., New York	H. D. Rallion, 45 Broadway	25	3/4	Starch paste	—	—	—
	Damson Jam.							
2334	Ayer Pres. Co., Ayer, Mass.	*New Haven.*—O. Boettger, 209 Shelton Ave.	15	1	—	Glucose	Coal-tar dye	Salicylic Acid
	Peach Jelly.							
2921	Manufacturer not stated	*Norwich.*—Henry Norman, 36 Franklin St.	10	1/2	Starch paste	Glucose	—	—
	Pineapple Jelly.							
2532	Ayer Pres. Co., Ayer, Mass.	*New Haven.*—Booth Meat Co., 9 Grand Ave.	5	1/2	Starch paste	Glucose	—	Salicylic Acid
	Raspberry Jelly.							
2538	My Favorite	*New Britain.*—Boston Branch Grocery, 240 Main St.	10	3/4	—	Glucose	Ponceau*	—
2531	Ayer Pres. Co., Ayer, Mass.	*New Haven.*—Booth Meat Co., 9 Grand Ave.	5	1/3	Starch paste	Glucose	Coal-tar dye	Salicylic Acid
2327	Mrs. Jane Rogers. Brant, N. Y.	S. J. Brown, 954 State St.	10	2/3	—	Glucose	Ponceau*	—
2510	Hill Home Pres. Works, Rochester	A. A. Eisele, 289 Shelton Ave.	15	3/4	—	Glucose	Coal-tar dye	Salicylic Acid
2511	My Favorite	Frederick Bros., 11 Edwards St.	10	3/4	—	Glucose	Ponceau*	—
	Raspberry Jam or Preserve.							
2529	H. J. Heinz Co., Pittsburg	*Hartford.*—Hills & Co., 370 Asylum St.	25	2 1/2	—	Glucose	Ponceau*	Benzoic Acid
2931	Elk Brand, The Avery Pres. Co., Detroit	*Middletown.*—A. M. Bidwell, 344 Main St.	20	1	—	Glucose	Ponceau*	—
2509	Williams Bros. & Charbonneau, Detroit	*New Haven.*—A. A. Eisele, 289 Shelton Ave.	15	1	—	Glucose	Ponceau*	—
2329	W. N. Clark & Co., Rochester	P. Jente, 107 Broadway	15	1	—	Glucose	—	Benzoic Acid
2925	Ontario Pres. Co., Middleport, N. Y.	*Norwich.*—R. D. Rallion, 45 Broadway	22	1	—	Glucose	Bordeaux*	Benzoic Acid
2928	Republic, Austin Nichols & Co., New York	*Willimantic.*—Frank Larrabee, 20 Church St.	12	1	—	Glucose	—	—

* Coal-tar dye. See foot note, p. 124.

TABLE VIII.—ADULTERATED JELLIES, JAMS AND PRESERVES, 1901—*Continued.*

Station No.	Brand.	Dealer.	Price per package, cents.	Quantity in package, pounds.	Gelatinous matter.	Sugar.	Color.	Preservative.
	Strawberry Jelly.							
2519	My Favorite	*Hartford.*—C. N. Dodge, 340 Main St.	10	$\frac{3}{4}$		Glucose	Ponceau*	
2466	Eagle Pres. Co.	Franklin Market, 142 Main St.	10	$\frac{3}{4}$	Starch paste	Glucose	Ponceau*	
2506	Columbia Pres. Co., Boston	*New Haven.*—S. S. Adams, 412 State St.	17	5	Starch paste	Glucose	Magenta*	
2328	Mrs. Jane Rogers, Brant, N. Y.	S. J. Brown, 954 State St.	10	$\frac{2}{3}$		Glucose	Ponceau*	
	Strawberry Jam.							
2917	Republic, Austin Nichols Co., New York	*Bridgeport.*—Village Store Co., 158 State St.	15	1		Glucose	Coal-tar dye	
2527	Rochester Packing Co.	*Hartford.*—Newton, Robertson & Co., 338 Asylum St.	18	1		Glucose		Benzoic Acid
2528	Cross & Blackwell, London	Newton, Robertson & Co., 338 Asylum St.	25	1		Glucose		
2539	Winner Brand	*Meriden.*—F. H. Lewis, 98 W. Main St.	10	1	Starch paste	Glucose	Bordeaux*	Salicylic Acid
2534	Logan, Johnson & Co., Boston	*New Haven.*—S. H. Gaunya, 195 Lloyd St.	15	1		Glucose	Bordeaux*	
2330	W. N. Clark & Co., Rochester	P. Jente, Broadway	15	1		Glucose	Coal-tar dye	Benzoic Acid
2929	Republic, Austin Nichols & Co., New York	*Willimantic.* — Frank Larrabee, 20 Church St.	12	1		Glucose		

* Coal-tar dye. See foot note, p. 124.

METHODS OF EXAMINATION OF JELLIES, JAMS AND PRESERVES.

Water. Into a flat-bottomed aluminum dish, 8 cm. in diameter, containing a glass stirring-rod, both of which have been weighed together, weigh two grams of the material, ten grams of ignited sand and 50 cc. of water. Place the dish on the water bath and stir its contents until the jelly has completely dissolved. Evaporate the solution to dryness, stirring when the mass begins to stiffen to break up the lumps and mix with the sand. Heat the dish and contents in a drying cell at 100 C. till the weight is constant.

By this method the drying is complete in nearly every case within fifteen hours, whereas in trials made without sand or without preliminary solution in water, the jelly continues to lose in weight appreciably even after drying several days.

Ash. Burn five grams of the material below redness in a platinum dish.

Nitrogen. Determine by the Kjeldahl method.

Polarization. Dissolve 13.024 grams (one-half the normal weight) of the material in about 80 cc. of water. Add 3 cc. of basic lead acetate and 2 cc. of alumina cream, make the volume up to 100 cc. and filter through a dry filter. Determine the rotatory power of the solution in a 200 mm. tube.

To 50 cc. of the filtrate referred to above, add 5 cc. conc. C. P. hydrochloric acid. After thorough mixing, place in a cold water bath and heat quickly to 68° C. After standing at that temperature for 10 minutes, cool quickly, filter from lead chloride, if necessary, and examine in a 220 mm. tube, first at the room temperature and finally at 86° C.

*Arata's Wool Test for Dyes.** Dilute 25 to 50 cc. of the material to 100 cc., boil for 10 minutes with 10 cc. of a 10 per cent. solution of potassium bisulphite and a piece of white wool, or woolen cloth, which has been previously heated to boiling in a 0.1 per cent. solution of sodium hydrate, and thoroughly washed in water. Remove the wool from the solution, wash in boiling water, and dry between pieces of filter paper. If the coloring matters are entirely from fruit, the wool will either be uncolored, or will take on a faint pink or a brown color, which is changed to green by ammonia and is not restored by washing in water; but acid magenta, tropeolin, ponceau and various azo-colors are fixed on the wool and the color of the latter is either not changed by ammonia, or, if changed, is restored on washing. Cochineal, cudbear and some other vegetable colors dye the wool a reddish color which is changed to blue by ammonia.

Care should be taken to determine whether the wool is dyed, or merely coated with the color. For example, chlorophyl, from green coloring preparations of vegetable origin, is deposited on wool, together with fat

*Ztschr. anal. Chem. *28*, 639. See also Borgman, Anleitung chem. Anal. d. Weines, Wiesbaden, 1898, p. 91. Koenig, Untersuchung landw. u. gewerb. wich. Stoffe, Berlin, 1898, 577.

Table IX.—Jellies, Jams and Preserves Labeled "Compounds."

Station No.	Brand.	Dealer.	Price per package, cents.	Quantity in package, pounds.	Gelatinous matter.	Sugar other than cane sugar.	Color.	Preservative.
	Currant Jelly.							
2513	Middle B. Colored and flavored	*New Haven.*—627 Grand Ave.	10	¾	Starch paste	Glucose	-----	-----
2533	Hudson Pres. Co., New York	N. H. Provision Co., 384 Grand Ave.	10	⅔	Starch paste	Glucose	-----	-----
2919	Clifford's Fruit Flavor Jellies	*New London.*—F. H. Smith, 100 State St.	10	¾	Apple	Glucose	Ponceau*	Benzoic Acid
2927	E. S. Kibbe Co., Hartford	*Willimantic.*—877 Main St.	10	¾	Starch paste	Glucose	Bordeaux*	-----
	Pineapple Preserve.							
2504	Maple Leaf, Williams Bros. & Charbonneau, Detroit	*New Haven.*—Bronson & Platt, 356 State St.	10	1		Glucose	-----	-----
	Quince Preserve.							
2344	Ivanhoe Jam, Crescent Pres. Co., Camden	*New Haven.*—J. V. Rattlesdorfer, 95 Greene St.	15	1		Glucose	Coal-tar dye	-----
	Raspberry Jelly.							
2523	Boston Pres Co.	*Hartford.*—Public Market, 653 Main St.	10	⅔	Starch paste	Glucose	Bordeaux*	Salicylic Acid
2502	Hudson Pres. Co., New York	*New Haven.*—Bronson & Platt, 356 State St.	10	½	Starch paste	Glucose	Bordeaux*	Salicylic Acid
2926	E. S. Kibbe Co., Hartford	*Willimantic.*—877 Main St.	10	¾	Starch paste	Glucose	Bordeaux*	Salicylic Acid
	Raspberry Jam or Preserve.							
2515	Tourist's Brand, The Avery Pres. Co., Detroit	*New Haven.*—G. W. Cooper, Grand Ave.	10	1	Apple	Glucose	Coal-tar dye	-----
2507	Maple Leaf, Williams Bros. & Charbonneau, Detroit	C. Kipp, 290 Shelton Ave.	10	1	-----	Glucose	Ponceau*	-----
2324	American Pres. Co., Phila.	H. M. Strack, 13 Shelton Ave.	15	¾		Glucose	Ponceau*	-----
2332	Tourist's Brand, The Avery Pres. Co., Detroit	Voelker Bros., 123 Shelton Ave.	10	1	Apple	Glucose	Ponceau*	-----
	Strawberry Jelly.							
2524	Strawberry Flavor, Logan, Johnson & Co.	*Hartford.*—C. S. Caswell, 295 Asylum St.	10	¾		Glucose	-----	-----
2512	Middle B. Colored and flavored	*New Haven.*—627 Grand Ave.	5	½	Starch paste	Glucose	-----	-----
2920	Clifford's Fruit Flavor Jellies	*Norwich.*—6 Franklin St.	10	¾		Glucose	Coal-tar dye	Benzoic Acid
	Strawberry Jam or Preserve.							
2916	Franklin Pres. Co., New York	*Bridgeport.*—Lee & Ketcham, 20 Fairfield Ave.	10	1	-----	Glucose	Coal-tar dye	Benzoic Acid
2514	Tourist's Brand, The Avery Pres. Co., Detroit	*New Haven.*—G. W. Cooper, Grand Ave.	10	1	-----	Glucose	Ponceau*	-----
2508	Maple Leaf, Williams Bros. & Charbonneau, Detroit	C. Kipp, 290 Shelton Ave.	10	1	-----	Glucose	Ponceau*	-----
2323	American Pres. Co., Phila.	H. M. Strack, 13 Shelton Ave.	10	1	Starch paste	Glucose	Coal-tar dye	-----

* Coal-tar dye. See foot note, p. 124.

and resin, but the color, unlike the coal-tar dyes, rubs off on the fingers and is readily washed out with soap and water.

The dye present may often be identified by noting the color of the wool after addition of enough concentrated sulphuric acid to thoroughly moisten the fibers and again after dilution of the acid. In doubtful cases, however, treat the wool with dilute tartaric acid solution to remove vegetable colors, wash in water and dry between sheets of filter paper. Transfer to a test tube and saturate with concentrated sulphuric acid. After standing 5 or 10 minutes, add water sufficient to make 10 cc. and remove the wool. After neutralizing with ammonia and cooling, shake the solution with 5 to 10 cc. of pure amyl alcohol, to which a few drops of ethyl alcohol are added, to facilitate the separation. Wash the alcoholic extract, evaporate to dryness, and test the residue according to the scheme of Witt,* Weingaertner,† Dommergue,‡ or Girard and Dupré.§

Amyl Alcohol-Ammonia Test for Dyes.|| Make 25 cc. of the diluted material under examination alkaline with ammonia; shake cautiously for some minutes in a separatory funnel, with pure amyl alcohol. If the clear alcoholic layer, when separated from the aqueous solution, is colored, or if addition of acetic acid developes a magenta color (fuchsine), heat a portion of it, together with an equal bulk of water and a thread of wool, on a water bath, replacing from time to time the water lost by evaporation. The presence of a coal-tar dye should not be affirmed until the color has been fixed on wool and the wool has been washed in boiling water, dried and tested.

Evaporate another portion of the alcoholic solution to dryness and test the residue. When fuchsine (magenta) is present, the color, which appears on adding acetic acid to the alcohol extract, is changed to yellow by hydrochloric acid.

Amyl Alcohol-Hydrochloric Acid Test for Dyes. Acidify 25 cc. of the diluted material with a few drops of hydrochloric acid, shake with amyl alcohol and make dyeing tests and tests on the residue as described in the preceding section.

A colored amyl alcohol does not prove the presence of a coal-tar color, as we have found that red coloring matters are extracted by this solvent from acid solutions of fruit juices.** These solutions, however, do not dye wool, when treated as above described.

Girard's Test for Acid Fuchsine (Acid Magenta).†† If a bright magenta color is fixed on wool by Arata's test and if ordinary fuchsine has been proved to be absent, test should be made for acid fuchsine.

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*Ztschr. anal. Chem. *26*, 100.

†Ibid., *27*, 232.

‡Ibid., *29*, 369.

§Analyse des Matières Alimentaires et Recherche de leurs Falsification, pp. 583-593.

||Ibid., 167, 582.

**Report of this Station, 1898, p. 110.

††Girard et Dupré, Analyse des Matières Alimentaires et Recherche de leurs Falsification, p. 169.

TABLE X.—ANALYSES OF JELLIES, JAMS AND PRESERVES.

Station No.		Total solids.	Nitrogen.	Polarization. Direct.	After inversion.	Temp. C.	After inversion. Reading at 86° C.
	Not Found Adulterated.	%	%				
2530	Blackberry Jam or Preserve	80.00	0.09	38.2	−23.2	18	0.0
2941	Currant Jelly	67.62	0.02	−2.0	−21.6	20	0.0
2940	" "	72.50	0.02	−4.8	−20.0	20	0.0
2521	" "	61.83	0.02	−12.8	−20.0	19	0.0
2522	" "	60.83	0.04	−10.4	−20.2	19	1.2
2525	" "	65.11	0.01	4.4	−20.0	19	0 0
2526	" "	53.85	0.02	−12.0	−18.0	18	0.0
2537	" "	67.52	0.04	−1.6	−22.6	18	0.0
2923	" "	59.82	0.04	−12.0	−16.0	17	3.0
2520	Raspberry Jam or Preserve	71.02	0.06	10.0	−21.0	23	4.0
2535	" " "	75.80	0.15	42.6	−22.0	18	1.0
2518	Grape Jelly	68.27	0.02	18.0	−21.6	19	0.0
2918	" "	65.16	0.02	−7.4	−22.4	17	0.0
	Adulterated.						
2325	Blackberry Jam or Preserve	70.00	0.08	106.0	104.0	20	94.0
2536	Red Cherry Jelly	76.25	0.08	69.0	57.4	18	64.4
2540	Currant Jelly	62.60	0.03	19.0	−2.8	16	14.6
2932	" "	67.68	0.05	17.4	−21.6	20	1.0
2505	" "	62.95	0.03	117.0	116.0	22	108.0
2501	" "	68.87	0.07	0.0	−22.4	22	0.0
2517	" "	68.07	0.02	28.2	−22.0	18	0.0
2922	" "	71.92	0.02	37.0	27.0	17	41.2
2924	" "	63.77	0.04	−15.6	−22.2	17	0.0
2334	Plum Jam or Preserve	72.55	0.04	109.0	106.0	20	106.0
2921	Peach Jelly	74.00	0.02	34.0	30.0	18	40.0
2532	Pineapple Jelly	76.16	0.03	97.4	93.2	19	94.2
2538	Raspberry Jelly	61.54	0.03	104.8	100.8	18	96.0
2531	" "	75.53	0.04	93.2	90.0	18	91.0
2327	" "	63.22	0.03	104.4	103.4	20	96.8
2510	" "	59.78	0.04	77.0	74.4	18	72.0
2511	" "	65.25	0.02	109.0	104.8	20	98.0
2529	Raspberry Jam or Preserve	72.59	0.05	42.0	2.4	19	19.6
2931	" " "	70.00	0.03	86.0	79.2	20	80.0
2509	" " "	69.95	0.02	112.6	104.4	18	96.0
2329	" " "	61.57	0.09	48.8	26.6	21	36.8
2925	" " "	68.52	0.09	61.0	38.8	20	47.0
2928	" " "	70.60	0.05	76.6	71.2	19	74.0
2519	Strawberry Jelly	62.67	0.02	107.4	102.0	18	98.0
2466	" "	64.37	0.02	96.0	92.6	21	88.0
2506	" "	62.60	0.02	114.0	114.6	20	107.0
2328	" "	64.92	0.02	106.0	102.6	20	87.0
2917	Strawberry Jam or Preserve	66.55	0.03	50.4	37.0	17	44.0
2527	" " "	65.11	0.04	64.4	28.0	19	40.0
2528	" " "	73.15	0.08	34.4	3.6	19	21.0
2539	" " "	73.62	0.04	136.0	128.4	18	124.0
2534	" " "	68.75	0.05	115.2	108.6	19	104.0
2330	" " "	64.43	0.06	55.0	28.0	22	36.0
2929	" " "	75.17	0.05	72.8	56.0	19	62.8

TABLE X.—ANALYSES OF JELLIES, JAMS AND PRESERVES —*Continued.*

Station No.	Compound.	Total solids.	Nitrogen.	Polarization. Direct.	Polarization. After inversion.	Polarization. Temp. C.	Polarization. After inversion. Reading at 86° C.
		%	%				
2513	Currant Jelly	69.92	0.02	61.4	47.4	22	49.0
2533	" "	63.45	0.02	108.0	106.0	18	100.0
2919	" "	60.66	0.02	85.6	82.6	17	82.0
2927	" "	65.20	0.03	92.4	87.6	18	81.6
2504	Pineapple Jam or Preserve	74.30	0.03	111.0	108.8	20	99.0
2344	Quince Jam or Preserve	62.05	0.04	99.0	92.0	21	86.0
2523	Raspberry Jelly	68.14	0.03	101.6	98.6	19	96.0
2502	" "	68.15	0.05	108.4	107.6	20	99.0
2926	" "	65.22	0.03	88.0	85.0	20	83.0
2515	Raspberry Jam or Preserve	74.72	0.03	148.8	143.0	20	135.0
2507	" " "	73.59	0.04	103.6	96.0	20	94.4
2324	" " "	73.50	0.03	82.2	60.0	20	64.6
2332	" " "	68.50	0.03	130.6	128.0	20	116.6
2524	Strawberry Jelly	64.00	0.02	90.0	87.4	19	88.0
2512	" "	68.28	0.02	42.4	36.0	19	44.0
2920	" "	67.86	0.02	99.0	83.6	17	84.4
2916	Strawberry Jam or Preserve	65.90	0.05	96.0	82.0	18	82.0
2514	" " "	67.35	0.02	134.0	130.0	19	124.0
2508	" " "	67.50	0.04	105.0	96.8	21	94.8
2323	" " "	67.67	0.03	91.0	88.4	20	88.4

To 10 cc. of the diluted material, add 2 cc. or more of 5 per cent. solution of potassium hydrate. Mix the strongly alkaline liquid with 4 cc. of 10 per cent. solution of mercuric acetate and filter. The filtrate should be alkaline and colorless. If addition of a slight excess of dilute sulphuric acid produces a violet red coloration and other dyes have not been found by the amyl alcohol test, the presence of acid fuchsine may be affirmed.

*Test for Cochineal.** If amyl alcohol extracts from the liquid, after acidifying, an orange color which has not been found to be of coal-tar origin, test for cochineal.

Wash the alcohol several times with water and divide into two portions. To one portion add a solution of uranium acetate, drop by drop, with shaking. In the presence of cochineal the aqueous solution acquires an emerald-green color. As a confirmatory test, make the other portion alkaline with ammonia, which changes the orange color of cochineal to purple.

Vegetable Colors are identified by the methods described by Girard and Dupré.

*Girard et Dupré, Analyses des Matières Alimentaires, etc., p. 580.

TOMATO CATSUP, CHILI SAUCE, AND OTHER SAUCES.

BY A. L. WINTON AND A. W. OGDEN.

Tomato Catsup or Ketchup is the most popular of the bottled table sauces on our market. It is found on the tables of nearly every hotel and restaurant and is consumed in large quantities in families.

When made in the household, ripe tomatoes are pared, cored, boiled down to the desired consistency and strained through a sieve to remove seeds. The strained pulp is cooked for a time with vinegar, spices and other flavoring matters.

Chili Sauce is prepared in a similar manner from tomatoes, peppers (chillies), vinegar, spices, etc., but unlike catsup is not usually strained.

Both of these sauces are bottled hot and closed to exclude germs, but while the sterilization or the sealing is not always perfect, the contents of the bottles are kept from spoiling, during storage as well as during use, by virtue of the spices and vinegar.

Commercial Catsup, Chili Sauce, etc. Some of the catsups and chili sauces on the market are made from good materials, but others are said to be made from the refuse of tomato canneries or other inferior pulp and most of them are colored with dyes and preserved with chemicals.

Among the colors used are eosin, ponceau, tropeolin, magenta and others of coal-tar origin. They impart to the sauces a brilliant red color which those who are unaware that the uncolored products have a dull red or brown color, believe is the natural color of the fruit. The objections to their use are: first, they deceive the purchasers while they in no way improve the quality of the sauce; second, they may serve to hide inferior material used in their manufacture; third, they are possibly injurious to health; and fourth, they put genuine uncolored goods to a disadvantage in the market.

The chemicals commonly employed as preservatives are salicylic acid, salicylate of soda, benzoic acid and benzoate of soda. The preserving agent actually present in the product is the same whether one of these acids or its soda salt is used, since the free acid of the tomato liberates the acid of both the salicylate and benzoate of soda. The use of any of these preservatives in catsups and sauces without informing the purchaser of its presence is a violation of the pure food law.

Examination of Samples Sold in Connecticut.

Forty-one brands of catsup were examined in 1897, of which only 6 were free from chemical preservatives. Of the remaining 35 brands, 27 contained salicylic acid and 8 benzoic acid. Although many of these samples were evidently colored, no tests for dyes were made.

During the present year, 106 samples of catsup, chili sauce and other sauces were tested for both dyes and chemical preservatives and, in addition, determinations of total solids and acidity were made. Detailed results are given in Tables XIII and XIV, and a summary of the tests for colors and preservatives in Tables XI and XII, which follow:

Table XI.—Summary of Tests for Preservatives in Sauces, 1901.

	Tomato catsup.	Chili sauce.	Misc. sauces.	Total
Preserved with salicylic acid	15	1	2	18
" " benzoic acid	61	6	0	67
No preservative found	18	2	1	21
Total number of samples	94	9	3	106

Table XII.—Summary of Tests for Dyes in Sauces.

	Tomato catsup.	Chili sauce.	Misc. sauces.	Total.
Colored with eosin	31	2	0	33
" " ponceau	43	4	0	47
" " tropeolin	2	1	0	3
" " other coal-tar dyes	3	0	0	3
No artificial color found	15	2	3	20
Total number of samples	94	9	3	106

Of the 106 brands examined, 67 contained benzoic acid (probably added in most cases as sodium benzoate) and 18 contained salicylic acid. It thus appears that the former of these preservatives is now more commonly employed than the latter, whereas the reverse was true in 1897.

Tests for dyes showed that 31 brands were colored with eosin (the common dye of red ink), 47 with ponceau, 3 with tropeolin and 3 with other coal-tar dyes. All but 20 of the 106 brands were found to contain artificial coloring matter.

The percentages of solids in the tomato catsups ranged from 6.03 to 42.64 and of acidity from 0.60 to 2.20. Otherwise expressed, some of the samples were seven times as concentrated and nearly four times as sour as others.

In the chili sauces, the percentages of solids ranged from 12.02 to 37.36 and of acidity from 0.80 to 1.60.

Methods of Analysis.

Total Solids. Evaporate 5 grams of the material to dryness in a flat-bottomed metal dish on a water bath, and dry in a boiling water-oven for 20 hours.

Acidity. Dilute 1 gram with water and titrate with standard alkali, using phenolphthalein as an indicator.

Detection of Dyes and Preservatives. See pages 128, 132, and 134.

Table XIII.—Catsup and Sauces not found to contain Chemical Preservatives or Coal Tar Dyes.

Station No.	Brand.	Dealer.	Price per bottle, cents.	Capacity of bottle, fluid oz.	Total solids.	Acidity calculated as acetic acid.
	Tomato Catsup.				%	%
2495	Gulden's Strictly Pure	*Bridgeport.*—Platt & Ritch, 89 State St.	10	10	6.51	1.30
2468	National Pure Food Co., Boston	*Hartford.*—Newton, Robertson & Co., 338 Asylum St.	15	16	22.52	1.40
2305	Home Brand, Home Packing Co., Cincinnati	Public Market Co., 653 Main St.	10	12	14.90	1.26
2304	Climax, Climax Packing Co., Cincinnati	Sweeney Grocery, 983 Main St.	10	12	20.77	1.40
2487	Anchor, Anchor Packing Co., Cincinnati	*Meriden.*—H. E. Bushnell, 75–79 W. Main St.	10	8	21.65	1.50
2308	Monogram, R. C. Williams & Co., New York	*New Britain.*—H. A. Hall, 212 Main St.	20	17	20.31	1.26
2335	Shrewsbury, E. C. Hazard & Co., New York	*New Haven.*—Bronson & Platt, 356 State St.	25	15	16.58	1.30
2348	Tomato Pure, H. Desegaulx & Cie., Bordeaux	E. E. Hall, 381 State St.	20	5	8.24	0.60
2992	Superior, Treanor Bros., New York	*So. Norwalk.*—Model Grocery, 13 Main St.	5	10	8.06	1.25
3000	Climax, Climax Packing Co., Cincinnati	*Stamford.*—W. W. Waterbury, 207 Main St.	10	9	24.54	1.50
	Celery Catsup.					
2336	Celery Ketchup Co., New York	*New Haven.*—C. Kipp, 290 Shelton Ave.	15	16	29.19	1.50
	Chili Sauce.					
2945	Shrewsbury, E. C. Hazard & Co., New York	*Stamford.*—H. S. Daskam, 59 Atlantic St.	20	8	23.89	1.80

TABLE XIV.—CATSUP AND SAUCES CONTAINING CHEMICAL PRESERVATIVES AND COAL-TAR DYES.

Station No.	Brand.	Dealer.	Price per bottle, cents.	Capacity of bottle, fluid ounces.	Total solids.	Acidity calculated as acetic acid.	Dye.	Preservative.
					%	%		
	Tomato Catsup.							
1927	Star Brand, D. M. Welch & Son	*Ansonia.*—D. M. Welch, 188 Main St.	10	14	16.70	1.34	Eosin.*	Benzoic Acid.
1918	Standard Brand, P. J. Ritter Co., Phila.	450 Main St.	20	15	15.01	0.96	Eosin.*	Benzoic Acid.
1919	Home Comfort, Brant Canning Co., Brant, N. Y.	450 Main St.	10	15	18.14	1.50	Eosin.*	Benzoic Acid.
1921	Connecticut Brand, New York	454 Main St.	15	27	7.09	1.76	Eosin.*	
2486	Eclipse, M. J. Meyer, New York	*Bridgeport.*—Coe & White, 562 Main St.	10	14	10.93	0.95	Ponceau.*	Benzoic Acid.
2493	Paramount, Alart & McGuire, New York	A. F. Harvey, 114 Main St.	10	12	12.01	1.10	Eosin.*	Benzoic Acid.
2492	Yankee Doodle, American Relish Co., Indianapolis	N. Y. Butter House, 12 Fairfield Ave.	10	15	19.90	1.80	Eosin.*	Benzoic Acid.
2491	Savoy, Savoy Ketchup Co., New York	N. Y. Butter House, 12 Fairfield Ave.	10	15	10.75	1.00	Ponceau.*	Benzoic Acid.
2496	Yankee Doodle, American Relish Co.	S. M. Phillips, 252 State St.	10	15	20.85	1.70	Eosin.*	Benzoic Acid.
2494	Royal Scotch, Hallock-Denton Co., Newark	C. Russel & Co., 335 Main St.	25	16	24.02	1.35	Ponceau.*	Salicylic Acid.
2943	Red Jacket, Lewis De Groff & Son., New York	*Danbury.*—C. Beers, 101 White St.	8	16	11.56	0.60	Ponceau.*	Benzoic Acid.
2983	Wild Rose, Ohio Valley Pres. Co., Wheeling	Danbury Grocery Co., 289 Main St.	10	15	15.58	1.30	Ponceau.*	Benzoic Acid.
2984	"O. K.," Alart & McGuire, New York	Hoyt & Scott, 7 West St.	10	27	7.04	1.20	Ponceau.*	Salicylic Acid.
2982	Lenox, Lenox Catsup Co.	McGraw & Baldwin, 93 White St.	10	15	13.88	1.30	Ponceau.*	Benzoic Acid.
2987	Our Diploma	105 White St.	10	8	14.89	0.70		Benzoic Acid.
2471	The Windsor Canning Co.	*Hartford.*—Bushnell Market, 371 Asylum St.	10	20	10.01	1.20	Ponceau.*	
2303	Bordeaux, Standard Packing Co., Indianapolis	C. N. Dodge, 340 Main St.	10	15	21.03	1.68	Eosin.*	Benzoic Acid.
2463	Our Favorite, Farnham Packing Co., New York	C. N. Dodge, 340 Main St.	10	16	24.67	1.30	Eosin.*	Benzoic Acid.
2302	Sunny Side, The Tip Top Ketchup Co., Cincinnati	H. Griswold, 547 Main st.	10	14	11.26	0.60	Ponceau.*	Benzoic Acid.
2469	Gold Seal, Hills & Co.	Hills & Co., 370 Asylum St.	15	9	29.93	1.30	Eosin.	Benzoic Acid.
2467	Newport, The Tip Top Ketchup Co.	Public Market, 653 Main St.	10	12	11.30	0.60	Ponceau.*	
2464	Melrose, Melrose Packing Co., Phila.	A. H. Tillinghast, 341 Main St.	10	10	16.07	1.20	Ponceau.*	Benzoic Acid.
2470	Mayflower Brand, Rivkin Bros., Hartford	336 Pearl St.	10	16	23.64	1.40	Ponceau.*	Benzoic Acid.
2485	Oriole, Phila.	*Meriden.*—Fred H. Lewis, 98 W. Main St.	10	8	9.57	1.00	Ponceau.*	Benzoic Acid.
2488	King, Sherwood & Son	Pure Food, 64 W. Main St.	14	15	20.07	0.70	Ponceau.*	Benzoic Acid.
2489	Faust's Oyster Cocktail, Dodson-Braun Co., St. Louis	Public Meat Market, 25 E. Main St.	25	16	21.95	1.50	Ponceau.*	Salicylic Acid.
2490	Gold Leaf, J. S. Birden & Co., Hartford	H. F. Rudolph, 48 E. Main St.	10	9	17.50	1.10	Ponceau.*	Benzoic Acid.
2976	20th Century, Jas. G. Powers & Co., New York	*Middletown.*—R. A. Pease & Sons, 236 Main St.	10	15	18.18	0.90	Ponceau.*	Benzoic Acid.
2975	Violet, J. V. Sharp Can. Co., Williamstown, N. J.	150 Main St.	10	8	18.54	0.80		Benzoic Acid.

* Coal-tar dye. See foot note, p, 124.

Table XIV.—Catsup and Sauces containing Chemical Preservatives and Coal-Tar Dyes—*Continued.*

Station No.	Brand.	Dealer.	Price per bottle, cents.	Capacity of bottle, fluid ounces.	Total solids.	Acidity calculated as acetic acid.	Dye.	Preservative.
	Tomato Catsup.				%	%		
2309	Gold Medal, Boston Branch	*New Britain.*—Boston Branch Grocery, 240 Main St.	9	12	11.16	1.02	Ponceau.*	Benzoic Acid.
2480	Gold Medal, Boston Branch	Boston Branch Grocery, 240 Main St.	18	12	11.34	1.00	Ponceau.*	Benzoic Acid.
2481	East Hamburg Canning Co., Orchard Park, N. Y.	Boston Branch Grocery, 240 Main St.	9	16	25.55	1.10	Eosin.*	
2484	Club House	City Market, 318 Main St.	10	17	10.88	1.15	Eosin.*	Benzoic Acid.
2479	Long Island, Mason Pres. Co., Brooklyn	H. A. Hall, 212 Main St.	10	16	9.15	1.00	Ponceau.*	Benzoic Acid.
2477	Violet, J. V. Sharp Can. Co.	Herrman, 73 Arch St.	15	16	15.69	0.60	Ponceau.*	Benzoic Acid.
2483	East Rock, Brown & Co., New Haven	Public Market, 373 Main St.	10	23	9.37	1.20	Ponceau.*	Benzoic Acid.
2307	Standard, Standard Mfg. Co., Wheeling	Public Market & Grocery House, 373 Main St.	10	12	10.45	0.96	Ponceau.*	Benzoic Acid.
2306	Winner, The E. S. Kibbe Co., Hartford	Union Trading Co., 61 Arch St.	15	14	21.52	1.30	Eosin.*	Benzoic Acid.
2966	Home Made, Treanor Bros., New York	*New London.*—51 State St.	10	10	7.16	1.20	Tropeolin.*	
3008	Van Camp's, Van Camp Packing Co., Indianapolis	*New Haven.*—M. M. Allyn, 7 Broadway	20	16	27.55	1.11	Eosin.*	Salicylic Acid.
2541	Green Label, The Little Silver Sauce Co., N. J.	Atlantic & Pacific Tea Co, 386 State St.	15	15	23.04	0.70		Benzoic Acid.
2333	Royal, The John T. Doyle Co., New Haven	Boettger, 209 Shelton Ave.	20	12	21.50	1.18	Eosin *	Salicylic Acid.
2337	Tomato Catsup	G. W. Cooper, 3 Atwater Blk.	10	27	7.47	1.10	Eosin.*	Salicylic Acid.
2338	A. C. Blenner & Co.'s, New Haven	G. W. Cooper, 3 Atwater Blk.	15	9	7.98	1.20	Eosin.*	Salicylic Acid.
2475	New England, Berwick Pres. Co., New York	E. L. Dutcher, 99 Grand Ave.	8	10	15.02	0.95	Ponceau.*	Benzoic Acid.
2474	Buckeye, The Wm. Boardman & Son's Co., Hartford	Hubbard, 24 Grand Ave.	10	12	11.36	0.90	Ponceau.*	Salicylic Acid.
2346	Flaccus Bros., Wheeling	Johnson & Bros., 411 State St.	15	9	19.25	1.20	Eosin.*	Benzoic Acid.
2326	Blue Label, Curtice Bros. Co., Rochester	F. J. Markle, 105 Broadway	20	16	19.55	0.92		Benzoic Acid.
2476	Uncle Sam, Brown & Co., New Haven	New Haven Provision Co., 384 Grand Ave.	5	10	16.52	1.40	Ponceau.*	Benzoic Acid.
3007	Snider's, T. A. Snider Pres. Co., Cincinnati	E. E. Nichols, 378 State St.	25	16	19.23	0.88	Ponceau.*	Benzoic Acid.
2460	Conn. Brand, Bryan, Miner & Read, New Haven	S. Sax, 251 Grand Ave.	8	13	13.18	1.60	Coal-tar dye.	Benzoic Acid.
2461	J. S. Birden & Co., Hartford	S. Sax, 251 Grand Ave.	5	10	12.73	1.10	Coal-tar dye.	
2516	Home Sweetest	A. Schultz, 802 Grand Ave.	10	14	21.46	1.10	Eosin.*	Salicylic Acid.
2322	Bergen's Brunswick Brand, New York	H. M. Strack, 13 Shelton Ave.	10	27	6.03	0.88	Tropeolin.*	Salicylic Acid.
2472	Pride of Long Island, The Longfield Bergen Co., New York	D. M. Welch & Sons, 8 Grand Ave.	15	16	17.65	1.10	Eosin.*	Salicylic Acid.
2473	High Grade	D. M. Welch & Sons, 8 Grand Ave.	5	8	8.15	1.10	Eosin & Ponceau.*	Benzoic Acid.
2999	Finney & Benedict's	*Norwalk.*—Finney & Benedict, 41 Wall St.	20	16	23.34	1.60	Ponceau.*	Salicylic Acid.
2998	Savoy, Savoy Ketchup Co., New York	H. Glover & Sons, 35 Wall St.	10	15	15.78	1.00	Ponceau.*	Benzoic Acid

* Coal-tar dye. See foot note, p. 124.

TABLE XIV.—CATSUP AND SAUCES CONTAINING CHEMICAL PRESERVATIVES AND COAL-TAR DYES—*Continued.*

Station No.	Brand.	Dealer.	Price per bottle, cents.	Capacity of bottle, fluid ounces.	Total solids.	Acidity calculated as acetic acid.	Dye.	Preservative.
	Tomato Catsup.				%	%		
2996	The Champion. The Champion Pres. Co., Wheeling	New York Cash Grocery, 37 Main St.	10	15	18.34	0.95	Ponceau.*	Benzoic Acid.
2944	White Label, Schoenberg & Co., New York	H. N. Rider, 18 Wall St.	10	13	11.26	1.10	Ponceau.*	Benzoic Acid.
2968	New Process, J. E. Thompson	*Norwich.*—H. I. Palmer, 231 Main St.	15	16	13.95	0.95	Ponceau.*	Benzoic Acid.
2969	The Gem, Mrs. Bradley	H. I. Palmer, 231 Main St.	5	9	10.59	1.00	Eosin.*	Benzoic Acid.
2310	New England, The Berwick Pres. Co., New York	*Southington.*—S. J. Griffin, Main St.	10	16	18.19	1.26	Ponceau.*	Benzoic Acid.
2311	"Now We Have It," Eagle Pres. Co., New York	Upson Bros.	12	15	14.25	1.28	Ponceau.*	Benzoic Acid.
2990	Cedar Valley, Wooster Pres. Co., Wooster, O.	*So. Norwalk.*—G. C. Friedrich, 9 Railroad Ave.	10	12	20.73	1.05	Eosin.*	Benzoic Acid.
2993	Eclipse Gigantic, M. J. Meyer, New York	F. D. Lawton & Co., 22 Main St.	15	27	9.88	1.30	Ponceau.*	Benzoic Acid.
2994	Lion, Hudson Pres. Co., New York	F. D. Lawton & Co., 22 Main St.	10	16	6.25	1.00	Ponceau.*	Benzoic Acid.
2995	Surprise, Crescent Pres. Co., Camden, N. J.	F. D. Lawton & Co., 22 Main St.	12	15	12.01	1.20	Eosin.*	Benzoic Acid.
2991	New England, The Berwick Pres. Co., New York	Model Grocery, 13 Main St.	15	15	21.78	1.10	Ponceau.*	Benzoic Acid.
3003	Pride of the Farm	*Stamford.*—O. S. Brown, 10 Main St.	10	14	18.33	1.30	Ponceau.*	Benzoic Acid.
3005	Gulden's Star Catsup	Kirk & Dixon, 38 Atlantic St.	10	11	6.42	1.10	Eosin.*	Salicylic Acid.
3006	Eddy's, E. Pritchard, New York	New York Prov. Co., 61 Atlantic St.	10	10	18.33	1.10	Ponceau.*	Benzoic Acid.
3001	Club House, Rafferty & Co., New York	Stamford Cash Market, 1 Pacific St.	10	16	42.64	0.75	Eosin.*	
2317	Crescent, Crescent Pres. Co., Camden, N. J.	*Torrington.*—Aug. Mahien, 28 E. Main St.	10	9	11.29	1.26	Coal-tar dye.	Benzoic Acid.
2315	Blue Bell, The John T. Doyle Co., New Haven	*Waterbury.*—Hamilton Cash Grocery, 47 E. Main St.	10	16	15.56	1.20		Benzoic Acid.
2933	Sunflower, Bay State Pres. Co., Boston	The Mammoth Market, 155 Bank St.	8	16	14.12	0.85	Ponceau.*	Salicylic Acid.
2934	Guilford, The John T. Doyle Co., New Haven	The Mammoth Market, 155 Bank St.	8	16	17.06	1.00	Ponceau.*	
2312	Lutz & Schramm Co., Allegheny	Spencer & Pierpont Co., 362 E. Main St.	10	10	21.37	1.30	Eosin.*	Benzoic Acid.
2938	Honey Dew, Erie Pres. Co., Buffalo	The White Simmons Co., 165 Bank St.	20	16	24.21	1.20	Eosin.*	
2937	Eagle Brand, Charles F. Loomis	The White Simmons Co., 165 Bank St,	15	16	22.68	1.40	Ponceau.*	Benzoic Acid.
2313	Bordeaux, Standard Packing Co., Indianapolis	The White Simmons Co., 165 Bank St.	10	14	20.22	1.18	Eosin.*	Benzoic Acid.
2973	Yale Club, The John T. Doyle Co.	*Willimantic.*—Purington & Read, 717 Main St.	18	9	18.68	2.10	Eosin.*	Salicylic Acid.
2971	Ponce Dressing, Caterer's Specialty Co., New York	Willimantic Cash Store, 17 Union St.	40	17	21.09	2.20	Eosin.*	Benzoic Acid.
2320	Heinz, H. J. Heinz Co., Pittsburg	*Winsted*—Deming & Phelps, Main St.	15	9	19.98	1.04	Ponceau.*	Benzoic Acid.
2319	Buckeye, The Wm. Boardman & Son's Co.	Sam Perlysky, Main St.	10	13	13.81	0.92	Ponceau.*	Benzoic Acid.

* Coal-tar dye. See foot note, p. 124.

TABLE XIV.—CATSUP AND SAUCES CONTAINING CHEMICAL PRESERVATIVES AND COAL-TAR DYES—*Continued.*

Station No.	Brand.	Dealer.	Price per bottle, cents.	Capacity of bottle, fluid ounces.	Total solids.	Acidity calculated as acetic acid.	Dye.	Preservative.
					%	%		
	Chili Sauce.							
2465	No Label	*Hartford.*—Allen Bros., 466 Main St.	10	8	12.02	1.50		Salicylic Acid.
2341	Sunny Side, The Tip Top Ketchup Co., Cincinnati	*New Haven.*—Frederick Bros., 11 Edwards St.	10	9	25.39	1.20	Ponceau.*	
2347	Old Virginia, McMechen & Son Co., Wheeling	E. E. Hall, 389 State St.	32	16	18.31	1.10	Ponceau.*	Benzoic Acid.
2345	Flaccus Bros., Wheeling	Johnson & Bros., 411 State St.	18	9	34.83	1.00	Ponceau.*	Benzoic Acid.
2343	Campbell's, J. Campbell Pres. Co., Camden	J. V. Rattlesdorfer, 95 Greene St.	10	11	20.25	1.20	Eosin.*	Benzoic Acid.
2331	Columbia, The Mullen, Blackledge Co., Indianapolis	Voelker Bros., 123 Shelton Ave.	15	9	23.71	1.60	Eosin.*	Benzoic Acid.
2967	High Grade, Treanor Bros. & Co., New York	*New London.*—Schwaner's Grocery, 21 Main St.	15	10	13.42	1.10	Tropeolin.*	Benzoic Acid.
2970	Tourist Brand, The Avery Pres. Co., Detroit	*Willimantic.*—877 Main St.	10	12	37.36	0.80	Ponceau.*	Benzoic Acid.
	Appetizer Sauce.							
2478	Appetizer Sauce Co., Boston	*New Britain.*—Union Trading Co., 61 Arch St.	10	8	10.47	1.60		Salicylic Acid.
	Grape Ketchup.							
2342	Hammondsport Pres. Co., N. Y.	*New Haven.*—E. E. Nichols, 378 State St.	20	16	30.67	1.40		Salicylic Acid.

* Coal-tar dye. See foot note, p. 124.

CRÊME DE MENTHE, CRÊME DE VIOLETTE, CRÊME DE ROSE AND OTHER CORDIALS.

BY A. L. WINTON, A. W. OGDEN AND C. LANGLEY.

The examination of bright-colored cordials has been undertaken, not because they are seriously adulterated—if indeed they may be regarded as adulterated at all—but because they illustrate most strikingly the extreme to which the present mania for colored food may be carried.

Crême de menthe is a cordial usually containing from 13 to 30 per cent. of alcohol, from 10 to 40 per cent. of sugar, a certain amount of oil of peppermint and possibly other flavoring matter, and a vivid green dye or mixture of dyes. Uncolored crême de menthe has very little sale, and it is doubtless true that the popularity of the green product is due quite as much to its color as to its flavor.

Crême de violette and crême de rose (rose cordial) have about the same amount of alcohol and sugar as the preceding, but the former is flavored with a violet-like extract (probably orris) and colored with methyl violet or other coal-tar product, and the latter is flavored with rose and colored with various red dyes.

Other cordials, such as crême de cacao and crême de celery, belong in the same class with those already described.

Table XV gives analyses of twenty-nine brands of cordials found on sale in Connecticut.

All but two of the mint cordials were colored with coal-tar

TABLE XV.—ANALYSES OF CORDIALS.

Station No.			Price per bottle, cents	Capacity of bottle, fluid ounces.	Specific gravity at 15.5° C.	Total solids.	Cane sugar.	Glucose.	Alcohol by weight.	Dye.	Polarization.			
											Direct.	After inversion.	Temp. degrees C.	After inversion, reading at 86° C.
						%	%		%					
	Crême de Menthe.													
2048	Angelique Boughard & Rochelle	*Bridgeport.*—Drew Bros., 502 Main St.	12	2	1.1346	39.46	38.5	none	19.49	Malachite green* and yellow dye	39.2	−13.0	17	0.0
2050	Compagnie Imperial	*Hartford.*—P. Donaghue, 133 State St.	85	24	1.0771	30.58	29.3	none	27.04	Malachite green*	29.6	−9.6	20	0.6
2545	Victor Gautier et Cie.	*Meriden.*—Charley Argo, 35 E. Main St.	40	16	1.1316	38.68	present	present	19.84	Malachite green*	48.8	1.4	19	11.0
2546	Renaux Bernard Jean et Cie.	*New Britain.*—Luke Bowen, 420 Main St.	20	2	1.1191	37.16	35.6	none	19.22	Vegetable color	35.2	12.8	18	0.0
2997	Liquer Superfine	*New Haven.*—The M. J. Beck Co., 398 Grand Ave.	60	24	.9989	11.90	11.1	none	29.16	Malachite green*	11.6	−3.2	20	0.0
2349	Ade Claremount Co.	Bronson & Platt, 356 State St.	10	2	1.1283	38.12	36.3	none	18.44	Malachite green*	36.0	−13.0	18	0.0
2550	Marie Brizard & Roger	E. E. Hall, 381 State St.	25	2	1.0924	33.80	32.6	none	25.07	Malachite green* and yellow dye	33.0	−10.8	19	0.0
2500	Qualite Extra Superieure	Donato Vece, 849 Grand Ave.	65	24	1.1212	33.88	33.8	none	14.03	Coal-tar dyes	34.4	−11.2	18	0.6
2350	Dorval, Pere & Fils	Jacobson & Diamond, 784 Grand Ave.	40	16	1.1233	36.90	36.9	none	19.62	Coal-tar dyes	36.8	−12.6	20	2.0
2951	Victor Gautier et Cie.	*Norwich.*—B. A. Herrick (drug store), Cor. Broadway and Main St.	15	2	1.0951	28.12	27.7	none	13.70	Coal-tar dyes	28.0	−9.6	17	1.0
2953	Bordeaux Cordial Co.	J. R. McNamara, 27 Shetucket St.	75	24	1.1032	36.42	36.0	none	26.01	Vegetable color	36.0	−11.0	21	0.8
	Crême de Violet.													
2049	Angelique Boughard & Rochelle	*Bridgeport.*—Drew Bros., 502 Main St.	12	2	1.1104	35.70	35.7	none	21.46		36.0	12.2	18	0.0
2043	Universal Cordial Co.	*New Haven.*—The M. J. Beck Co., 800 Grand Ave.	10	2	1.1342	37.76	37.6	none	16.51	Methyl violet*	37.6	−13.0	19	1.0
2045	Moray Freres et Cie.	The M. J. Beck Co., 800 Grand Ave.	10	2	1.1355	38.36	35.6	none	16.63	Methyl violet*	35.2	−13.0	17	0.0
2462	The Regent Cordial Co.	Jacobson & Diamond, 782 Grand Ave.	65	24	1.1274	39.08	present	present	22.56	Methyl violet*	46.0	4.0	20	14.0
2961	Victor Gautier et Cie.	*New London.*—A. Leverone, 10 Golden St.	15	2	1.1265	36.22	present	present	14.17	Methyl violet*	42.4	4.4	18	13.2
	Crême de Rose.													
2947	Victor Gautier et Cie.	*Norwich.*—B. A. Herrick (drug store), Cor. Broadway and Main St.	15	2	1.1344	39.24	38.8		17.40	Bordeaux*	39.6	−13.0	17	0.0
2498	The Regent Cordial Co.	*New Haven.*—Jacobson & Diamond, 782 Grand Ave.	65	24	1.1485	40.52	present	present	17.06	Bordeaux*	49.2	9.2	21	18.0
2981		*Waterbury.*—G. Lavoraty, 642 Bank St.	10	2	1.0313	18.20	19.0	none	25.99	Magenta*	19.6	−6.0	18	0.0
	Rose Cordial.													
2989	French Cordial Co.	*Danbury.*—E. Pancirole, 78 White St.	100	24	1.1281	40.46	39.3	none	23.27	Ponceau*	39.6	−12.8	21	2.0
2978	Regina Margherita	*Waterbury.*—G. Lavoraty, 642 Bank St.	90	24	1.1435	38.92	38.8	none	13.60	Cochineal	39.6	−13.0	17	0.0
	Crême de Cacao.													
2962	Moray Freres et Cie.	*New London.*—A. Leverone, 10 Golden St.	15	2	1.1095	35.14	30.2	none	19.74		29.6	−11.0	19	0.0
2948	Victor Gautier et Cie.	*Norwich.*—B. A. Herrick (drug store), Cor. Broadway and Main St.	15	2	1.1437	37.95	35.9	none	10.43		36.0	−12.4	18	0.8
	Crême de Celery.													
2964	Moray Freres et Cie.	*New London.*—A. Leverone, 10 Golden St.	15	2	1.1189	38.00	26.4	none	19.61		24.0	−11.4	19	0.0
	Crême de Café.													
2549	Moray Freres et Cie.	*New Haven.*—The M. J. Beck Co., 398 Grand Ave.	10	2	1.1260	37.14	33.2	none	17.74		32.8	−12.0	18	0.0
	Ratafia de Mures.													
2957	Moray Freres et Cie.	*New London.*—Newark Wine and Liquor House, 70 Bank St.	10	2	1.1114	29.14			8.21	Tropeolin* and other colors	4.0	−4.8	19	3.6
	Ratafia de Cerises.													
2956	Moray Freres et Cie.	Newark Wine and Liquor House, 70 Bank St.	10	2	1.0260	32.60			13.64		1.0	1.6	16	2.6
	Curacao.													
2046	The Regent Cordial Co.	*Bridgeport.*—R. F. Whiting, 61 Main St.	12	2	1.1273	39.82	38.8	none	22.81	Tropeolin*	38.6	−14.1	16	0.0
	Absynthe.													
2979		*Waterbury,*—G. Lavoraty, 642 Bank St.	10	2	92.60	0.28	none	none	46.15	Vegetable	0.0	0.0	20	0.0

* Coal-tar dye. See foot note, p. 124.

dyes—usually malachite green or a closely allied color mixed with a yellow dye. The two brands which were free from coal-tar dyes contained what appeared to be vegetable colors, probably chlorophyl or leaf-green.

The five samples of crême de violette, with one exception, were colored with methyl violet, a dye commonly used in violet ink.

Of the samples of crême de rose and rose cordials, two contained a Bordeaux red or a related dye, one fuchsine (magenta), one a ponceau, and one cochineal.

In two of the miscellaneous cordials, a coal-tar orange color (tropeolin) was detected.

The solid matter in all of the samples of crême de menthe and most of the other cordials consisted largely, if not entirely, of cane sugar, but in two of crême de violette and one of crême de rose it was in part glucose.

The range in composition of the samples is as follows:

	Number of Samples.	Total Solids.	Cane Sugar.	Alcohol by weight.
		%	%	%
Crême de menthe	11	11.9–39.5	11.1–38.6	13.7–29.2
Crême de violette	5	35.7–39.1	35.6–37.6	14.2–22.6
Crême de rose (rose cordial)	5	18.2–40.5	19.0–39.3	13.6–26.0
Crême de cacao	2	35.1–38.0	30.2–35.9	10.4–19.7
"Crême de celery"	1	38.	26.4	19.6
Ratafia de cerises	2	29.1–32.6	----	8.2–13.6
Curacao	1	39.8	38.8	22.8
Absynthe	1	0.3	none	46.2

Methods of Analysis.

Specific Gravity is determined by the Westphal balance, at 15.5° C.

Total Solids and Sugars. See page 128.

Alcohol. Dilute 25 grams of the liquid to 150 cc. and distill into a 100 cc. pycnometer. Cool to 15.5° C., make up to the mark with water of the same temperature, and weigh. Ascertain the percentage of alcohol from an alcohol table, multiply this by the weight of the distillate, and from the weight of alcohol thus obtained calculate the percentage.

Detection of Dyes. See pages 124, 132 and 134.

VANILLA EXTRACT.

By A. L. Winton and M. Silverman.

The Vanilla Bean is the fruit of a vine belonging to the orchid family, a native of Mexico, but now cultivated in South America, Réunion, Mauritius, Java, Tahiti and other tropical countries. The term "bean" is a misnomer, as the plant is not a legume and neither the fruit nor the seeds resemble beans. The elongated fruit pods are from five to eight inches long and of the size of a small lead pencil. They are black, glossy and somewhat wrinkled on the surface, and contain thousands of exceedingly minute black seeds.

The grades of vanilla beans sold in the United States are the Mexican (whole, $6.75 to $11.00; cut, $5.75 to $6.25 per pound), the South American ($5 to $7), the Bourbon ($3 to $6.75), and the Tahiti ($1.45 to $1.50).* This range in price from $1.45 to $11.00 per pound is due to the great difference in the delicacy, not the amount, of flavor in the beans from different localities.

Vanillin, the chief flavoring principle of the vanilla bean, is a white crystalline substance, of which the beans of commerce contain from 1.5 to 2.5 per cent. Vanillin identical in chemical composition with that from the beans is now prepared by a chemical process from oil of cloves and is quoted at from 70 cents to $1.00 per ounce. This artificial vanillin is extensively used in extracts in place of the beans.

The Tonka Bean is the seed of a large tree grown in Guiana, Venezuela, Brazil and other parts of tropical America. As the tree belongs to the legume family, the seeds are well named "beans." They are dark-colored, almond-shaped, more or less wrinkled on the surface and from one to one and a half inches long. The flavor somewhat resembles vanilla, but is much ranker. Angostura tonka beans are quoted at from 75 to 85 cents; Surinam, at 52 to 55 cents, and Para, at 30 to 35 cents per pound.*

Coumarin, the flavoring principle of the tonka bean, a white crystalline substance, is, like vanillin, prepared by artificial means, and sells at 30 to 35 cents per ounce.

*These prices were quoted Dec. 2, 1901.

Vanilla Extract or Tincture of the United States Pharmacopoeia is prepared as follows:*

"Vanilla, cut into small pieces and bruised		100 grams.
Sugar, in coarse powder		200 "
Alcohol, Water	a sufficient quantity of each	
	to make	1000cc

Mix alcohol and water in the proportion of 650 cc. of alcohol to 350 cc. of water. Macerate the vanilla in 500 cc. of this mixture for twelve hours, then drain off the liquid, and set it aside. Transfer the vanilla to a mortar, beat it with the sugar into a uniform powder, then pack it in a percolator, and pour upon it the reserved liquid. When this has disappeared from the surface, gradually pour on menstruum, and continue the percolation, until 1000 cc. of tincture are obtained."

The liquid thus prepared is of a deep brown, almost black, color, and has a delightful perfume and flavor. The cost at wholesale of the alcohol in a quart of extract is about 30 cents, of the sugar about 2 cents, and of the vanilla beans from 30 cents to $2.30, according to the grade used, making the total cost per quart from about 62 cents to $2.62. In an extract made from the cheapest beans, the cost of the alcohol and sugar would slightly exceed that of the beans, but in one made from the best beans it would be less than one-eighth as much.

Six extracts were made in the Station laboratory, from different grades of beans, after the U. S. Pharmacopœia formula. The percolation extended through about 60 hours and was stopped when the percolate measured about 950 cc., the 50 cc. necessary to complete the volume being obtained by squeezing the residue in a cloth. The analyses of five of these extracts follows:

ANALYSES OF VANILLA EXTRACTS U. S. P., MADE IN THE STATION LABORATORY.

Station No.	Grade of Bean.	Specific gravity.	Vanillin. %	Alcohol by weight. %	Total residue. %	Cane sugar. %	Residue other than cane sugar. %
4562	Mexican (whole)	1.0159	0.125	37.96	22.60	19.90	2.70
4561	Mexican (cut)	1.0146	0.065	39.92	23.10	19.20	3.90
4504	South American (whole)	1.0109	0.215	38.58	22.00	19.00	3.00
4505	Bourbon (whole)	1.0166	0.138	38.32	23.13	20.40	2.73
4506	Tahiti (whole)	1.0104	0.108	38.84	21.75	20.00	1.75

*U. S. Pharmacopœia 1890, p. 432.

From these analyses it may be seen that the percentage of vanillin varies from 0.065 to 0.215 per cent. and that there is no relation between this percentage and the quality of the bean used. None of the extracts contained the slightest trace of coumarin.

The exhausted residues after preparing these extracts were treated a second time with 60 per cent. alcohol, and in these second extracts search was made for vanillin, but in no case was an appreciable amount obtained, showing that the first extraction, so far as vanillin was concerned, was complete.

An extract of tonka beans prepared in the laboratory in the same manner as the vanilla extracts, substituting, however, tonka beans for vanilla beans, contained 0.21 per cent. of coumarin, but no trace of vanillin.

Genuine Vanilla Extracts are made from vanilla beans by many reputable manufacturers. The amount of sugar and alcohol in these extracts is not always the same as in the U. S. P. tincture. and in some a certain amount of glycerine or glucose is present, but these differences are unimportant so long as the extract was prepared from the proper amount of good quality beans.

It is stated by Hess* that in cheap extracts containing as little as 20 per cent. of alcohol, potassium bicarbonate is sometimes used to aid in getting the resin, gum, etc., into solution. By this treatment, the color is deepened materially and the flavor is impaired.

Imitation Vanilla Extracts, because of their cheapness, are now sold in many groceries and drug stores. Occasionally the word "compound" or a statement of their composition appears on the label, but, as a rule, there is nothing to distinguish them from real vanilla extract. Some of these preparations contain a certain amount of the real extract, but most of them do not.

Perhaps the least objectionable of these artificial extracts are those prepared from three parts of vanilla beans and one part of tonka beans. This is actually preferred by some consumers to the genuine extract, just as a mixture of coffee and chicory is preferred by some to real coffee. But this preference of the few is no reason why the imitation should be sold under a misleading

*Jour. Am. Chem. Soc. 21, 720.

name, but on the contrary is a strong argument why it should bear an honest label and be sold at an honest price.

Most of the imitation extracts, however, contain no extract of vanilla bean whatever, but are preparations of artificial vanillin, artificial coumarin, tonka beans or a mixture of two or more of these materials, colored with caramel.

The cost of the artificial vanillin required to make a quart of an extract approximately the same in strength as that prepared according to the U. S. Pharmacopœia from the beans is but five or six cents, and the total cost of the mixture but 37 or 38 cents, whereas a genuine extract, as we have seen, costs from 62 cents to $2.62. By using weaker alcohol, as is customary, the cost may be still further reduced. It might seem that an artificial extract of this kind would be equal to the genuine, as the vanillin, the chief ingredient of both, is identical, but the genuine extract, as a matter of fact, has a much more delicate flavor, due to the presence of minute quantities of flavoring substances other than vanillin, and readily commands a higher price. Vanillin, wintergreen oil and indigo are now made cheaply in the laboratory, but preparations made from these artificial products are not considered as good as those made from the natural products.

EXAMINATION OF VANILLA EXTRACTS SOLD IN CONNECTICUT.

Sixty-two samples, representing as many distinct brands, have been examined. The results are given in detail in Tables XVI and XVII; a summary of the results in the following statement:

	Number of Samples.
Not found adulterated	15
Adulterated with coumarin	37
Otherwise adulterated	4
Labeled "compound"	6
Total	62

Extracts not found Adulterated. Of the 62 samples examined, 15 appeared to be genuine extracts of the vanilla bean, free

from other flavoring and coloring substances. Most of these, however, contained less alcohol (20.50 to 40.00 per cent.) and cane sugar (0.90 to 0.200 per cent.) than extracts made strictly according to the pharmacopœia, and some contained glycerine (1.03 to 10.76 per cent.) or glucose, but these differences bear little or no relation to the value of the extract. The amount of vanillin ranged from 0.06 to 0.24 per cent.

Adulterated Extracts. The most important point brought out by the analyses is the presence of coumarin, ranging in amount from 0.02 to 0.23 per cent. in 37 of the 41 adulterated extracts. Whether this coumarin was added as tonka bean extract or artificial coumarin cannot usually be determined by analysis, but in either case it must be regarded as an adulterant, in extracts not labeled "compound." The amount of vanillin ranged from 0.01 to 0.68 per cent.

Whenever the amount of vanillin present is greater than 0.25 per cent., which is the maximum amount usually present in an extract made from vanilla bean, the extract almost invariably contains artificial vanillin. More decisive evidence is, however, obtained by special tests depending on the presence of gums, resins, etc., in extracts made from the vanilla bean, and their absence in artificial extracts. Many of the adulterated extracts, according to these tests, unquestionably contained artificial vanillin; in others, however, containing but a small percentage of vanillin, the presence of the artificial vanillin was doubtful. Four samples (Nos. 4056, 4085, 3880 and 4008) contained no coumarin, but were found by special tests to be artificially colored and below standard.

The amount of cane sugar in the samples ranged from 0.47 to 31.88 per cent. and of alcohol from 4.09 to 41.42 per cent. Glucose was present in appreciable amount in one sample, invert sugar (possibly formed from cane sugar during the process of manufacture) in 5 samples and glycerine in 5 samples.

Nearly all the adulterated and compound extracts were artificially colored, the coloring matter being, in nearly if not every instance, caramel. This, of itself, is an indication that the extracts were imitations, as genuine vanilla extract is of such a dark color that addition of caramel would be useless.

TABLE XVI.—VANILLA EXTRACT NOT FOUND ADULTERATED.

Station No.	Brand.	Dealer.	Price per bottle, cents.	Capacity of bottle, ounces.	Vanillin.	Coumarin.	Alcohol by weight.	Total residue.*	Cane sugar.	Glycerine.	Solids other than cane sugar.
					%	%	%	%	%	%	%
4193	Mrs. Bradford's, Claremont, N. H.	*Bristol.*—C. A. Lane, 17 No. Main St.	30	2.1	0.08	0.00	40.00	21.81	10.36	8.87	2.61
4180	Double Strength, Danbury Grocery Co.	*Danbury.*—Danbury Grocery Co., Main St.	15	1.9	0.09	0.00	20.90	16.72	15.44	------	1.28
4174	Williams', Williams & Carleton Co., Hartford, Conn.	Ives Andrews Co., 249 Main St.	40	4.2	0.22	0.00	20.50	15.66	9.90	1.03	4.73
4132	Gold Seal Brand, Hills & Co., Hartford, Conn.	*Hartford.*—Hills & Co., 375 Asylum St.	60	4.1	0 18	0.00	27.51	13.52	0.90	10.76	1.86
4137	Union Club, Lincoln, Seyms & Co., Hartford, Conn.	Otto Ludwig, 223 Main St.	25	2.1	0.15	0.00	21.27	16.43†	4.54	4.54	7.35
4054	Worth's, Worth Extract Co., New York	*Middletown.*—G.E. Burr, 136 Main St.	25	1.9	0.06	0.00	22.49	7.88	5.14	------	2.74
4052	Thompson's Triple Extract, J. E. Thompson, New York	J. B. Patterson, 110 Main St.	45	3.8	0.22	0.00	23.79	22.66	20.00	------	2.66
4055	Globe Extract, Globe Extract Co., Boston	W. K. Spencer, 98 Main St.	25	2.1	0.24	0.00	24.61	9.22	6.96	------	2.26
4082	Dr. Price's, Price Extract Co., New York	*New Britain.*—Sovereign Trading Co., 282 Main St.	45	3.8	0.10	0.00	32.79	13.63	11.50	------	2.13
4083	Burnett's, Joseph Burnett Co., Boston	W. W. Walker, 238 Main St.	20	2.3	0.15	0.00	25.13	7.82	6.14	------	1.68
4280	Baker's, Baker Extract Co., Springfield, Mass.	*New Haven.*—S. S. Adams, State and Court Sts.	25	2.0	0.17	0.00	25.86	17.84†	3.78	8.35	5.71
4018	Princess, Bennett, Sloan & Co., New York	*Norwich.*—H. D. Avery, 196 Franklin St.	25	1.9	0.09	0.00	24.44	20 44	16.34	------	4.10
4222	Doetschmann's, Deotschmann Mfg. Co., New York	*Torrington.*—Austin Beckwith, Main St.	45	4.2	0.13	0.00	23.65	11.90	8.84	------	3.06
4227	Sage's No. 1, Sage's Laboratory, Torrington, Conn.	Torrington Co-op. Store, 135 Main St.	25	2.3	0.18	0.00	25.21	5.47	4.04	------	1.43
4039	Foss's, Schlotterbeck & Foss Co., Portland, Me.	*Willimantic.*—C. R. Hibbard, North St.	25	2.0	0.15	0.00	33.16	19.16	6.94	8.00	4.22

* Includes glycerine. † Contains glucose.

Compound Extracts. These were artificial extracts of the same general composition as the adulterated extracts, but being labeled "compound" were legitimate articles of commerce.

It may be noted in passing that the cost per ounce of the pure extracts was on the average 10.6 cents, of the adulterated extracts 9.2 cents.

METHODS OF ANALYSIS.

Total Residue. Dry 5 grams of the extract with sand, as described on page 128, continuing the heating until the loss sustained in one hour is less than 2 milligrams. Absolutely constant results cannot be secured in extracts containing glycerine.

Sugar. Polarize as described on page 128.

Glycerine. Determine glycerine in 5 grams as directed for sweet wine.*

Vanillin and Coumarin. Hess and Prescott Method,† modified. Dealcoholize 25 grams of the extract in an evaporating dish upon a water bath, at a temperature of about 80° C.; adding water from time to time to retain the original volume. After removal of the alcohol, add normal lead acetate solution, drop by drop, until no more precipitate forms. Stir with a glass rod to facilitate flocculation of the precipitate, filter through a moistened filter, and wash three times with a few cubic

*U. S. Dept. Agr. Div. Chem. Bull. 46, Revised Edition, page 63.
†Jour. Am. Chem. Soc. 21, 256.

TABLE XVII.—ADULTERATED AND COMPOUND VANILLA EXTRACTS.

Station No.	Brand.	Dealer.
	Adulterated Extracts.	
4152	Walsh Bros., Ansonia, Conn.	*Ansonia.*—Walsh Bros., 246 Main St.
3922	Harrison's, Glens Falls, N. Y.	*Bridgeport.*—T. Dundon, 410 E. Main St.
3917	St. John's, New York	Richards & Schmidt, 2065 Main St.
3919	Chas. Peek & Co., Hartford, Conn.	W. L. Wolfram, 1001 E. Main St.
4179	Jackson's Standard, New York	*Danbury.*—W. W. Edwards, 147 Main St.
4177	Sovereign, Union Pacific Tea Co., New York	Union Pacific Tea Co., 253 Main St.
4140	M. Curry Co., Hartford, Conn.	*Hartford.*—Cady & Lombard, 165 Albany Ave.
4129	Robertson's, Hartford, Conn.	Cowles & Howard, 156 Windsor Ave.
4141	Perfect, Dow & Hatch, Hartford, Conn.	Dow & Hatch, 2 Church St.
4135	Samuel Stuart & Co., Hartford, Conn.	Public Market Co., 611 Main St.
4126	Stone's, Boston	W. J. Tolhurst, Maple Ave.
4078	McMonagle & Rogers, Middletown, N. Y.	*Meriden.*—H. E. Bushnell, 75 W. Main St.
4081	Elite, Grant's Tea store, Meriden, Conn.	Grant's Tea Store, Main and State Sts.
4053	D. Johnson & Co., Middletown, Conn.	*Middletown.*—C. Allison, 31 Main St.
4056	N. E. Tea Co., Middletown, Conn.	N. E. Tea Co., 445 Main St.
4088	J. E. Murphy, New Britain, Conn.	*New Britain.*—J. E. Murphy, 11 Franklin Square
4085	Anchor Brand, Miner, Read & Garrette, New Haven	Chas. Nothingale & Son, 363 Arch St.
3914	Double Extract, West Rock Chemical Co., Westville, Conn.	*New Haven.*—S. S. Adams, State and Court Sts.
3851	Frederick Bros., New Haven	Frederick Bros., Edward and Nash Sts.
3877	Victor Mfg. Co., Hartford, Conn.	H. Hahn, 1327 Chapel St.
3725	Doyle's, New Haven	Thos. Kilbride, 254 Wallace St.
3880	Gold Medal, Mfr. for F. J. Markle, New Haven	F. J. Markle, 105 Broadway
3912	French's, Rochester, N. Y.	E. E. Nichols, 380 State St.
3853	D. M. Welch & Son, New Haven	D. M. Welch & Son, 28 Congress Ave.
4008	Nichols & Harris, New London, Conn.	*New London.*—Keefe & Davis, 137 Bank St.
3998	Snyder's, W. Broadway, New York	John Rollo, 70 Main St.
4001	Lanman's, Chas. M. Taylor, New London, Conn.	C. M. Taylor, 237 State St.
3960	C. L. Glover, Norwalk, Conn.	*Norwalk.*—C. L. Glover, 35 Wall St.
3959	Forest City, Forest City Extract Co., Portland, Me.	Reardon & Lyons, 19 Main St.
4016	Rallion's, Norwich, Conn.	*Norwich.*—H. D. Rallion, 45 Broadway
4024	Franklin, Franklin Mfg. Co., New York	J. A. Stoddard, 94 Franklin St.
3974	Fleur de Lis, Rivaud Fruit Co., New York	*So. Norwalk.*—G. E. Friedrich, Railroad Ave.

TABLE XVII.—ADULTERATED AND COMPOUND VANILLA EXTRACTS.

Station No.	Price per bottle, cents.	Capacity of bottle, ounces.	Vanillin.	Coumarin.	Alcohol by weight.	Total residue.*	Cane sugar.	Glycerine.	Solids other than cane sugar.	Color.
			%	%	%	%	%	%	%	
4152	20	2.5	0.68	0.15	17.32	14.00	10.64	2.42	0.94	
3922	5	1.0	0.05	0.03	21.03	7.14	6.80	----	0.34	
3917	10	2.0	0.07	0.06	15.99	9.52‡	0.90	1.46	7.16	Artificial
3919	20	2.0	0.11	0.03	18.78	19.32	16.60	----	2.72	
4179	10	1.0	0.02	0.10	14.15	14.34‡	0.75	----	13.59	
4177	20	1.9	0.03	0.05	20.63	15.89	11.84	----	4.05	Artificial
4140	10	1.8	0.14	0.04	06.34	21.70	18.66	----	3.04	Artificial
4129	25	2.2	0.22	0.08	6.34	0.86	0.47	----	0.39	Artificial
4141	10	2.1	0.15	0.04	5.28	15.15	12.28	----	2.87	Artificial
4135	10	1.5	0.27	0.04	10.20	18.44	15.52	----	2.92	Artificial
4126	45	2.9	0.14	0.03	22.09	19.80‡	6.74	3.09	9.97	
4078	45	4.0	0.14	0.05	41.42	12.94	0.60	9.74	2.60	
4081	10	1.3	0.12	0.08	15.46	25.12	12.26	2.22	10.64	Artificial
4053	20	2.0	0.24	0.18	11.91	14.62	10.92	----	3.70	
4056	20	1.9	0.07	0.00	31.72	14.35	11.20	----	3.15	Artificial
4088	25	2.0	0.25	0.07	32.79	13.05	10.48	----	2.57	Artificial
4085	10	1.6	0.07	0.00	11.25	7.22	5.54	----	1.68	Artificial
3914	45	7.7	0.27	0.08	14.55	5.45	4.08	----	1.37	Artificial
3851	10	1.0	0.15	0.07	4.09	13.86	12.80	----	1.06	Artificial
3877	10	1.1	0.13	0.06	4.62	14.75‡	7.70	----	7.05	
3725	10	1.1	0.44	0.11	10.73	26.54	21.00	----	5.54	Artificial
3880	10	1.3	0.33	0.00	5.28	4.02	2.86	----	1.16	Artificial
3912	15	1.3	0.06	0.04	24.75	7.32	7.28	----	0.04	
3853	35	3.9	0.18	0.03	11.66	9.51	8.16	----	1.35	Artificial
4008	35	3.9	0.04	0.00	25.27	31.54	27.42	----	4.12	Artificial
3998	10	1.1	0.05	0.03	6.34	7.04	2.58	----	4.46	Artificial
4001	25	2.1	0.40	0.10	13.59	19.00‡	4.98	----	14.02	Artificial
3960	20	2.0	0.66	0.02	28.97	16.82	15.30	----	1.52	Artificial
3959	10	1.6	0.06	0.23	7.53	36.16†	12.96	----	23.20	Artificial
4016	45	3.8	0.45	0.07	28.14	17.54	14.00	----	3.54	
4024	10	1.4	0.03	0.06	15.46	13.17	8.88	----	4.29	Artificial
3974	10	1.6	0.03	0.03	14.28	8.88	6.82	----	2.06	Artificial

* Includes glycerine. † Contains glucose. ‡ Contains invert sugar.

TABLE XVII.—ADULTERATED AND COMPOUND VANILLA EXTRACTS. —*Continued.*

Station No.	Brand.	Dealer.	Price per bottle, cents.	Capacity of bottle, ounces.	Vanillin.	Coumarin.	Alcohol by weight.	Total residue.*	Cane sugar.	Glycerine.	Solids other than cane sugar.	Color.
					%	%	%	%	%	%	%	
3972	Fleur de Lis, Rivaud Fruit Co., New York	*South Norwalk.*—P. J. Lynch, 118 Washington St.	10	1.4	0.01	0.09	9.68	13.44	11.14	----	2.30	Artificial
3950	Crown Brand, W. A. Leggett & Co., New York	*Stamford.*—O. S. Brown, 10 Park Row	20	1.9	0.24	0.15	11.66	17.73	17.00	----	0.73	Artificial
3951	Brunswick, Brunswick Mfg. Co., New York	W. W. Waterbury, 207 Main St.	10	1.2	0.18	0.02	11.13	9.48	9.00	----	0.48	Artificial
4221	Choice No. 2, Sage's Laboratory, Torrington, Conn.	*Torrington.*—Wm. Mulcunry, 16 So. Main St.	10	2.1	0.06	0.03	16.66	4.00	----	----	----	Artificial
4196	Brown's A No. 1, Brown & Co., New Haven	*Union City.*—J. J. Linsky, Main St.	20	2.2	0.43	0.09	9.57	26.94	20.52	----	6.42	Artificial
4256	New York & China Tea Co., Waterbury, Conn.	*Waterbury.*—N. Y. & China Tea Co., 181 So. Main St.	12	1.6	0.21	0.08	10.97	10.91	8.12	----	2.79	Artificial
4043	Delmonico, Talcott, Frisbie & Co., Hartford, Conn.	*Willimantic.*—F. P. Casey, Jackson St.	25	2.1	0.06	0.05	30.27	12.99	8.76	----	4.23	
4042	Crawford's, W. W. Crawford, Stafford Springs, Conn.	H. C. Hall, Union St.	25	2.1	0.06	0.05	13.36	35.50	31.88	----	3.62	
4040	Clinton, Hartford, Conn.	A. A. Trudeau, Main St.	25	2.0	0.05	0.11	15.06	24.86	19.42	----	5.44	
	Compound Extracts.											
4151	Sovereign, Union Pacific Tea Co., New York	*Ansonia.*—Union Pacific Tea Co., 204 Main St.	20	2.0	0.03	0.05	20.50	15.53	11.24	----	4.29	Artificial
4079	Trumbull & Co., Hartford, Conn.	*Meriden.*—C. N. Dutton, 17 Colony St.	10	1.0	0.25	0.06	9.81	21.66	17.62	----	4.04	Artificial
3718	C. N. Searle, New Haven	*New Haven.*—E. L. Dutcher, 99 Grand Ave.	15	2.5	0.26	0.13	16.12	7.04	2.40	----	4.64	
3886	Hart's	Mrs. G. F. Gerner, State and Clark Sts.	25	1.4	0.008	0.12	10.07	20.74	17.60	----	3.14	
3908	Water White, T. Metcalf Co., Boston	E. E. Hall, 381 State St.	58	4.1	0.31	0.02	15.07	19.30	6.60	7.66	5.04	
4231	Our Standard, King & Gay, Winsted, Conn.	*Winsted.*—King & Gay, 683 Main St.	15	1.7	0.22	0.09	17.85	19.38	16.46	----	2.92	Artificial

* Includes glycerine.

centimeters of hot water. Cool the filtrate and extract with ether by shaking out in a separatory funnel. Use 15 to 20 cc. of ether at each separation, repeating the process three or four times, or until a few drops of the ether, evaporated upon a watch-glass, leave no residue. Place the combined ether extracts containing all of the vanillin and coumarin in a clean separatory funnel, and shake out four or five times with two per cent. ammonia, using 10 cc. for the first shaking, and 5 cc. for each subsequent shaking.

Set aside the combined ammoniacal solutions for the determination of vanillin.

Wash the ether solution into a weighed dish, and allow the ether to evaporate at the room temperature. Dry in a desiccator and weigh. Usually the dried residue is pure coumarin. Treat the residue with 5 to 10 cc. of cold petroleum ether, boiling between 30 and 40° C. and decant

off the clear liquid into a beaker. Repeat the extraction with petroleum ether until a drop, evaporated on a watch-glass, leaves no residue. Dry the dish for a few moments in a water oven, cool and weigh. Subtract the weight of the dish and the residue (if any) from the weight previously obtained after evaporation with ether, thus obtaining the weight of pure coumarin. Allow the petroleum ether to evaporate at the room temperature, and dry, if necessary, in a desiccator. The residue should be crystalline and have a melting point of 67° C. This, with the characteristic odor of coumarin, is sufficient for its identification.

Slightly acidulate the ammoniacal solution reserved for vanillin with 10 per cent. hydrochloric acid. Cool and shake out in a separatory funnel with four portions of ether as described for ether extraction. Evaporate the ether at room temperature in a weighed platinum dish, dry over sulphuric acid, and weigh. Treat the residue with boiling ligroin (boiling point, 80 to 85° C.), decanting into a dry beaker. Repeat the treatment until all vanillin is removed. Dry the dish with residue (if any) for a few moments at 100° C. and weigh. Subtract the weight from the weight previously obtained after evaporating the ether. The difference is the weight of vanillin. Evaporate the ligroin at room temperature and dry in a desiccator. The residue should be crystalline, have a melting point of 80 to 81° C. and have the characteristic odor and crystalline form of vanillin.

The method above described differs from the original method in several details:

First. 2 per cent. instead of 10 per cent. ammonia is used, and consequently a less concentrated ammonium chloride solution is obtained after neutralizing with hydrochloric acid, thus reducing the chance of carrying this salt into the extract.

Second. A somewhat greater bulk of ammonia is used, to diminish the error due to possible mechanical loss during shaking.

Third. The vanillin and coumarin are weighed after evaporation of the ether solutions, whereas in the original process they are not weighed until they have been redissolved in petroleum ether and again evaporated. This procedure not only materially shortens the process, but avoids the errors due to crawling of the solutions while redissolving and re-evaporating. Any matter insoluble in the petroleum solvent is afterwards weighed with the dish and a correction introduced, but if reasonable care is exercised in the separation, this residue is insignificant. The evaporation of the petroleum extract is, however, necessary if melting points are to be determined, but this evaporation can go on at leisure after obtaining the quantitative results.

Hess and Prescott,* as a test of their process, determined vanillin and coumarin in two 25 gram portions of vanilla extract U. S. P., to each of which had been added 0.5 gram of pure coumarin. The following are their results:

Vanillin (I) 0.3081, (II) 0.2997 gram.†
Coumarin (I) 0.4910, (II) 0.4820 gram.

These figures illustrate the accuracy of the process for determination of coumarin, but throw no light on its value for determination of vanillin, as the amount present was unknown.

As a further test of the Hess and Prescott method, the writers have made determinations in 25 gram portions of a solution containing the same amount of sugar and alcohol as vanilla extract U. S. P., to which weighed quantities of pure vanillin and coumarin had been added, proceeding as follows:

Method A. The original Hess and Prescott method, using ether in all extractions and 10 per cent. ammonia for separation of vanillin and coumarin.

*Loc. cit. p. 259.
†Owing probably to a typographical error, these amounts are about ten times what are usually present.

Method B. Same as A, except that chloroform was substituted in all cases for ether.

Method C. Same as A, except that chloroform was used in the extraction of vanillin from the ammonia extract.

Method D. The modified method used by the writers, as already described.

In each case the separated vanillin and coumarin was weighed after the evaporation of the ether or chloroform, and only in a few instances was it reweighed after dissolving in the petroleum solvent and re-evaporating. The results follow:

RESULTS OBTAINED BY VARIOUS MODIFICATIONS OF HESS AND PRESCOTT'S METHOD, ON MIXTURES CONTAINING KNOWN QUANTITIES OF VANILLIN AND COUMARIN.

Method.	Vanillin.			Coumarin.		
	Taken.	Found after 1st evaporation.	Found after 2d evaporation.	Taken.	Found after 1st evaporation.	Found after 2d evaporation.
	Gram.	Gram.	Gram.	Gram.	Gram.	Gram.
A	0.0120	0.0101	0.0100	0.0170	0.0162	0.0165
B	.0695	.0723	.0705	.0975	.0902	.0900
C	.0495	.0490				
C	.0280	.0261				
C	.0610	.0630	.0575	.0855	.0751	.0740
C	.0120	.0136	.0120	.0170	.0160	.0162
C	.0290	.0280				
C	.0495	.0455				
D	.0625	.0636	.0610	.0875	.0800	.0786
D	.0625	.0620		.0875	.0796	
D	.0625	.0621	.0585	.0875	.0803	.0795
D	.0625	.0602		.0125	.0125	
D	.0625	.0630		.0125	.0124	
D	.0625	.0615		.0125	.0122	

From these figures it is evident that the process, both as originally described and as abbreviated by the writers, gives remarkably accurate results for vanillin and sufficiently accurate results for coumarin.

Where the amount of coumarin was large, there was an unaccountable deficiency of this substance, but for the amounts present in extracts, which, in our experience, has not exceeded .0600 gram per 25 grams of extract, the method is all that could be desired. The melting points of the coumarin and vanillin in all cases were close to theory.

Without doubt, this excellent method is in all points the best that has yet been devised.

Alcohol. See page 148.

Tests for Caramel, Coal-tar Dyes, etc. Valuable indications of the nature of an extract are obtained in the process of determination of vanillin and coumarin. Pure extracts of vanilla beans give, with lead acetate, a bulky, more or less glutinous, brown-grey precipitate, and a yellow or straw-colored filtrate, whereas purely artificial extracts colored with caramel give a slight dark-brown precipitate and a dark-brown filtrate which is not decolorized by shaking with ether.

If both vanilla bean extract and caramel are present, the precipitate is more or less bulky and dark-colored, and the solution is more or less brown.

Test a portion of the brown solution, after extracting the vanillin and coumarin with ether, for caramel by shaking with fuller's earth and filtering as recommended by Crampton and Simons.* If the color is due to caramel, and a grade of fuller's earth is used which experience has proved suitable, the filtrate is yellow or colorless and the fuller's earth a brownish color.

Test another portion of the solution for coal-tar dyes, as directed on page 129.

Amthor's test† and Hess' test‡ for caramel have not given, in our hands, decisive results.

"VANILLA CRYSTALS."

By A. L. Winton and M. Silverman.

Two sealed boxes of "vanilla crystals," Nos. 4576 and 4589, bought at different times from D. M. Welch & Son, 28 Congress Ave., New Haven, have been examined. The boxes in which the material was sold were labeled:

"Butler's Vanilla Crystals in Sugar. The only form of vanilla whose flavor is not lost in cooking. Vanilla Crystal Co. New York. Price 10 cts. Non-alcoholic."

The following quotations are taken from a circular describing the preparation:

"Enduring as the Pyramids. Butler's Vanilla Crystals."

"One of the most discouraging things a cook has to contend with is the uncertain strength of liquid flavoring extracts, of which Vanilla is the most used. A given quantity of a certain flavoring has one strength to-day, and another next week when a new bottle is opened. Why is this? The explanation is simple. No two individual Vanilla Beans contain the same amount of flavoring principle.

The Vanilla Bean is chopped up and macerated in water and alcohol for the purpose of extracting the flavor. The alcohol in drawing out the flavor also draws out the undesirable coloring matter, gums and woody fibre, and in addition to this, the foundation of the flavor being alcohol, it necessarily evaporates when subjected to heat in cooking, carrying part of the flavor with it. One thing is positive—that to have

* J. Amer. Chem. Soc. **21**, 355. **22**, 810.
† Ztschr. anal. Chem. **24**, 30.
‡ J. Amer. Chem. Soc. **21**, 721.

a Vanilla flavoring of unvarying strength in any climate or degree of artificial heat, alcohol must form no part of it.

Vanilla Crystals fill in every respect this exacting condition, and constitute a perfect flavoring, which stays where it is placed, and with the degree of strength originally intended.

A ten cent tin of Vanilla Crystals will flavor as much material as twenty-five cents worth of liquid flavoring extract, while the final quality of the article flavored will be infinitely superior."

The boxes purchased contained about 2 ounces of sugar mixed with 0.04 per cent. of vanillin and 0.03 per cent. of coumarin. At the present prices, sugar sufficient for a box of such a mixture may be bought for about three-fifths of a cent, and the vanillin and coumarin together for about one-tenth of a cent.

LEMON EXTRACT.

By A. L. Winton and A. W. Ogden.

Oil of Lemon is made in Sicily and other Mediterranean countries from the rind of lemon; the best grades by simple expression and clarification, the cheaper by distillation.

It is quoted at from 85 to 95 cents per pound at wholesale.

The Extract, Spirit or Essence of Lemon of the United States Pharmacopœia is a 5 per cent. (by volume) solution of the oil in strong alcohol, colored with lemon peel. The formula for its preparation is as follows:*

"Oil of Lemon,	50^{cc}
Lemon Peel, freshly grated,	50^{gms}
Deodorized Alcohol, a sufficient quantity,	
to make	1000^{cc}

Dissolve the Oil of Lemon in 900^{cc} of Deodorized Alcohol, add the Lemon Peel, and macerate for twenty-four hours, Then filter through paper, and add, through the filter, enough Deodorized Alcohol to make the Spirit measure 1000^{cc}."

The materials for a quart of good extract cost about 75 cents—60 cents for the alcohol and 15 cents for the oil and peel—or about 2½ cents per ounce. Since an ounce bottle of lemon extract usually sells at retail for 10 cents, there is a margin of about 7½ cents to cover cost of manufacture, cost of

* U. S. P., 1890, p. 375.

TABLE XVIII.—LEMON EXTRACTS MADE IN LABORATORY.

Station No.	Brand of Oil.	Polariscopic reading, 200mm. tube.	Specific gravity at 15.5°C.	Alcohol by weight	Alcohol by volume.	Lemon oil. Polariscopic method. by weight.	Lemon oil. Polariscopic method. by volume.	Lemon oil. Mitchell's precipitation method. by weight.	Lemon oil. Mitchell's precipitation method. by volume.	Refractive index of precipitated oil at 30° C.	Solids.	Ash.	Specific gravity of original oil at 15.5°C.	Refractive index of original oil at 30°C.
				%	%	%	%	%	%		%	%		
4597	Sanderson's	17.0	.8240	84.56	87.97	5.21	5.00	5.21	5.00	1.4691	0.12	0.01	.8590	1.4704
4598	Sanderson's*	17.0	.8360	80.07	84.47	5.11	5.00	5.11	5.00	1.4691	0.48	0.02	.8590	1.4704
4599	From the market	15.9	.8256	84.75	88.31	4.84	4.68	5.12	5.00	1.4681	0.07	0.00	.8550	1.4691
4600	do.	17.0	.8255	84.30	87.76	5.8	5.00	5.18	5.00	1.4688	0.14	0.02	.8560	1.4694
4601	do.	16.0	.8257	84.40	88.09	4.89	4.71	5.19	5.00	1.4685	0.10	0.01	.8565	1.4694
4602	W. J. Bush & Co.	16.0	.8248	84.20	87.70	4.88	4.71	5.12	5.00	1.4685	0.08	0.00	.8550	1.4691

* Made strictly according to U. S. P., using lemon peel. In the other extracts no peel was used.

package and labels, and profits, even when the best materials are used.

Six extracts of lemon have been made in the laboratory; two from Sanderson's lemon oil (Dodge & Olcott), and four from different grades found on the market, some of which were of poor quality and possibly adulterated. In preparing these extracts the directions of the Pharmacopœia were followed, except that lemon peel, which serves chiefly for coloring, was used in but one extract (No. 4598). The analyses are given in Table XVIII.

Adulteration of Lemon Extract. Notwithstanding the liberal margin for profit, even when the best materials are used, lemon extract is subject to the grossest forms of adulteration. As four-fifths of the cost of a good extract is for the alcohol, the manufacturer naturally seeks to reduce the amount of this ingredient. But oil of lemon is almost insoluble in weak alcohol. If a good lemon extract is diluted with half its bulk of water, the liquid becomes cloudy from separation of oil, and finally the oil rises to the surface. (This, by the way, is a reliable test for lemon extract. If the oil does not come out by dilution, it is because the extract does not contain an appreciable amount.) In reducing the amount of alcohol, the manufacturer must also cut out the lemon oil almost entirely, and he often actually goes to this extreme.

Many of the brands on the market contain so little lemon oil that it can scarcely be detected either by chemical analysis or by the nostrils. They are commonly made either by shaking a little lemon oil with weak alcohol and filtering through magnesia to remove the excess of oil, or by dissolving a little "citral"* in dilute alcohol. To cover up the fraud, the bogus extracts are colored a beautiful golden-yellow with turmeric tincture or, more commonly, a coal-tar dye. An ounce of such an extract selling for 10 cents contains material costing but a fraction of a cent, and almost worthless as a flavor.

EXAMINATION OF LEMON EXTRACTS SOLD IN CONNECTICUT.

Analyses of the 66 samples examined, with other particulars, are given in Tables XX and XXI, and a classification based on these analyses follows:

*A product made from oil of lemon grass.

TABLE XX.—LEMON EXTRACTS ABOVE STANDARD (LEMON OIL OVER 4.50 PER CENT.).

Station No.	Brand.	Dealer.	Price per bottle, cents.	Capacity of bottle, fluid ounces.	Specific gravity at 15.5° C.	Alcohol by weight.	Lemon oil by weight. Polariscopic method.	Lemon oil by weight. Mitchell's precipitation method.	Refractive index of precipitated oil at 30° C.	Solids.	Ash.	Color.
						%	%	%		%	%	
4139	Burnett's, Joseph Burnett & Co., Boston	*Hartford.*—H. Griswold, 547 Main St.	40	4.0	.8250	81.31	8.27	8.44	1.4691	0.25	0.00	
4128	Dr. Price's, Price Ext. Co., New York	Newton, Robertson & Co., 340 Asylum St.	40	4.0	.8420	76.51	6.31	6.54	1.4691	0.15	0.00	
3910	Colton's, J. W. Colton, New York	*New Haven.*—Johnson & Bro., 411 State St.	50	4.1	.8300	81.72	6.01	5.91	1.4694	0.52	0.02	
3887	Sauer's, The C. F. Sauer Co., Richmond, Va.	F. J. Markle, Cor. State and Olive Sts.	20	1.9	.8439	76.21	5.93	6.01	1.4685	0.15	0.01	Tropeolin.*
3893	Sauer's, The C. F. Sauer Co., Richmond, Va.	W. D. Minor, 184 Shelton Ave.	10	1.0	.8434	76.55	5.67	5.86	1.4685	0.15	0.01	Tropeolin.*
3984	Williams', Williams & Carleton Co., Hartford	*New London.*—W. Holt, 50 Main St.	40	4.0	.8260	82.70	5.88	6.04	1.4691	0.15	0.01	
3982	Nichols & Harris, New London	G. H. Thomas, 437 Bank St.	15	1.7	.8513	73.06	6.35	6.36	1.4685	0.16	0.01	
3961	Miller's, The Miller Mfg. Co., 94 Duane St., N. Y.	*Norwalk.*—E. H. Morehouse, West Ave.	25	1.9	.8360	79.52	5.81	5.81	1.4685	0.18	0.03	
4021	Colton's, J. W. Colton, New York	*Norwich.*—A. T. Otis, 261 Main St.	40	3.8	.8295	82.29	6.09	6.22	1.4691	0.39	0.00	
4023	J. D. Cranston	J. D. Cranston, 170 W. Main St.	20	1.9	.8220	84.88	5.66	5.86	1.4691	0.18	0.01	
4017	Rallion's	H. D. Rallion, 45 Broadway	20	2.1	.8270	82.60	6.11	6.24	1.4685	0.23	0.01	Turmeric.

* Coal-tar dye. See foot note, p. 124.

TABLE XIX.—RESULTS OF EXAMINATION OF LEMON EXTRACT.

Samples above Standard. (Lemon oil over 4.50 per cent.)	
Not found to contain foreign color	8
Containing foreign color	3
Total	11
Samples Adulterated or below Standard. (Lemon oil below 4.50 per cent.)	
Lemon oil below 0.25 per cent.	31
Lemon oil between 0.25 and 1.00 per cent.	6
Lemon oil between 1.00 and 4.50 per cent.	13
Containing foreign oil (probably turpentine)	1
Total	51
Samples marked "Compound"	4
Total Number of Samples examined	66

Extracts above Standard. Lemon extract made according to the U. S. Pharmacopœia, as is shown by the analyses on p. 164, should contain at least 4.50 per cent. of pure lemon oil (by

weight), with no coloring matter other than from the lemon peel. Judged by these standards, only 11 of the samples examined contained the full amount of lemon oil, and of these, 3 were objectionable in that they contained a considerable amount of foreign color.

The amount of lemon oil ranged from 5.81 to 8.44 per cent. and of alcohol from 73.06 to 84.88 per cent. The agreement in the results by the two methods used for determining the oil, and the refractive index of the oil show that no considerable amount of foreign oil was present. One of the samples was colored with turmeric and two, both of the same brand, with tropeolin, a coal-tar dye.

Extracts Adulterated or below Standard. Fifty samples contained less than 4.50 per cent. of oil and are, therefore, adulterated. In 31 of these, the amount of lemon oil was less than 0.25 per cent. (usually so little that it could not be detected by chemical test) and in 6 others the amount was but little greater. The percentage of alcohol ranged from 8.68 to 85.49 per cent.

TABLE XXI.—ADULTERATED AND "COMPOUND" LEMON EXTRACTS (LEMON OIL BELOW 4.50 PER CENT.).

Station No.	Brand.	Dealer.	Price per bottle, cents.	Capacity of bottle, fluid ounces.	Specific gravity at 15.5° C.	Alcohol by weight.	Lemon oil by weight. Polariscope method.	Lemon oil by weight. Mitchell's precipitation method.	Refractive index of precipitated oil at 30° C.	Solids.	Ash.	Color.
						%	%	%		%	%	
	Adulterated or below Standard.											
4148	Hope's, New York	*Ansonia.*—P. J. Fogarty, 13 High St.	10	1.2	.8840	62.68	0.88	1.07	----	0.04	0.00	
4149	Mexican Brand, American Mills, New York	Wm. Kelley, Liberty St.	10	1.5	.9680	16.90	0.00	0.00	----	0.65	0.00	Tropeolin*
4153	Walsh Bros.	Walsh Bros., 246 Main St.	20	2.6	.8570	73.69	3.07	3.01	1.4688	0.05	0.01	Turmeric
3916	Grand Union Tea Co.	*Bridgeport.*—Grand Union Tea Co., 1114 Main St.	20	2.0	.9083	53.55	0.77	0.85	1.4697	0.06	0.01	Turmeric
3920	Trumbull & Co., Hartford	Osborne Bros., 633 Noble Ave.	10	1.3	.9516	30.31	0.00	0.00	----	0.03	0.01	
3921	Royal Brand, Lambert & Lowman, Detroit	Stapleton Bros., 102 N. Washington Ave.	10	1.4	.9377	35.86	0.19	trace	----	0.11	0.03	Tropeolin*
3918	Clark Extract Co., West Haven	C. G. Stewart, 198 Fairfield Ave.	10	1.1	.8768	66.26	1.99	1.96	1.4691	0.70	0.04	Naphthol yellow S*
4192	Cotton's, The C. L. Cotton Ex't. Co., Earlville, N. Y.	*Bristol.*—C. A. Lane, 17 No. Main St.	20	2.0	.9220	44.38	0.21	trace	----	0.11	0.02	Naphthol yellow S*
4178	Jackson's Standard, A. B. Jackson & Co., New York	*Danbury.*—W. W. Edwards, 147 Main St.	10	1.1	.9762	15.63	0.00	0.00	----	0.06	0.02	Naphthol yellow S*
4182	McKahan's Mexican Brand, J. E. McKahan & Co., Newburgh	N. T. Hoyt, West St.	10	2.0	.9650	24.64	0.05	0.00	----	0.36	0.01	Tropeolin*
4183	Coe's Triple Strength, Coe Roborant Co., Newburgh	N. T. Hoyt, West St.	10	1.3	.9750	16.55	0.00	0.00	----	0.69	0.01	
4130	A. & P., The Great Atlantic & Pacific Tea Co., New York	*Hartford.*—Atlantic & Pacific Tea Co., 979 Main St.	25	2.0	.9626	23.38	0.05	0.00	----	0.09	0.00	Naphthol yellow S*
4138	E. Brand, Union Extract Co., Buckland, Conn.	S. Divinsky, 192 Front St.	10	1.2	.9730	16.59	0.00	0.00	----	0.15	0.06	Naphthol yellow S*
4134	Perfect, Dow & Hatch	Dow & Hatch, 2 Church St.	10	2.1	.9619	23.55	0.00	0.00	----	0.02	0.00	Naphthol yellow S*
4131	Premium, McMonagle & Rogers, Middletown, N. Y.	Hills & Co., 375 Asylum St.	45	4.0	.8215	82.84	4.09†	6.80†	1.4665	0.11	0.00	
4125	Robertson's, J. T. Robertson, Hartford	M. Ruffkess, 122 Capen St.	20	2.1	.8530	75.56	2.55	2.77	1.4688	0.07	0.00	
4080	Elite Brand, Grant's Tea Store	*Meriden.*—Grant's Tea Store, State and Main Sts.	10	1.3	.9336	36.97	0.08	trace	----	0.05	0.00	
4058	Thompson's Triple Extract, J. E. Thompson, New York	*Middletown.*—S. T. Camp, 234 Main St.	40	4.1	.8930	60.19	0.89	0.96	1.4697	0.04	0.01	Tropeolin*
4057	D. Johnson & Co., Middletown, Conn.	York State Butter House, 262 Main St.	25	2.0	.8963	58.56	1.25	1.25	1.4691	0.03	0.00	
4087	Delmonico, Talcott. Frisbie & Co., Hartford	*New Britain.*—Wm. Foulds, 226 Park St.	20	1.9	.8268	85.49	3.12	3.12	1.4691	0.13	0.01	Turmeric
3913	C. N. Searle, New Haven	*New Haven.*—S. S. Adams, 412 State St.	45	8.3	.8877	62.24	1.26	1.26	1.4694	0.12	0.01	
3911	A. & P., The Great Atlantic & Pacific Tea Co., New York	Atlantic & Pacific Tea Co., 392 State St.	25	2.1	.9638	23.00	0.00	0.00	----	0.12	0.05	Naphthol yellow S*
3722	Baker's, Baker Ex't. Co., Springfield, Mass.	R. I. Blakeslee, 40 Grand Ave.	20	2.0	.8610	70.99	4.06	4.00	1.4685	0.25	0.02	
3723	Anchor Brand, Bryan, Miner & Read, New Haven	Cash Store, Grand Ave. and Poplar St.	10	1.6	.9606	25.55	0.00	0.00	----	0.05	0.01	Tropeolin*
4264	Choice Extract	D. Dore, 579 Grand Ave.	10	1.0	.9755	16.55	0.05	0.00	----	0.08	0.04	Naphthol yellow S*
3858	Frederick Bros.	Frederick Bros., 251 Davenport Ave.	10	1.0	.9573	26.69	0.05	0.00	----	----	----	
3915	Forest City, Forest City Ex't. Co., Portland, Me.	Frederick Bros., Derby Ave. and Norton St.	10	1.4	.9616	24.42	0.44	0.00	----	0.23	0.03	Naphthol yellow S*
3883	Gibbons Bros'.	Gibbons Bros., 824 State St.	25	2.9	.9153	48.97	0.39	0.61	----	0.13	0.02	Naphthol yellow S*
3899	Gold Medal Brand, F. J. Markle	F. J. Markle, 101 Dixwell Ave.	10	1.5	.9663	21.72	0.05	0.00	----	0.04	0.02	Tropeolin*

* Coal-tar dye. See foot note, p. 124.

† Apparent percentage. The disagreement in the results by the two methods and the low refractive index show that foreign oil (probably turpentine) is present.

TABLE XXI.—ADULTERATED AND "COMPOUND" LEMON EXTRACTS

Station No.	Brand.	Dealer.
	Adulterated or below Standard.	
3724	New Haven Provision Co.	*New Haven.*—N. H. Provision Co., 384 Grand Ave.
3855	Sherman Bros., New Britain	L. L. Rosenberg, 152 Congress Ave.
3892	Concentrated Extract	H. Strack, 13 Shelton Ave.
3859	Doyle's, The John T. Doyle Co., New Haven	J. L. Thuesen, 309 Oak St.
3857	H. M. Tower	H. M. Tower, 379 Congress Ave.
3721	Concentrated Ex't., D. M. Welch & Son	D. M. Welch & Son, 8 Grand Ave.
4000	Lanman's, Chas. M. Taylor	*New London.*—C. M. Taylor, 237 State St.
3981	The Snyder Brand, The O. P. Snyder Co., New York	Grocery, 138 Bank St.
3962	Concentrated Ex't., Gross & Co., New York	N. Y. Grocery Co., 32 Main St.
3975	Myers, The Miller Mfg. Co., New York	*Norwalk.*—L. Dibble, 13 No. Main St.
4019	Harris', Frank E. Harris, Binghamton, N. Y.	*Norwich.*—E. F. Burlingame, W. Main St.
4025	Lion Brand, Red Lion Ex't. Co., New York	Mohican Co., 262 Main St.
3973	Seeman Bros., Waverly Extract Co., New York	*So. Norwalk.*—L. Joseloff, 72 No. Main St.
3953	St. John's	*Stamford.*—Samuel Price, 96 Main St.
3954	The Celebrated Liberty, Liberty Ex't. Co., New York	Samuel Price, 96 Main St.
4223	The German Brand, Doetschmann Mfg. Co., New York	*Torrington.*—A. Beckwith, Main St.
4220	Sage's No. 1, Sage's Laboratory, Torrington	G. W. Main, 71 Main St.
4252	Pure Extract, New York Extract Co.	*Waterbury.*—Hamilton Cash Grocery, 45 E. Main St.
4255	Highly Concentrated, N. Y. & China Tea Co.	N. Y. & China Tea Co., 181 So. Main St.
4044	Forest City, Forest City Extract Co., Portland, Me.	*Willimantic*—S. E. Amidon, 877 Main St.
4038	Princess Brand, Bennett, Sloan & Co., New York	D. F. Blish, 66 Church St.
4041	Globe, Globe Extract Co., Boston	F. Larrabee, Church St.
	"Compounds."	
4181	Crescent Compound, Crescent Ex't. Co., New York	*Danbury.*—Danbury Grocery Co., Main St.
3726	Concentrated Compound	*New Haven.*—D. Dore, 579 Grand Ave.
3949	20th Century Compound, J. G. Powers & Co., New York	*Stamford.*—W. W. Edwards, 99 Main St.
3952	Brunswick Compound, Brunswick Mfg. Co., New York	I. N. Waterbury, 527 Pacific St.

(LEMON OIL BELOW 4.50 PER CENT.)—*Continued.*

Station No.	Price per bottle. cents.	Capacity of bottle, fluid ounces.	Specific gravity at 15.5° C.	Alcohol by weight.	Lemon oil by weight. Polariscope method.	Lemon oil by weight. Mitchell's precipitation method.	Refractive index of precipitated oil at 30° C.	Solids.	Ash.	Color.
				%	%	%		%	%	
3724	10	1.1	.9557	27.69	0.00	0.00	----	0.04	0.02	Naphthol yellow S*
3855	10	1.5	.9700	19.09	0.08	0.00	----	0.08	0.04	Naphthol yellow S*
3892	8	1.9	.9794	12.20	0.05	0.00	----	0.06	0.02	Tropeolin*
3859	10	1.1	.9155	50.69	0.38	0.52	----	0.13	0.03	Naphthol yellow S*
3857	10	2.0	.9434	33.35	0.08	0.00	----	0.07	0.05	Naphthol yellow S*
3721	30	3.5	.8903	60.76	1.82	1.59	1.4691	0.09	0.02	
4000	20	2.1	.8677	68.28	2.13	2.48	1.4691	0.15	0.02	Naphthol yellow S*
3981	10	1.7	.9886	8.68	0.10	0.00	----	0.07	0.01	Tropeolin*
3962	10	1.4	.9794	12.29	0.11	0.00	----	0.09	0.04	Tropeolin*
3975	15	1.6	.9404	34.60	0.11	0.00	----	0.07	0.02	Naphthol yellow S*
4019	20	2.1	.8472	76.90	3.82	3.86	1.4691	0.12	0.00	
4025	10	1.4	.9616	22.15	0.00	0.00	----	0.12	0.01	
3973	15	1.7	.9824	10.80	0.13	0.00	----	0.06	0.03	Naphthol yellow S*
3953	10	1.6	.9630	22.40	0.00	0.00	----	0.15	0.04	Turmeric
3954	10	1.5	.9242	46.40	0.14	trace	----	0.04	0.02	Naphthol yellow S*
4223	35	4.2	.8736	68.07	1.79	1.67	1.4685	0.06	0.00	Naphthol yellow S*
4220	15	2.0	.8870	62.99	0.77	0.77	1.4691	0.23	0.01	Turmeric
4252	25	4.2	.9653	22.60	0.00	0.00	----	0.09	0.04	Naphthol yellow S*
4255	12	1.6	.9730	17.12	0.08	0.00	----	0.06	0.00	Tropeolin*
4044	10	1.5	.9588	25.56	0.44	0.00	----	0.30	0.02	Naphthol yellow S*
4038	20	2.0	.8510	76.07	3.09	3.13	1.4691	0.11	0.02	Tropeolin*
4041	20	1.9	.8655	69.97	3.01	2.98	1.4691	0.10	0.00	
4181	10	1.9	.9480	30.61	0.00	0.00	----	0.09	0.04	
3726	10	1.6	.9684	21.15	0.00	0.00	----	0.13	0.05	Naphthol yellow S*
3949	10	1.7	.9388	35.64	trace	0.00	----	0.05	0.01	
3952	10	1.1	.9349	37.89	trace	0.00	----	0.06	0.01	Tropeolin*

* Coal-tar dye. See foot note, p. 124.

One sample, No. 4131, was not deficient in lemon oil and alcohol, but contained a foreign oil with the properties of turpentine, which may have been an ingredient of the oil used in making the extract.

Thirty-seven of the 51 extracts contained foreign color, which in 21 samples was naphthol yellow S, or a closely allied nitro-color, in 11 samples a tropeolin, and in 5 samples turmeric. Of these, naphthol yellow S and the tropeolins are coal-tar colors, which readily dye wool in an acid bath.

We have in our collection numerous pieces of woolen cloth which we have dyed brilliant golden-yellow and orange shades with the colors extracted from these commercial lemon extracts.

Samples marked "Compound." None of these extracts contained more than a trace of lemon oil and all but one were colored with a coal-tar dye.

On the average the genuine lemon extract cost 10.3 cents per ounce and the fraudulent "lemon extract" two cents less.

Methods of Analysis.

The following methods, with the exception of the "Tests for Dyes," are taken, with slight changes, from "The Methods for the Analysis of Flavoring Extracts," by A. S. Mitchell, Associate Referee on Methods of Food Analysis of the Association of Official Agricultural Chemists, and are essentially the same as are described in a paper published in 1899 by the same author.

Specific Gravity. Determine the specific gravity by the pycnometer or Westphal balance.

Total Residue. Evaporate 10 grams of the extract on a water bath at a heat below the boiling point of the alcohol. In the absence of glycerine dry to a constant weight at 100°. Examine the residue for sugar and glycerol. The presence of capsicum may be readily detected by taste.

Ash. Ignite the residue from 10 grams of the extract at a dull red heat. Examine the ash for magnesia. Where the extract has been made with insufficient alcohol to effect complete solution of the oil, the liquid is frequently clarified by filtration with magnesia, in which case the latter substance may be detected in the ash.

Alcohol. Dilute 30 grams to 200 cc.; pour the mixture into a dry Erlenmeyer flask containing 3.5 grams of light carbonate of magnesia. Stopper, shake well and filter quickly through a large, dry, plaited filter. Determine the alcohol in 150 cc. of the filtrate, and calculate the percentage of alcohol by weight in the extract by the following formula:

$$x = \frac{100\,ab\left(200 - \frac{cd}{86}\right)}{150\,c} \text{ in which}$$

x = per cent. of alcohol by weight in the extract.
a = weight of distillate.
b = per cent. of alcohol by weight in the distillate (from table).
c = weight of extract.
d = per cent. of oil by weight in extract.

Lemon Oil by Polarization. Polarize the original extract in a 200 mm. tube at a temperature of 20°, using the sugar scale. Divide the reading by 3.4 and, in the absence of other optically active substances, the result will be the percentage of lemon oil by volume. To obtain the percentage by weight, multiply the percentage by volume by 0.86 and divide by the specific gravity of the extract.

A small amount of cane sugar is occasionally present, being used to facilitate solution of the oil. In such case wash the "solid residue" from 10 cc. of sample with three portions of 5 cc. each of ether to remove waxy and fatty matters; dry and weigh residue of cane sugar, deducting 0.38 from the reading for each 0.1 per cent. of sugar so found.

Lemon Oil by Mitchell's Precipitation Method. Pipette 20 cc. of the extract into a Babcock milk flask; add 1 cc. dilute hydrochloric acid (1:1); add 25 to 28 cc. of water previously warmed to 60°; mix and stand in water at 60° for five minutes; whirl in centrifuge for five minutes; fill with warm water to bring the oil into the graduated neck of the flask; repeat whirling for two minutes; stand in water at 60° for a few minutes and read the per cent. of oil by volume. Where the oil of lemon is present in amounts over 2 per cent. add to the percentage of oil found 0.4 per cent. to correct for the oil retained in solution. Where less than 2 per cent. and more than 1 per cent. is present, add 0.3 per cent. for correction. To convert into per cent. by weight, proceed as directed under polarization.

Save the precipitated oil for the determination of refraction.

When the extract is made in accordance with the United States Pharmacopœia the results by the two above methods should agree within 0.2 per cent.

Refraction of Precipitated Oil. Place a few drops of the oil obtained above in a Zeiss butyro-refractometer at a temperature of 30°. Normal oil when treated under these conditions will have a refraction of 64° to 72° (refractive index 1.4685 to 1.4735) and a dispersion of 2°.

Limonene and most commercial adulterants give a higher reading, with the exception of citronella aldehyd and oil of turpentine.*

Detection of Methyl Alcohol.† Oxidize a small roll of copper gauze by holding it in the oxidizing flame of a Bunsen burner until thoroughly blackened. While at a red heat, plunge the gauze into a test tube con-

* J. Amer. Chem. Soc. 21, 1132.

† H. P. Mullikin and H. Scudder, Am. Chem. Jour., 21, 266, and A. B. Prescott, by personal communication.

taining about 3 cc. of the extract, previously diluted until the alcohol does not exceed 4 per cent. Repeat the operation at least once. If methyl alcohol is present, the liquid will now give a distinct reaction for formaldehyd.

Ethyl alcohol forms little or no acetaldehyd under the above conditions, and oil of lemon, citral, and citronella do not interfere.

Formaldehyd may be demonstrated by the resorcin test, being careful not to use an excess of the reagent, or a few drops of the solution may be added to milk and formalin shown by Leach's modification of Hehner's test. (Add 10 cc. of concentrated hydrochloric acid and 1 to 2 drops of dilute ferric chloride solution to 10 cc. of the milk to be tested; heat slowly to boiling. A strong violet coloration is produced when formalin is present.)

Tests for Dyes. Mitchell* has pointed out that on the addition of hydrochloric acid in the determination of lemon oil by his precipitation method, valuable indications as to the color are frequently obtained. Turmeric (curcuma) remains unchanged, some of the tropeolins change to an orange, pink or red color, and naphthol yellow S is partially and the dinitrocresols are completely decolorized.

Test a portion of the liquid remaining in the distilling flask after determination of alcohol by Arata's test.† On addition of the potassium bisulphate solution, color reactions like those described above are usually obtained.

Turmeric does not dye the wool by this process, but the tropeolins commonly used dye it an orange color which is changed to a magenta by strong hydrochloric or sulphuric acid, and naphthol yellow (Martius yellow) and naphthol yellow S dye it a golden-yellow which, in the case of the latter dye, is partially decolorized by strong acid. Wrap a piece of the dyed cloth in filter paper and heat at 120°. If naphthol yellow is present, the color is transferred to the paper.

For the further identification of the nitro-colors, concentrate another portion of the residual liquid from the alcohol determination test, and test according to the scheme proposed by Weyl.‡

Test for turmeric by the boric acid method.

Loc. cit., p. 1136.

†See page 129.

‡Sanitary Relation of the Coal-tar Colors, translated by Leffmann, p. 67.

ORANGE EXTRACT.

By A. L. Winton and A. W. Ogden.

Orange oil is prepared from orange peel by the same process as is used in making lemon oil. Orange extract is a solution of orange oil in strong alcohol.

Eight commercial extracts and one made in the laboratory have been analyzed. Of the commercial extracts, four con-

Table XXII.—Orange Extracts.

Station No.	Brand.	Dealer.
	Containing more than 4.50 per cent. of Orange Oil.	
4147	Williams', Williams & Carlton Co., Hartford	*Ansonia*.—G. E. May & Son, High St.
4189	Colton's, J. W. Colton, New York	*Bristol*.—L. G. Merrick, 182 Main St.
4195	Miller's, Miller Mfg. Co., New York	*Danbury*.—Doran's Grocery, 150 Main St.
4229	Delmonico, Talcott, Frisbie & Co., Hartford	*Winsted*.—Deming & Phelps, 613 Main St.
4603	Made in the laboratory from Sanderson's Orange Oil	
	Containing less than 4.50 per cent. of Orange Oil.	
4191	Cotton's, C. L. Cotton Ex't. Co., Earlville, N. Y.	*Bristol*.—C. A. Lane, 17 No. Main St.
4173	Pansy, Pansy Ex't. Co., Phila.	*Danbury*.—N. Y. Grocery Co., 309 Main St.
4225	Sage's, Sage's Laboratory, Torrington	*Torrington*.—S. L. Blackman, 70 Water St.
4250	Sunrise, Sunrise Ex't. Co., Phila.	*Waterbury*.—Pa. Merchandise Co., 116 E. Main St.

tained more than 4.50 per cent. of orange oil (5.20 to 6.20 per cent.) and four less (0.19 to 2.12 per cent.). The results appear in Table XXII.

Methods of Analysis.

The methods employed are those described under "Lemon Extract," except that the factor 5.2 instead of 3.4 was used for calculating the percentage of oil from the degrees of rotation on the sugar scale.

TABLE XXII.—ORANGE EXTRACTS.

Station No.	Price per bottle. cents.	Capacity of bottle, fluid ounces.	Specific gravity at 15.5° C.	Alcohol by weight.	Orange oil by weight. Polariscopic method.	Mitchell's precipitation method.	Refractive index of precipitated oil at 30° C.	Solids	Ash.	Color.
				%	%	%		%	%	
4147	25	2.0	.8205	84.90	6.10	6.20	1.4672	0.14	0.02	
4189	30	2.0	.8320	81.54	5.77	5.80	1.4678	0.95	0.02	
4195	20	1.9	.8379	79.33	6.15	6.20	1.4672	0.14	0 01	Tropeolin*
4229	20	2.3	.8233	84.64	5.31	5.20	1.4678	0.20	0.01	Turmeric
4603	--	--	.8242	84.19†	5.16‡	5.16‡	1.4672	0.14	0.01	
4191	20	2.0	.9246	43.08	0.19	trace	----	0.07	0.01	Naphthol yellow S [*
4173	10	1.6	.8585	73.87	2.12	2.10	1.4678	0.10	0.02	
4225	25	2.0	.8860	65.32	0.83	0.90	1.4678	0.28	0.02	Tropeolin*
4250	10	1.6	.8602	73.71	1.94	2.00	1.4678	0.09	0.00	

* Coal-tar dye. See foot note, p. 124.
† By volume 87.60 per cent. ‡ By volume 5.00 per cent.

MISCELLANEOUS FLAVORING EXTRACTS.

BY A. L. WINTON.

Of 19 samples of so-called raspberry extract and strawberry extract examined, 18 contained artificial flavor and color. Three of these artificial extracts were labeled as compounds, imitations, etc., and are therefore legitimate products; the remaining 15, however, not being so labeled, are adulterated.

TABLE XXIII.—RASPBERRY AND STRAWBERRY EXTRACTS, 1901.

	No. of samples.
Raspberry Extract	
Not found adulterated	0
Adulterated	3
Labeled "compound," etc.	0
Strawberry Extract	
Not found adulterated	1
Adulterated	12
Labeled "compound," etc.	3
Total	19

The following is the sample not found to contain foreign flavor or color:

4155. "Mrs. Bradford's Pure Extract Strawberry. Prepared by Mrs. M. J. Bradford, Claremont, N. H." Bought of Geo. E. May & Son, 246 Main St., Derby. Price 30 cents per bottle (2.2 ounces).

The following were marked "compound," etc.:

4086. "Harris' Pure Extract Strawberry, Frank E. Harris, Binghampton, N. Y."; also marked "Compound Extract of Strawberry." Bought of Union Trading Co., 61 Arch St., New Britain. Price 10 cents per bottle (1.1 ounce), flavored with fruit ethers and colored with ponceau.

3885. "Sauer's Pure Concentrated Extract Strawberry, G. F. Sauer Co., Richmond, Va." On another label it is stated that it is "made from Pure Fruit Juice and Artificial Extract combined." Bought of W. E. Waterbury, 772 State St., New Haven. Price 9 cents per bottle (1.0 ounce). Flavored with fruit ethers and colored with an azo coal-tar dye.

4253. "Thompson's Triple Extract Artificial Strawberry, J. E. Thompson." Bought of Hewitt Grocery Co., 20 N. Main St., Waterbury. Price 25 cents per bottle (2.1 ounces). Flavored with fruit ethers and colored with magenta.

The adulterated extracts are described in Table XXIV.

TABLE XXIV.—ADULTERATED RASPBERRY AND STRAWBERRY EXTRACTS.

Station No.	Brand.	Dealer.	Price per bottle, cents.	Capacity of bottle, ozs.	Flavor.	Color.
	Raspberry Extract.					
4146	Williams', Williams & Carleton Co., Hartford	*Ansonia.*—D. M. Welch, 186 Main St.	20	2.1	Fruit Ethers	Artificial.
4157	Harrison's, Everett Harrison, Glens Falls, N. Y.	*Derby.*—N. Y. Grocery Co., 215 Main St.	10	1.6	"	Bordeaux.*
4251	Globe, Globe Ext. Co., Boston	*Waterbury.*—Spencer & Pierpont, 352 E. Main St.	20	2.0	"	Bordeaux.*
	Strawberry Extract.					
4154	Walsh Bros.	*Ansonia.*—Walsh Bros., 246 Main St.	20	2.3	Fruit Ethers	Magenta.*
3923	Harrison's, Everett Harrison, Glens Falls, N. Y.	*Bridgeport.*—E. E. Wheeler, Main & Elm Sts.	5	1.1	"	Bordeaux.*
4190	Hallock's, Hallock, Denton & Co., Newark	*Bristol.*—J. E. Edman, 19 Prospect St.	15	1.3	"	Vegetable color.†
4176	Williams', Williams & Carleton Co., Hartford	*Danbury.*—W. D. Baldwin, White St.	25	2.0	"	Ponceau.*
4175	Wightman's Ethereal, N. Y. and Boston	A. C. Benedict, 193 Main St.	25	1.8	"	Coal-tar dye.
4133	Baker's, Baker Ext. Co., Portland, Me.	*Hartford.*—Boston Grocery, 743 Main St	25	2.0	"	Magenta.*
4127	McGuire's, J. M. McGuire, Hartford	Standard Tea Co., 1025 Main St.	20	2.2	"	Magenta (trace).*
4084	Pure Extract, Trumbull & Co., Hartford	*New Britain.*—Union Tea Co., 317 Main St.	10	1.5	"	----------
3896	Pure Concentrated Extract, Hub Drug Co., Boston	*New Haven,*—S.S. Adams, 9 Shelton Ave.	15	2.1	"	Bordeaux.*
3983	Pure Extract, Nichols & Harris, New London	*New London.*—Keefe & Davis, 125 Bank St.	25	2.2	"	Magenta.*
4224	Sage's Absolutely Pure, Sage Laboratory, Torrington	*Torrington.*—Blackman's Tea Store, 70 Water St.	25	2.2	"	Magenta.*
4249	Pure Concentrated Extract, C. E. Nichols & Co., Providence	*Waterbury.*—White Simmons Co., 165 Bank St.	18	2.0	"	Bordeaux.*

* Coal-tar dye. See note, p. 124. † Probably cudbear.

"FROSTLENE."

By A. W. OGDEN.

These preparations, manufactured by the Frostlene Mfg. Co., Boston, are stated to be compounded with the pure juice of fresh fruits. They are designed for making frosting, ice cream, etc.

4263. Strawberry Frostlene. Bought of Foote's Cash Grocery, 412 W. Main St., Waterbury. Price 20 cents per bottle (6 ounces).

4277. Raspberry Frostlene. Bought of Frederick Bros., Edwards and Nash Sts., New Haven. Price 10 cents per bottle (2 ounces).

4276. Orange Frostlene. Bought of E. E. Nichols, 378 State St., New Haven. Price 10 cents per bottle (2 ounces).

All of the above preparations were fruit sirups made apparently from juices of the fruits specified and sugar. No. **4263**, however, contained a considerable amount of salicylic acid.

THE USE OF COAL-TAR DYES IN FOODS.

By A. L. WINTON.

The manufacture of the coal-tar or "aniline" dyes from a product formerly regarded as worthless, has during the past half century grown to be an enormous industry. In 1897, according to Schultz and Julius, over 500 distinct varieties of these dyes were on the market (not including many which had become obsolete) and since that time many new ones have been introduced.

Fuchsine, or magenta, one of the earliest coal-tar dyes discovered, came into use for coloring wine shortly after 1860, and soon displaced to a large extent the vegetable colors which from very early times had been employed for this purpose. More recently, various other coal-tar dyes, particularly the azo-colors, have been extensively used, not only in wines but in many other articles of diet.

Some of the facts brought out by the work of this Station during the past four years show the extent to which the use of dyes in foods is carried at the present time. In 1898, of sixtythree samples of jellies purporting to have been made from fruit, twenty-eight were found to be spurious mixtures colored with coal-tar dyes. Some of the most remarkable samples, labeled "strawberry jelly," "raspberry jelly," etc., consisted of starch paste, flavored with artificial "fruit ethers," sweetened with glucose and preserved with salicylic acid, the dye having been used to carry out the deception.

Of forty-seven samples of fruit preserves, eight were also colored with coal-tar dyes. In the following year (1899) of the ninety-two samples of soda-water sirups, chiefly strawberry, raspberry, and orange, which were analyzed, forty-five were colored with coal-tar dyes. As a rule the sirups which were artificially colored were also artificially flavored, and contained no genuine fruit juice whatever.

Many of the bottled carbonated beverages also contained artificial colors. The quantity of dye present in a single glass of soda water or an equivalent amount of sirup was, in many cases, sufficient to dye a piece of woolen cloth (nun's veiling), six inches square, a most brilliant color—scarlet, claret, magenta, orange, yellow or green, according to the dye.

During the present year, as may be seen from the pages of this report, 21 out of 66 samples of jellies and jams, and 86 out of 106 samples of catsup and other sauces, as well as most of the cheap cordials and lemon extracts, contained dyes of coal-tar origin. Among the other articles of food in which these colors have frequently been detected, at this Station or elsewhere, are milk, butter, cheese, ice cream, confectionery, pastries, flavoring extracts, mustard, cayenne pepper, sausages, noodles, wines and liquors.

The relation of coal-tar colors to public health first deserves attention. The experiments made with dogs and other animals by Cazeneuve and Lépine, Weyl, and others have proved beyond doubt the poisonous nature of picric acid, dinitrocresol, and Martius' yellow, among the nitro-colors, and of orange II and metanil yellow among the azo-colors. Fuchsine, sulphonated nitro-colors, and most of the azo-colors tested did not act as poisons, although some of them produced vomiting, others diarrhoea, and others still developed slight albuminuria.*

* "The Coal-tar Colors," by Theodore Weyl, translated by Henry Leffmann, pp. 54-148.

Although there is evidence that most of the coal-tar dyes are not injurious to some of the lower animals, it is not safe to assume that they are entirely harmless to human beings. The dog, the animal used in most of Weyl's experiments, has a proverbially strong stomach and eats, with no apparent discomfort, many things which would disturb the digestion of a man.

The unwholesomeness of certain coal-tar dyes not classed as poisons is indicated by the experience of Weber,* who tested their effect on the artificial digestion of fibrin with pepsin and with pancreatin. He found that oroline yellow (acid yellow) retarded the action of pepsin and that methyl orange, saffoline (acridine red), and magenta (fuchsine) seriously interfered with the pancreatic digestion, where the quantity of dye made one part in 1600 of the solution. Of these, fuchsine, at least when pure, had been pronounced entirely harmless by earlier investigators who based their conclusions on experiments with lower animals and some few with man.

Even if the entire harmlessness of most of the coal-tar dyes is admitted, the chemist encounters the difficulty of distinguishing these, when present in foods, from the harmful colors. He can determine, as a rule, whether or not a coal-tar color is present, but, owing to the lack of decisive tests and the presence of interfering substances, he often finds it impossible to name the particular dye or dyes, and with the introduction of new dyes, he finds his task still more difficult. If some of the coal-tar colors believed to be non-poisonous are allowed by law in foods, it is quite probable that others which may be harmful will escape detection.

Whenever coal-tar dyes, or, for that matter, any dyes, serve merely to give imitation products the appearance of the genuine or, to use the legal phraseology, "to make the articles appear better or of greater value than they really are," they are obviously adulterants, no matter how harmless the dyes. But to some food products, often the most expensive on the market, they are added merely to render the articles more attractive to the eye, with no intent of hiding inferiority,—a practice which has been defended by many producers and some chemists as being entirely beyond reproach. A well-known spice grinder

* Jour. Am. Chem. Soc. **18**, 1092.

once remarked to the writer, in referring to the coloring of ground mustard, that the practice was no more culpable than garnishing a steak with parsley or adorning the dinner-table with a bouquet of flowers. But even in cases where the articles thus colored are otherwise pure and of the best quality and the dyes are not injurious to health, their sale is a deception and works injustice to the conscientious manufacturer who does not use them and also to the consumer with old-fashioned notions who prefers nature's colors. Under the conditions which have existed, undyed goods have been in some instances almost driven from the market.

It is evident that there is need of reform in the use of colors, but there is a diversity of opinion as to just what colors should be allowed and in just what products. Certainly, if rules are adopted, they should be for the best welfare of both the consumer and the honest producer and should not discriminate unjustly in favor of or against manufacturers of any class of food.

The laws of some countries permit the addition of certain specified colors in food products, but forbid the use of others. Such a law, however, to accomplish the desired result, should exclude not only injurious colors, but all that would be liable to perplex the chemist and thus defeat justice. But measures of this kind do not fully protect the public against imposition, as they leave many loopholes for scientific and legal controversies. If anything is to be accomplished by legislation, the writer is inclined to advocate the prohibition of all dyes of coal-tar origin. In the meantime, the extent to which these colors are used should be brought to the attention of all consumers.

Coal-tar dyes in food products now attract the consumer by their brilliant colors, but when it becomes generally known that these dyes disguise inferiority or, at least, add nothing to the value of the products and are possibly injurious to health, like the red flag of danger they will serve as a warning to the public.

THE ADULTERATION OF TEA WITH TEA FRUIT.

By A. L. Winton.

In July of the present year, a sample of low-priced green tea from a consignment purchased for use in a city almshouse was sent to this Station for examination. The sample was found to contain 11.5 per cent. of dried tea fruit or berry with usually the peduncle and calyx adhering.

The flowers of various plants are often mixed with tea, to impart fragrance, and tea blossoms, it is said, are also used to some extent for this same purpose, but tea berries, having probably no value whatever, are doubtless added merely as an adulterant.

This form of adulteration, apparently, has not attracted the attention of food analysts,—at least, no mention is made of it in any of the leading works on food examination, and no descriptions which would serve for the identification of the fruit are given outside of the works on botany.

The appearance of the fruit obtained from the sample in question is shown in Figure 1, reproduced from a photograph by Mr. H. A. Doty.

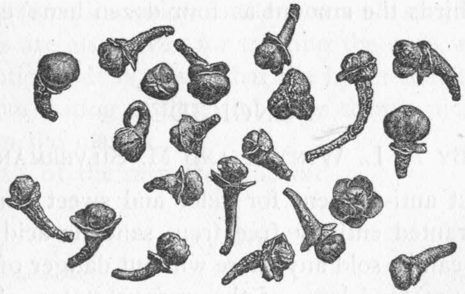

Fig. 1. Tea fruit, natural size.

The material resembles, quite closely, tea flower buds, the calyx and peduncle being about the same in size and form as in the earlier stages, and the globular or triangular pericarp presenting much the same external appearance as the closely imbricated petals of the bud. That they are not buds, but berries, is indicated by their triangular shape and the markings on the surface, and is readily demonstrated, beyond a doubt, by transverse sections into the three-celled and three-seeded ovaries.

"PUREGG."

By A. L. Winton and A. W. Ogden.

"Puregg is fresh laid eggs, with shell removed, and by our exclusive process, the water only is extracted, leaving the whites and yolks mixed, in small granules, containing all the nutritive qualities and natural flavor of the raw egg."

"One pound dissolved in one-half gallon of water is equivalent to four dozen eggs in the shell, or to one-half gallon of shell eggs in any bakery product, when the entire egg is used. Star Egg and Cold Storage Co., St. Louis."

An analysis of this material follows:

Station No.	4579
Water	7.42%
Ash	3.56
Protein	46.38
Fat	35.60

The material contained small amounts of a coal-tar dye (one of the tropeolins) and salicylic acid, but otherwise appeared to be desiccated eggs.

One pound of "puregg" contains about the same amount of nutrients as four dozen extremely small hens' eggs, but only about two-thirds the amount as four dozen hens' eggs of average size.

FUNGICIDE.

By A. L. Winton and M. Silverman.

"A perfect anti-ferment for cider and sweet wines. Fungicide is warranted entirely free from salicylic acid or its compounds and can be sold anywhere without danger of confiscation under the pure food laws of the various states. Seven-pound samples (sufficient for about 25 casks) $5.00. Douglas Filter & Specialty Co., Albany, N. Y."

An analysis of the material follows:

Station No.	4644
Sodium bicarbonate	7.98%
Sodium benzoate	51.78
*Other matters, chiefly mustard flour	40.24
	100.00

* Protein 17.69, fat 7.10.

As the mixture contains a large amount of sodium benzoate, a chemical preservative, cider containing it *cannot* be legally sold in Connecticut.

"HYPER-SAMPHIRE."

AN EGG PRESERVATIVE.

By A. L. Winton and M. Silverman.

A sample of this material, with directions for use, was sent to this Station by Prof. L. B. Mendel of Yale University. The box in which it was sold was labeled "Hyper-Samphire. A Pure Food Compound. Prepared expressly for Preserving Eggs. Price $2.50," and contained about four ounces of the material.

To prepare the preserving solution, it is directed to first stir 12 pounds of fresh lime and 6 pounds of common salt with 40 gallons of water for a day, then dissolve 8 ounces of cream tartar, 8 ounces of salt petre, 8 ounces of baking soda, 4 ounces of borax and 2 ounces of hyper-samphire in 1 gallon of water, and add the second solution to the first with stirring.

Directions are also given for treating the eggs with this preserving solution. It is stated that the hyper-samphire prevents the eggs from tasting of lime and gives them a nice appearance when put on the market.

An analysis of the mixture follows:

Analysis.

Station No.	4209
Common salt	71.35%
Sodium salicylate	9.58
Free salicylic acid	6.60
Acid sodium sulphite	1.10
Normal sodium sulphite	4.75
Sodium sulphate	2.34
Calcium sulphate	3.27
Water	1.01
	100.00

From this analysis it appears that over two-thirds of the mixture consists of common salt, the remainder being free salicylic acid, sodium salicylate and small amounts of sulphites, bisulphites and sulphates.

One and one-third ounces of a mixture of 3 parts of salicylic acid and 1 part of sodium bisulphate, costing not more than 15 cents, would have about the same value as 4 ounces of hypersamphire, for use in the preserving solution described.

SPICES.

By A. L. WINTON AND M. SILVERMAN.

In 1896, the year in which the Pure Food Law went into effect, the people in our State, according to a conservative estimate, spent about $200,000 for spices, of which amount, judging from the results of our examination of numerous samples, fully one-quarter (or $50,000) went for fraudulent mixtures.

One of the commonest adulterants is ground cocoanut shells (see page 221). Buckwheat products are also utilized. The black hulls ground with a little of the starchy matter are added to black pepper, and the middlings, which consist of the inner seed-coats and some starchy matter, serve as a basis for white pepper, and when dyed, for other spices. In addition, sawdust, linseed meal, mustard hulls, almond shells, biscuit crumbs, plaster (gypsum), pepper shells (by-product obtained in preparing white pepper), and by-products from wheat, corn, rice and other grains, as well as many other waste products, are used for adulterating the various spices.

These spurious mixtures are sold, for the most part, in bulk or in packages without the name of the grinder.

During the first three years after the passage of the Pure Food Law, 350 samples of spices sold in bulk were examined, of which 150 (or 43 per cent. of the whole number examined) were adulterated.

During the present year, 216 samples of bulk spices were examined, of which 63 (or 29 per cent.) were adulterated.

From these figures it can be seen that the adulteration of

spices has been and still is extensively practiced, but it should be noted that the percentage of adulterated samples in the whole number examined has decreased from 43 to 29 per cent. during the past few years.

As bulk spices are still very commonly adulterated, the purchaser is strongly advised to buy only in sealed boxes bearing the name of a reputable dealer.

Details with regard to the samples examined during the present year appear in Tables XXV and XXVI; a summary appears in the following statement:

EXAMINATION OF SPICES.

	Samples not found adulterated.	Samples adulterated or colored.	Total.
Black pepper	31	20	51
White pepper	13	4	17
Cayenne pepper	17	3	20
Mustard	17	14	31
Ginger	26	5	31
Cinnamon	26	7	33
Cloves	13	4	17
Allspice	10	6	16
	153	63	216

The adulterants detected in black pepper were wheat and buckwheat middlings, corn meal, linseed meal, a cooked wheat product (probably biscuit), charred cocoanut shell, mustard hulls, cayenne and pepper shells, or dirt; in white pepper,—corn meal, wheat and buckwheat middlings and cayenne; in cayenne pepper,—plaster (gypsum), sawdust, corn meal and a red coal-tar dye; in mustard,—wheat flour, corn flour or starch, plaster and turmeric; in ginger,—wheat, rice and buckwheat middlings, turmeric, cayenne and dirt; in cinnamon,—wheat middlings, mustard hulls, cotton seed meal, ginger and dirt; in cloves,—clove stems, ground cocoanut shells and a wheat product (probably biscuit); and in allspice,—the same as were found in cloves, and, in addition, pea meal.

TABLE XXV.—SPICES NOT FOUND ADULTERATED.

Station No.	Dealer.	Price per ¼ lb., cents.	Ash.
			%
	Black Pepper.		
2218	Bridgeport.—S. L. Feldmen, 240 Lindley St.	5	4.73
2220	C. Russell & Co., 945 Main St.	10	5.45
2205	Bristol.—G. S. Reed, North Main & North Sts.	10	5.15
2056	Danielson.—R. R. James & Co.	10	4.75
2060	Quinnebaug Store, Main St.	8	5.15
2255	Greenwich.—John L. Mahoney, 384 Greenwich St.	8	6.00
2166	Hartford.—W. J. Tollhurst, 55 Maple St.	10	5.33
2079	Middletown.—D. D. Warner, Summer St.	10	4.57
2198	New Britain—H. Oldershaw Co., 226 Park St.	10	4.90
2192	Union Trading Co., 61 Arch St.	10	6.48
2257	New Canaan—J. F. Silliman	10	4.35
2101	New Haven.—C. H. Harris, 161 Washington St.	10	5.10
2114	Maher Bros., 731 Grand Ave.	9	4.52
2135	New London.—J. R. Avery & Son, 19 Broad St.	10	6.45
2270	New Milford.—A. G. Ferriss	8	5.53
2055	Norwich.—W. A. Church, 20 Market St.	10	3.80
2061	Putnam.—J. E. Sullivan	10	4.93
2186	Rockville.—H. O. Keeney, Union St.	8	6.50
2184	Ransom Bros., 17 Market St.	7	4.73
2297	Southington.—Finch & Laity Co.	10	5.58
2296	Upson Bros.	10	5.88
2181	So. Manchester.—J. M. Burk, Prospect St.	8	5.25
2243	So. Norwalk.—Conrad Becker, 41 Washington St.	8	5.25
2248	Stamford.—W. W. Edwards, 99 Main St.	7	5.98
2125	Stonington.—Stivers, 72 Water St.	8	5.13
2299	Torrington.—Willis L. Pond, Main St.	10	5.65
2277	Waterbury.—Pa. Merchandise Co., 110 E. Main St.	10	6.45
2281	White, Simmons Co., 165 Bank St.	10	5.28
2279	Watertown.—J. J. Keilty	10	4.93
2456	West Winsted.—King & Gay, Main St.	10	4.58
2077	Willimantic.—A. A. Trudeau, Main St.	10	5.17
	White Pepper.		
2294	Ansonia.—W. H. Bronson, 234 Main St.	10	2.03
2211	Bristol.—L. G. Merick, Main and Prospect Sts.	10	2.80
2212	Milford.—Perry & Perry, River St.	10	3.90
2197	New Britain.—Boston Grocery, Main St.	10	2.90
2109	New Haven.—S. S. Adams, 375 Howard Ave.	8	3.88
2120	R. F. Copeland, 1206 State St.	9	2.60
2133	New London.—Geo. H. Thomas, 437 Bank St.	10	1.60
2148	Norwich.—H. D. Avery, 202 Franklin St.	10	1.53
2054	Wheeler Bros., 2 Cliff St.	15	1.43
2063	Putnam.—W. H. Mansfield & Co.	10	2.58
2178	So. Manchester.—G. F. Day, Charter Oak St.	8	3.10
2300	Torrington.—Torrington Cash Grocery, 36 Water St.	7	3.90
2075	Willimantic.—H. C. Hall, 17 Union St.	12	2.05
	Cayenne Pepper.		
2229	Bridgeport.—C. K. Bishop, 653 E. Washington Ave.	15	5.69
2204	Bristol.—P. Jennings, North Main and Center Sts.	10	5.45
2128	Groton.—C. W. Allyn	10	5.85
2164	Hartford.—W. Eustace, 119 Pearl St.	10	6.48
2097	Meriden.—H. F. Rudolph & Co., 46 E. Main St.	10	5.95
2086	Middletown.—Grand Union Tea Co., 272 Main St.	13	5.55
2552	Naugatuck.—Moulthrop & Gray, 265 Water St.	10	
2193	New Britain.—H. A. Hall, 212 Main St.	8	5.20

TABLE XXV.—SPICES NOT FOUND ADULTERATED.—*Continued.*

Station No.	Dealer.	Price per ¼ lb., cents.	Ash.
			%
	Cayenne Pepper.		
2116	New Haven.—A. Basserman, 211 Grand Ave.	10	6.30
2119	D. M. Smith & Son, 38 Grand Ave.	8	6.45
2272	New Milford.—Ackley, Hatch & Marsh	10	6.11
2144	Norwich.—H. D. Rallion, 45 Broadway	10	6.33
2187	Rockville.—F. Farrenkopf, 30 Union St.	10	4.90
2179	So. Manchester.—Boston Grocery, Main St.	10	5.90
2260	So. Norwalk.—S. H. Raymond, 42 So. Main St.	12	6.50
2454	W. Winsted.—Deming & Phelps, Main St.	10	6.43
2070	Willimantic.—Burt Thompson, 798 Main St.	10	6.75
	Mustard.		
2293	Ansonia.—S. W. Smith & Co., 178 Main St.*	10	6.75
2219	Bridgeport.—P. E. McCaffrey, 1162 Main St.	7	7.03
2127	Groton.—H. E. Marquardt	8	7.90
2159	Hartford.—C. H. Bell, 689 Main St.*	15	6.75
2177	Manchester.—Balch & Brown, Depot Square*	15	7.35
2085	Middletown.—Buell & Blatchley, 246 Main St.*	15	7.18
2288	Naugatuck.—Carlson's Tea Store, 162 Church St.	8	7.75
2118	New Haven.—S. L. Salisbury, 6 Grand Ave.*	15	6.23
2103	E. Wadewitz, 316 Columbus Ave.*	15	6.23
2137	New London.—W. M. Lucy, 193 Bank St.	8	6.53
2138	Moon's Pharmacy, 477 Bank St,*	15	6.30
2236	Norwalk.—C. L. Glover, 35 Wall St.	10	7.45
2150	Norwich.—Stiener's Pharmacy, Shetucket and Main Sts.*	15	7.58
2065	Putnam.—Dresser's Pharmacy*	10	6.70
2246	Stamford.—J. K. Lawrence, 55 Atlantic St.*	15	7.00
2089	Wallingford.—Pickett Bros., 3 Main St.*	15	6.05
2073	Willimantic.—Samuel Chesbro, 745 Main St.*	15	6.03
	Ginger.		
2291	Ansonia.—Bristol Drug Co., 100 Main St.*	15	3.73
2221	Bridgeport.—Coe & White, 1252 Main St.	8	6.13
2227	Geo. A. Jamieson, 1087 Main St.*	15	4.35
2209	Bristol.—Jas. D. Monaghan, Prospect St.	10	7.70
2262	Danbury.—Barnum's Pharmacy, White & Main Sts.*	15	4.35
2058	Danielson.—Reeves & Greiner, 226 Main St.	10	7.43
2453	East Winsted.—T. Baird & Co., Main St.*	15	5.93
2256	Greenwich.—S. A. Mosher, 129 Greenwich St.	8	5.10
2155	Hartford.—Cowles & Howard, 156 North Main St.	10	5.25
2160	Goodwin's Drug Store, 854 Main St.*	10	4.23
2176	Manchester.—John P. Smith, Main St.*	10	4.85
2087	Middletown.—W. F. Ackley & Co., 592 Main St.	7	7.10
2084	J. J. Curtin, 592 Main St.	10	7.35
2215	Milford.—Union Store Co., Broad St.	6	6.58
2104	New Haven.—I. H. Levy, 276 Washington St.*	15	4.93
2129	New London.—Nichols & Harris, 115 State St.*	15	5.23
2233	Norwalk.—Wm. Betts, 15 Main St.	10	6.95
2051	Norwich.—J. P. Halloway, 319 E. Main St.	10	4.50
2052	N. D. Sevin & Son, 141 Main St.*	10	6.25
2066	Putnam.—H. L. Burt*	10	4.50
2259	So. Norwalk.—E. G. Tomlinson, Main St.*	25	6.30
2245	Stamford.—P. H. Morgan, 24 Atlantic Square*	15	3.65
2124	Stonington.—F. D. Burtch & Co., 57 Water St.*	15	4.53
2170	Thompsonville.—G. R. Steele, Main and Prospect Sts.*	15	4.38
2090	Wallingford.—D. J. Tucker, Colony St.*	15	4.45
2067	Willimantic.—Baker's Pharmacy, Main St.*	15	4.03

* Drug store.

TABLE XXV.—SPICES NOT FOUND ADULTERATED.—*Continued.*

Station No.	Dealer.	Price per ¼ lb., cents.	Ash.
			%
	Cinnamon.		
2224	Bridgeport.—Lee & Ketchum, 20 Fairfield Ave.	15	4.50
2207	Bristol.—C. A. Lane, 17 North Main St.	15	3.80
2273	Danbury.—A. G. Benedict, 193 Main St.	20	3.55
2275	W. W. Edwards, 147 Main St.	10	2.95
2264	J. W. Smith, 62 Elm St.	10	5.30
2457	East Winsted.—Larkin & Sparks, Main St.	10	3.55
2126	Groton.—G. S. Avery	10	3.95
2163	Hartford.—Cady & Lombard, 81 Albany Ave.	10	3.90
2153	Greenbaum, Albany Ave. and Belden St.*	20	4.00
2151	Meriden.—Grant's Tea Store, E. Main St.	10	4.60
2083	Middletown.—N. E. Tea Co., 442 Main St.	10	4.50
2190	New Britain.—E. W. Thompson & Co., 181 Main St.*	20	6.50
2136	New London.—J. W. Miner, 51 Huntington St.	10	5.85
2271	New Milford.—G. H. Jackson	10	4.50
2237	Norwalk.—P. J. Lynch, 21 Main St.	12	3.75
2140	Norwich.—A. Francis & Son, Thames St.	10	4.65
2053	Stanton & Tyler, 58 Main St.	20	5.20
2180	So. Manchester.—W. B. Cheney, Main St.*	15	3.95
2250	Stamford.—O. S. Brown, 10 Park Row	10	3.05
2092	Wallingford.—S. J. Hall, Main St.	12	4.50
2088	Shortelle's Pharmacy, 76 Center St.*	15	4.65
2283	Waterbury.—L. P. & A. M. Guilfoil, 781 Bank St.	8	4.00
2278	W. C. Nichols, 39 East Main St.	10	5.05
2298	Spencer & Pierpont Co., 362 East Main St.	12	5.90
2458	West Winsted.—E. W. King, Main St.	13	3.65
2072	Willimantic.—C. DeVillers, Main St.*	15	4.95
	Cloves.		
2222	Bridgeport.—National Grocery Co., 956 Main St.	10	6.70
2263	Danbury.—D. E. Ketcham & Co., 35 Elm St.	15	7.30
2152	Meriden.—Kapitzke & Quinlan, 80 E. Main St.	8	7.85
2196	New Britain.—W. H. Pierce, 72 W. Main St.	10	7.25
2121	New Haven.—F. J. Markle, 101 Dixwell Ave.	8	7.75
2108	Arthur Tennant, 751 State St.	8	6.70
2130	New London.—A. M. Stacy, 123 State St.	15	6.90
2145	Norwich.—J. D. Cranston, 170 W. Main St.	10	6.50
2242	So. Norwalk.—Lorenzo Dibble, 13 No. Main St.	15	7.93
2093	Wallingford.—Miner & Bridgett, 66 Center St.	10	6.20
2076	Willimantic.—C. R. Hibberd, 22 North St.	12	7.95
2069	Purinton & Reade, 707 Main St.	15	7.05
2174	Windsor Locks.—Geo. W. Gates, Main St.	10	7.05
	Allspice.		
2080	Middletown.—J. B. Patterson, 110 Main St.	10	4.60
2105	New Haven.—N. E. Tea Co., 35 Congress Ave.	10	5.25
2132	New London.—W. A. Murray, Bank and Shaw Sts.	10	4.95
2141	Norwich.—Thos. Wilson, 72 Franklin St.	10	4.30
2064	Putnam.—Edward Mullen	10	4.70
2189	Rockville.—McNeill & Conway, Market St.	12	5.40
2122	Stonington.—S. H. Chesbro, 146 Water St.	8	5.80
2232	Westport.—Beers Brothers	13	5.15
2068	Willimantic.—Frank Larrabee, 16 Church St.	10	4.70
2173	Windsor Locks.—James Keevers, Main St.	10	5.25

* Drug store.

TABLE XXVI.—SPICES, ADULTERATED OR BELOW STANDARD.

Station No.	Dealer.	Price per ¼ lb., cents.	Ash.	Sand	Adulterants
			%	%	
	Black Pepper.				
2295	Ansonia.—N. Y. Grocery Co., 130 Main St.	7	5.15	....	Wheat, linseed and buckwheat products.
2225	Bridgeport.—Atlantic & Pacific Tea Co., 707 E. Main St.	7	16.25	3.83	Pepper shells or dirt.
2267	Danbury.—M. McPhelamy, 45 White St.	8	6.70	1.93	Pepper shells or dirt.
2268	N. Y. Cash Grocery, 307 Main St.	5	6.67	1.47	Wheat product,* cayenne, dirt.
2274	The Ives, Andrews Co., 249 Main St.	8	7.83	1.98	Pepper shells or dirt.
2154	Hartford.—P. S. Kennedy, Main and Morgan Sts.	7	10.85	2.75	Pepper shells or dirt.
2096	Meriden.—Block & Behrens, 74 E. Main St.	8	7.40	1.75	Pepper shells or dirt.
2100	G. H. Kimball, 30 E. Main St.	10	7.20	1.55	Pepper shells or dirt.
2214	Milford.—J. B. Tibballs & Son, Broad St.	8	5.88	....	Wheat product,* cayenne.
2286	Naugatuck.—W. T. Davis, Main St.	8	7.38	1.65	Pepper shells or dirt.
2106	New Haven.—H. Halpin, 319 Washington St.	5	3.35	....	Corn, wheat and buckwheat products, charred cocoanut shells.
2234	Norwalk.—N. Y. Grocery Co., 37 Main St.	8	2.40	....	Corn meal, charred cocoanut shells.
2147	Norwich.—E. F. Burlingame, Thames and W. Main Sts.	10	8.10	2.60	Pepper shells or dirt.
2185	Rockville.—I. Raichie & Co., 40 Union St.	10	7.25	1.60	Pepper shells or dirt.
2168	Thompsonville.—Wm. Hilditch, Jr., Main St.	10	2.40	....	Corn meal, charred cocoanut shells.
2091	Wallingford.—Laden Bros., 104 Center St.	10	4.73	....	Wheat, buckwheat and linseed products, charcoal, cayenne.
2282	Waterbury.—Brooklyn Butter Store, 844 Bank St.	5	7.45	2.23	Wheat and linseed products, mustard hulls.
2276	Union Tea Co., 106 South Main St.	7	7.53	1.35	Starchy matter, charcoal.
2230	Westport.—G. A. Darrow	10	5.78	....	Wheat product (probably biscuit).
2175	Windsor Locks—J. B. Benson, Main St.	15	2.33	....	Corn meal, charred cocoanut shells.
	White Pepper.				
2223	Bridgeport.—City Market Co., 282 State St.	5	2.10	....	Corn meal, cayenne
2156	Hartford.—C. H. Strong, 139 Main St.	10	1.73	....	Corn meal, cayenne.
2082	Middletown.—C. A. Allison, Church and Main Sts.	13	2.13	....	Wheat product.
2239	So. Norwalk.—Edwin Wilcox, 70 Washington St.	12	2.63	....	Buckwheat middlings.

* Probably biscuit.

TABLE XXVI.—SPICES, ADULTERATED OR BELOW STANDARD—*Continued.*

Station No.	Dealer.	Price per ¼ lb., cents.	Ash.	Sand.	Adulterants.
	Cayenne Pepper.		%	%	
2290	Ansonia.—P. W. Fogarty, 13 High St.	9	21.95	0.23	Plaster (gypsum), sawdust, corn meal, coal-tar dye.‡
2287	Naugatuck.—Moulthrop & Gray, 268 Water St.	10	22.15	0.15	Plaster (gypsum), sawdust, corn meal, coal-tar dye.‡
2251	Stamford.—E. F. Lounsbury, Canal and Pacific Sts.	8	7.00	0.45	Corn meal.
	Mustard.				
2228	Bridgeport.—L. F. Curtis, 1149 Main St.*	20	5.90	----	Wheat flour, turmeric.
2208	Bristol.—Madden's Drug Store, 21 Prospect St.*	15	6.40	----	Wheat flour, turmeric.
2265	Danbury.—H. E. Northrop, 227 Main St.*	15	4.20	----	Wheat flour, turmeric.
2254	Greenwich.—H. C. Boswell, 113 Greenwich St.*	15	5.95	----	Turmeric.
2162	Hartford.—E. M. Palmer, 320 Albany Ave.	10	3.55	----	Wheat flour, corn product, turmeric.
2094	Meriden.—Boston Grocery, 17 Colony St.	10	6.78	----	Turmeric.
2201	New Britain.—Francis Dobson, 35 Spring St.	10	6.73	----	Turmeric.
2107	New Haven.—H. Halpin, 319 Washington St.	5	14.33†	0.80	Plaster (gypsum), turmeric.
2149	Preston.—J. M. Young, Main St.	10	7.25	----	Turmeric.
2240	So. Norwalk.—D. S. Davenport, 20 No. Main St.	10	7.43	----	Turmeric.
2167	Thompsonville.—W. L. Benton & Co., 79 Main St.*	15	7.68	----	Turmeric.
2451	Torrington.—Aug. Mahieu, 38 E. Main St.	5	5.75	----	Turmeric.
2172	Windsor Locks.—C. F. Cleaveland, Main St.	10	5.65	----	Turmeric.
2455	Winsted.—Wm. H. Mills, Main St.*	15	6.00	----	Wheat flour, turmeric.
	Ginger.				
2095	Meriden.—Meriden House Pharmacy, W. Main St.*	10	4.18	----	Wheat and buckwheat products, charcoal, turmeric, cayenne.
2285	Naugatuck.—W. F. Brennan, 172 Church St.	10	6.90	----	Rice middlings, turmeric.
2200	New Britain.—East End Cash Market, Spring and Hartford Aves.	10	9.05	3.30	Dirt.
2102	New Haven.—C. C. Stevens, 320 Columbus Ave.	8	5.93	----	Rice middlings, turmeric.
2452	Torrington.—Chas. S. Brenker, 16 So. Main St.	8	5.50	----	Rice middlings, turmeric.

* Drug store. † A tropeolin. ‡ Largely gypsum.

TABLE XXVI.—SPICES, ADULTERATED OR BELOW STANDARD—*Continued.*

Station No.	Dealer.	Price per ¼ lb., cents.	Ash.	Sand.	Adulterants.
	Cinnamon.		%	%	
2292	Ansonia.—D. M. Welch, Main St.	10	10.85	6.70	Dirt.
2059	Danielson.—Waldo Bros., 120 Main St.	10	5.05	----	Ginger.
2216	Milford.—M. T. Gregory & Son, Cherry St.	10	4.45	----	Ginger.
2289	Naugatuck.—Naugatuck Grocery Co., Main and Maple Sts.	8	6.35	----	Wheat product,* cotton seed meal, ginger.
2195	New Britain.—Union Tea Co., 317 Main St.	13	3.25	----	Wheat product,* mustard hulls.
2113	New Haven.—M. Gans & Son, 722 Grand Ave.	5	7.45	----	Wheat product,* cotton seed meal, ginger.
2110	L. L. Rosenberg, 150 Congress Ave.	5	10.83	7.28	Dirt.
	Cloves.				
2165	Hartford.—Atlantic & Pacific Tea Co., 979 Main St.	7	8.43	1.13	Clove stems.
2203	W. C. Wade, 199 State St.	10	7.40	----	Wheat product,* cocoanut shells.
2078	Middletown.—W. H. Spencer, 96 Main St.	15	8.33	0.83	Clove stems.
2146	Norwich.—Hong Kong Tea Co., 219 Main St.	15	3.05	----	Cocoanut shells.
	Allspice.				
2161	Hartford.—Boston Grocery, Main St.	5	7.13	1.05	Clove stems.
2194	New Britain.—C. M. Oquist, Elm and East Main Sts.	10	4.80	----	Wheat product,* pea meal.
2117	New Haven.—W. G. Graves, 341 Grand Ave	10	5.30	----	Cocoanut shells.
2134	New London.—Edward Keefe, 495 Bank St.	10	7.90	1.10	Clove stems.
2249	Stamford.—A. J. Finney, 202 Main St.	10	5.15	----	Wheat product.*
2284	Waterbury.—Cronan, 793 Bank St.	10	3.30	----	Pea meal.

* Probably biscuit.

CREAM OF TARTAR.

By A. W. Ogden.

Forty-one samples of cream of tartar have been examined this year, and are described in Tables XXVII and XXVIII. Of these, fourteen were bought of druggists and were in every case pure, none containing less than 99.3 per cent. of potassium bitartrate. Twenty-seven samples were bought of grocers, and of these eight were adulterated with acid phosphate of lime, starch, and sulphate of lime (plaster). Partial analyses of these adulterated samples are given in Table XXIX.

Table XXVII.—Cream Tartar not Found Adulterated. Bought Oct., 1900.

Station No.	Dealer.	Price per ¼ lb., cents.	Potassium bi-tartrate.
			%
	Bought of Druggists.		
2226	Bridgeport.—J. N. McNamara, 923 E. Main St.	15	99.9
2206	Bristol.—J. W. Skelly, 362 N. Main St.	15	99.9
2266	Danbury.—Wheeler's Drug Store, 99 White St.	15	99.5
2253	Greenwich.—P. B. Montels, 472 Greenwich St.	15	99.8
2158	Hartford.—C. R. Gladding, 1203 Main St.	15	99.8
2098	Meriden.—Cosmopolitan Pharmacy, 42 E. Main St.	15	99.8
2213	Milford.—J. H. Barnes, Broad St.	10	99.6
2191	New Britain.—Bancroft's Pharmacy, 257 Main St.	15	99.7
2188	Rockville.—Fitton's Pharmacy, Park Place	15	99.6
2261	So. Norwalk.—Apothecaries' Hall, 128 Washington St.	15	99.8
2247	Stamford.—Parker & Ward, 185 Main St.	15	99.8
2169	Thompsonville.—E. N. Smith, Main St.	15	99.3
2280	Watertown.—D. G. Sullivan	15	99.5
2071	Willimantic.—City Drug Store, Main St.	15	99.9
	Bought of Grocers.		
2217	Bridgeport.—E. E. Wheeler, 475 Main St.	10	99.6
2252	Greenwich.—A. W Avery, 51 Greenwich St.	14	99.9
2099	Meriden.—Russell Bros., 2 Colony St.	10	99.9
2081	Middletown.—D. I. Chapman, 146 Main St.	15	99.5
2258	New Canaan.—Kinsella & Smallhorn	13	99.6
2199	New Britain—G. B. Grocock, 250 Park St.	10	99.9
2112	New Haven.—O. Boettger, 209 Shelton Ave.	8	99.4
2115	J. V. Rattlesdorfer, 97 Greene St.	10	99.6
2131	New London.—W. A. Murray, 672 Bank St.	13	99.6
2238	Norwalk.—F. D. Lawton, 47 Main St.	12	99.0
2139	Norwich.—Disco Bros., 267 Main St.	12	99.6
2142	W. A Smith, 137 Main St.	15	99.9
2062	Putnam.—A. C. Stetson	10	99.6
2182	South Manchester.—Citizen's Cash Store, Main St.	12	99.9
2241	South Norwalk.—L. Joseloff, 72 No. Main St.	10	99.7
2244	Stamford.—H. S. Daskam, 59 Atlantic Ave.	13	99.5
2123	Stonington.—M. Pendleton, 62 Water St.	10	99.6
2231	Westport.—W. E. Osborn	15	99.5
2074	Willimantic.—Grand Union Tea Co., 725 Main St.	13	99.4

Table XXVIII.—Adulterated Cream of Tartar. Bought Oct., 1900.

Station No.	Dealer.	Price per ¼ lb., cents.	Adulterants found.
	Bought of Grocers.		
2210	Bristol.—J. E. Edman, 19 Prospect St.	15	Acid phosphate of lime, starch, plaster.
2057	Danielson.—A. H. Armington, 142 Main St.	8	Acid phosphate of lime, starch, ammonia alum.
2157	Hartford.—Buckley & Reardon, 557 Main St.	12	Acid phosphate of lime, starch.
2202	Dow & Hatch, 2 Church St.	15	Plaster.
2269	New Milford.—Farmers' Trading Co.	10	Acid phosphate of lime, starch.
2143	Norwich.—J. Connor & Son, 72 Water St.	10	Acid phosphate of lime, starch, soda alum.
2183	Rockville.—Cooley & Thompson, West St.	10	Acid phosphate of lime, starch.
2171	Thompsonville.—M. A Mitchell, Prospect St.	12	Acid phosphate of lime, starch.

Table XXIX.—Chemical Analyses of Adulterated Cream of Tartar. Bought Oct., 1900.

Station No.	Lime.	Soda.	Potash.	Alumina.	Sulphuric acid	Phosphoric acid.	Nitrogen as ammonia.	Starch.
	%	%	%	%	%	%	%	%
2210	26.60	0.41	3.38	0.00	33.75	8.60	0.00	1.29
2057	13.00	0.94	1.63	3.13	27.72	10.50	1.41	23.09
2157	1.56	0.91	20.30	0.00	2.68	0.40	0.00	3.02
2202	28.63	1.39	1.15	0.00	40.95	0.00	0.00	0.00
2269	9.82	1.18	15.18	0.00	8.21	10.47	0.00	4.87
2143	17.00	3.13	2.34	2.29	27.16	12.84	0.00	16.57
2183	31.29	1.22	0.09	0.00	38.55	11.07	0.00	0.68
2171	10.56	0.75	14.79	0.00	8.93	10.99	0.00	2.67

MACARONI, SPAGHETTI, VERMICELLI AND NOODLES.

By A. L. Winton and A. W. Ogden.

Macaroni, spaghetti and vermicelli are made in Italy, France and to some extent in other countries from wheat flour rich in gluten. The flour is wet with hot water, kneaded into a dough and placed in a hollow metal cylinder provided at one end with a perforated plate. By means of a plunger the dough is forced through the perforations, thus forming tubes or cylindrical sticks which when dried are ready for the market.

Noodles are prepared by European housewives and some manufacturers from flour, with the addition of a certain amount of eggs and salt. The dough is rolled into sheets and cut into strips or fanciful shapes.

Most of the noodles on the market, however, although of a golden yellow color, are not made with eggs, but have about the same composition as macaroni, being dyed either with a vegetable color (commonly turmeric) or a coal-tar dye (tropeolins, dinitrocresol, Martius yellow, naphthol yellow S, etc.).

Examination of Samples Sold in Connecticut.

Analyses of 83 samples are given in detail in Table XXXI, and a summary of these analyses in the following statement:

Table XXX.—Summary of Examinations of Macaroni, Spaghetti, etc.

	Macaroni.	Spaghetti.	Vermicelli.	Noodles.
Uncolored, or colored with eggs	37	8	7	4
Colored with turmeric	0	0	0	10
Colored with coal-tar dyes	0	0	2	12
Color not identified	0	0	1	2
Total number of samples	37	8	10	28

Macaroni. All the samples appeared to have been made from wheat flour without addition of any considerable amount of salt, eggs or color. The ash ranged from 0.38 to 0.96, the protein from 11.94 to 20.69, the nitrogen-free extract (including fiber) from 64.82 to 75.60 and the fat from 0.15 to 1.11 per cent.

Spaghetti and Vermicelli. The percentages of the ingredients were all within the limits given for macaroni. One sample was colored with a tropeolin (orange coal-tar dye), another with a nitro-color (yellow coal-tar dye), and another still with an unidentified dye.

Noodles. Most of the samples were of about the same composition as macaroni; four, however (Nos. 3931, 3934, 4275 and 3964) contained more than the average amount of protein and from 1.70 to 5.70 per cent. of fat. From these figures and the reactions of the yellow coloring matter, it is reasonable to assume that these four were real egg noodles. The colors of the remaining samples, some of which were labeled egg noodles, were derived from yellow and orange dyes. Ten were colored with turmeric, twelve with coal-tar dyes and two with unidentified colors. Two samples contained respectively 1.96 and 1.94 per cent. of common salt.

Methods of Analysis.

The methods employed in the quantitative analyses are those of the Association of Official Agricultural Chemists.

Tests for Dyes. Turmeric and nitro colors are extracted from the finely ground materials by long-continued shaking with alcohol, and are identified by the usual tests.

The orange coal-tar dyes commonly employed are not dissolved by this treatment but are readily extracted by shaking with a mixture of 10 parts of alcohol and one part of hydrochloric acid. The dye designated "tropeolin"* in the table is soluble in the acid alcohol, the filtered liquid being a rich orange color, which on evaporation at a gentle heat changes to a rose red. After a time this rose red color also appears on the edges of the filter and in the extracted (but not washed) starchy residue. It disappears on addition of alcohol but reappears on drying. Ammonia changes the color of the extract to a golden yellow.

The color dyes wool a dirty yellow by Arata's test which changes to rose red on addition of acid. Concentrated hydrochloric acid added to the powdered material imparts a rose red coloration. These reactions indicate that the dye is a coal-tar color closely related to methyl orange and is probably the same as Geissler* and Crampton find in butter colors.

*J. Amer. Chem. Soc. 20, 110.

TABLE XXXI.—ANALYSES OF MACARONI, SPAGHETTI, VERMICELLI AND NOODLES.

Station No.	Brand.	Dealer.	Price per pound, cents.	Water.	Ash.	Protein.	Nitrogen-free extract and fiber.	Fat.	Color.
				%	%	%	%	%	
	Macaroni.								
3932	Sold in bulk	*Bridgeport.*—Village Store Co., 748 E. Main St.	4	13.26	0.96	13.56	71.11	1.11	Uncolored.
4194	Sold in bulk	*Bristol.*—101 N. Main St.	--	11.64	0.63	16.50	70.95	0.28	"
4171	Sceau D'or	*Danbury.*—Herman & Glazer, 21 Elm St.	10	12.71	0.47	12.37	74.11	0.34	"
4121	Rodier Fils et Cie, Bordeaux, Lyon, France	*Hartford.*—A. H. Tillinghast, 341 Main St.	15	10.34	0.64	13.00	75.60	0.42	"
4049	La Armor Brandi	*Middletown.*—W. K. Spencer, 98 Main St.	10	12.65	0.64	13.19	72.81	0.71	"
4091	W. A. Castle. Springfield, Mass.	*New Britain.*—H. A. Hall, 212 Main St.	13	11.95	0.66	13.87	73.27	0.25	"
4092	Crown Brand, Gragnano, near Naples, Italy	J. E. Murphy, 11 Franklin Sq.	12	12.33	0.67	14.12	72.26	0.62	"
3903	Sold in bulk	*New Haven.*—A. Altiere, 259 Wallace St.	8	12.93	0.38	14.69	71.85	0.15	"
3850	Domenico Camina, Italia	C. F. Curtis, State and Bishop Sts.	7	11.63	0.70	15.31	71.81	0.55	"
3882	Mon. Margerie, Valence, France	Gibbons Bros., State and Pearl Sts.	15	12.61	0.69	12.69	73.71	0.30	"
3902	Sold in bulk	559 Grand Ave.	10	14.32	0.60	15.62	69.30	0.16	"
4273	Marvelli, The Marvelli Co., Detroit, Mich.	Johnson & Bro., State and Court Sts.	15	13.40	0.46	20.69	64.82	0.63	"
4274	Calvé, Lyon, France	R. H. Nesbit Co., Elm & Church Sts.	12	13.14	0.93	12.69	72.98	0.26	"
3900	Sold in bulk	F. Rose, 177 Hamilton St.	6	13.38	0.45	12.62	72.83	0.72	"
3860	Climax, The Pfaffmann Egg Noodle Co.	J. L. Thuesen, 309 Oak St.	10	12.33	0.49	14.12	72.57	0.49	"
3979	Gold Medal, Daniels, Cornell & Co., Providence, R. I.	*New London.*—J. R. Avery & Son, 19 Broad St.	13	13.29	0.79	13.69	71.63	0.60	"
4009	La Bella, Pinto, Aine et Cie., Lyon. France	W. M. Dart, 484 Bank St.	15	13.53	0.66	12.87	72.65	0.29	"
3978	Chevalier Père et Fils, Toulouse, France	Keefe & Davis, 125 Bank St.	13	13.17	0.50	12.62	73.19	0.52	"
3980	Sold in bulk	J. Rollo, 70 Main St.	10	12.67	0.92	16.94	69.10	0.37	"
3963	Marin et Cie., Marseille, France	*Norwalk.*—C. L. Glover, 35 Wall St.	15	12.24	0.75	13.44	73.30	0.27	"
4013	Non Plus Ultra, A. Zerega Fils.	*Norwich.*—W. H. Cardwell, 118 Water St.	20	12.47	0.50	13.56	72.84	0.63	"
4011	La Rosa, Genova, Italy	Mohican Co., 262 Main St.	12	13.18	0.62	14.37	71.20	0.63	"
3967	Marca l'Aquila	*So. Norwalk.*—N. Y. Grocery Co., 118 Washington St.	15	12.64	0.95	13.12	72.57	0.72	"
3940	Sold in bulk	*Stamford.*—F. Bandi, 21 Pacific St.	8	13.81	0.65	12.06	73.22	0.26	"
3939	Sold in bulk	37 Pacific St.	8	13.55	0.68	13.44	72.08	0.25	"
3941	F. Scaramelli Fils et Cie., Marseille, France	Kirk & Dixon, 40 Atlantic Sq.	15	12.94	0.61	13.00	73.07	0.38	"
3948	Franco Russe	B. Polkin, 60 Pacific St.	10	12.49	0.58	14.19	72.15	0.59	"
4245	Campagnia Italiana	*Waterbury.*—Blanchette, 258 S. Main St.	10	12.88	0.75	13.12	72.48	0.77	"
4244	Sonnette & Co., Lyon, France	Hewitt Grocery Co., 20 No. Main St.	15	11.78	0.87	14.00	72.97	0.38	"
4246	Flag Brand, C. F. Mueller & Co., Jersey City	Market, 900 Bank St.	10	12.29	0.89	12.75	73.58	0.49	"
4248	Sold in bulk	J. Tan, 598 So. Main St.	10	13.47	0.78	16.06	69.48	0.21	"
4247	Sold in bulk	J. Tato, 362 W. Main St.	10	12.70	0.46	11.94	74.43	0.47	"
4046	Rivals & Audibert, St. Loup les Marseille	*Willimantic.*—Amidon, 877 Main St.	13	12.80	0.65	12.50	73.78	0.27	"
4045	Club, Hotaling, Warner Co., Syracuse, N. Y.	40 Jackson St.	13	12.85	0.50	14.69	71.57	0.39	"
4047	Gordon Rouge	C. R. Hibbard, North St.	15	12.48	0.85	14.62	71.75	0.30	"
4243	Sold in bulk	*Winsted.*—C, Lavieri, Main St.	8	11.86	0.80	14.94	72.06	0.34	"
4242	Domenico Camina	S. Pearlsky, 236 Main St.	10	12.38	0.72	15.44	70.37	1.09	"

TABLE XXXI.—ANALYSES OF MACARONI, SPAGHETTI, VERMICELLI AND NOODLES—*Continued.*

Station No.	Brand.	Dealer.	Price per pound, cents.	Water.	Ash.	Protein.	Nitrogen-free extract and fiber.	Fat.	Color.
				%	%	%	%	%	
	Spaghetti.								
3933	H. Rivals, Marseille, France, J. G. Powers, New York	*Bridgeport.*—H. E. Bailey & Co., 857 Kossuth St.	13	13.03	0.68	13.37	72.57	0.35	Uncolored.
3935	Sold in bulk	National Cash Grocery, 956 Main St.	10	13.18	0.46	13.12	72.62	0.62	"
3936	Sceau D'or	Young's Cash Grocery, 18 Fairfield Ave.	12	13.06	0.58	13.37	72.60	0.39	"
4120	The Windmill Brand, Mantes, France	*Hartford.*—J. Cersosimo & Co., 588 Asylum St.	15	12.69	0.65	12.81	73.66	0.19	"
4065	Le Lion, Gobelin Fils et Cie., Lyon, France	*Meriden.*—H. E. Bushnell, 75 W. Main St.	13	13.00	0.72	12.06	73.62	0.60	"
4064	Crown Brand, Lyon, France	Kapitzke & Quinlan, 80 E. Main St.	13	12.68	0.67	12.94	73.40	0.31	"
4090	Clermont, Puy-de-Dome, France	*New Britain.*—J. E. Murphy, 500 Main St.	12	13.37	0.46	11.94	73.91	0.32	"
4012	Clerget et Cie., Vesoul, France	*Norwich.*—W. A. Smith, 137 Main St.	15	13.21	0.66	12.00	73.78	0.35	"
	Vermicelli.								
4172	La Flora, Long Twist	*Danbury.*—Krakow, White St.	12	11.48	0.83	12.94	74.33	0.42	"
4159	Sold in bulk	*Derby.*—D. Vaccaro, 176 Main St.	10	12.08	0.78	15.31	71.52	0.31	Not identified.
4122	F. Scaramelli, Fils et Cie., Marseille, France	*Hartford.*—Guilfoil Co., 193 Asylum St.	15	11.98	0.70	13.94	73.01	0.37	Uncolored.
4048	Mon. Margerie, Valence, France	*Middletown.*—Lawton & Wall, 468 Main St.	12	12.11	0.72	14.12	72.72	0.33	Uncolored.
4050	Sold in bulk	J. B. Patterson, 110 Main St.	15	12.72	0.62	12.06	73.97	0.63	Nitro-color.*
4069	Sold in bulk	*Meriden.*—Block & Behrens, 76 E. Main St.	10	12.73	0.48	14.12	72.32	0.35	Tropeolin.*
3889	LaBella, Pinto Ainé et Cie., Lyon, France	*New Haven.*—Mrs. G. F. Gerner, State and Clark Sts.	15	12.23	0.69	12.81	73.95	0.32	Uncolored.
3906	Laroze et Cie., Lyon, France	H. Hahn, 1327 Chapel St.	13	12.07	0.97	14.56	71.97	0.43	"
3904	Monarch, Austin, Nichols & Co., New York	New Haven Provision Co., 384 Grand Ave.	13	12.70	0.53	13.19	73.11	0.47	"
3968	Columbia, Columbia Mfg. and Imp. Co., New York	*So. Norwalk.*—D. S. Davenport, 20 N. Main St.	12	12.22	0.72	12.75	73.82	0.49	"
	Noodles.								
3931	Sold in bulk	*Bridgeport.*—G. Englehardt, 587 E. Main St.	20	13.53	0.70	15.00	68.55	2.22	Probably eggs.
3934	Golden Seal, The Anger Baking Co., New York	Young's Cash Grocery, 18 Fairfield Ave.	20	12.81	0.72	14.69	70.08	1.70	Probably eggs.
4160	Sold in bulk	*Danbury.*—Hermann & Glazer, 21 Elm St.	15	12.45	0.56	13.81	72.92	0.26	Tropeolin.*
4124	"	*Hartford.*—B. Blumenthal, 155 Windsor Ave.	10	12.82	0.57	13.44	72.82	0.35	" *
4123	"	S. Duswinsky, 192 Front St.	12	12.67	0.51	13.25	72.98	0.59	" *
4067	"	*Meriden.*—G. A. Bauer, 73 W. Main St.	12	12.64	0.85	12.56	73.65	0.30	Turmeric.
4066	"	C. N. Dutton, 17 Colony St.	12	12.13	1.02	12.62	73.82	0.41	"
4068	"	H. F. Rudolph & Co., 48 E. Main St.	16	12.03	1.02	13.37	73.36	0.22	"
4051	"	*Middletown.*—Thos. Walsh, 486 Main St.	16	12.92	0.64	15.37	70.83	0.24	"
4089	"	*New Britain.*—Theo. Maurer, 77 Arch St.	16	13.29	0.97	12.62	72.76	0.36	"
3895	Fine Egg Noodles, Bremen Mfg. Co., New York	*New Haven.*—S. S. Adams, 9 Shelton Ave.	20	13.39	0.54	13.19	72.45	0.43	Tropeolin.*

* Coal-tar dye. See foot note, p. 124.

TABLE XXXI.—ANALYSES OF MACARONI, SPAGHETTI, VERMICELLI AND NOODLES—*Continued.*

Station No.	Brand.	Dealer.	Price per pound, cents.	Water.	Ash.	Protein.	Nitrogen-free extract and fiber.	Fat.	Color.
				%	%	%	%	%	
	Noodles.								
4265	Wide Egg Noodles, Bremen Mfg. Co., New York	*New Haven.*—S. S. Adams, 9 Shelton Ave.	20	12.61	0.58	12.19	74.21	0.41	Tropeolin.*
3890	Climax, The Pfaffmann Egg Noodle Co., New York	O. Boettger, 209 Shelton Ave.	20	12.53	0.86	13.62	72.43	0.56	Tropeolin.*
4275	Exquisite, The Phila. Noodle Co., Phila., Pa.	H. Buchter, State and Olive Sts.	40	13.14	3.15†	16.69	61.32	5.70	Probably eggs.
3854	Sold in bulk	A. Fehlberg, 116 Congress Ave.	6	12.70	0.97	12.62	73.43	0.28	Turmeric.
3852	C. F. Mueller, New York	Frederick Bros., Edward & Nash Sts.	15	12.75	0.88	12.69	73.34	0.34	"
3901	Sold in bulk	Simon Hugo, 120 Crown St.	15	12.80	0.94	12.75	73.17	0.34	"
3881	Golden Egg Noodles, The French Delicacy Co., New York	P. Jente & Bro., Broadway	20	12.94	2.65‡	13.12	70.53	0.76	Tropeolin.*
3891	Sold in bulk	H. Strack, 13 Shelton Ave.	10	13.30	0.93	12.31	73.13	0.33	Turmeric.
3977	Sold in bulk	*New London.*—Grocery, 138 Bank St.	10	12.95	0.52	12.81	73.29	0.43	Tropeolin.*
3976	Excelsior Brand, Deforth Bros., New York	J. K. Kopp & Son, 133 Bank St.	15	13.15	0.55	13.62	72.27	0.41	Not identified.
3964	White Rose, Seeman Bros., New York	*Norwalk.*—Matheis, 9 Main St.	20	12.89	0.58	14.25	69.58	2.70	Probably eggs.
4010	Monarch, Austin, Nichols & Co., New York	*Norwich.*—A. T. Otis & Son, 261 Main St.	15	12.65	0.50	14.06	72.50	0.29	Not identified.
3966	White Leghorn, C. F. Mueller & Co., Jersey City	*So. Norwalk.*—L. Dibble, 13 N. Main St.	20	12.32	0.98	14.75	70.13	1.82	Turmeric.
3965	Sold in bulk	G. E. Freidrick, Railroad Ave	16	13.83	0.55	13.69	71.66	0.27	Tropeolin.*
3938	"	*Stamford.*—10 Pacific St.	12	13.39	0.46	12.56	73.36	0.23	" *
3937	"	Stamford Cash Grocery, 88 Pacific St.	10	13.63	0.48	12.25	73.24	0.40	" *
4262	"	*Waterbury.*—H. Freedland, 774 Bank St.	15	13.84	1.17	12.94	71.33	0.72	" *

* Coal-tar dye. See foot note, p. 124. † Common salt 1.96.
‡ Common salt 1.94.

MISCELLANEOUS EXAMINATIONS.

By A. L. WINTON, A. W. OGDEN AND M. SILVERMAN.

COLLECTED BY THE STATION.

4198. *"Konut.* A pure Cocoanut Product. India Refining Co., Philadelphia." Bought of S. S. Adams, State and Court Streets, New Haven, for 45 cents per pail.

Specific gravity at 98° C.	0.869
Refractive Index at 25° C.	1.4548
Refractive Index at 40° C.	1.4496
Iodine number	9.26

The product appears to be as represented.

2434. *"Wesson's Cooking Oil."* Bought of Gibbons Bros., State and Pearl Sts., New Haven, for 25 cents per can.

Specific gravity at 15.5° C.	0.9228
Refractive Index at 25° C.	1.4713
Refractive Index at 15.5° C.	1.4744

Halphen test showed much cotton seed oil. The product consists largely or entirely of cotton seed oil.

SENT BY PRIVATE INDIVIDUALS.

3278. *Butter* sent by W. S. Thomas, Groton. Not found adulterated.

3245, 4580-4583 inclusive. *Wheat Flour* sent by Director C. D. Woods of the Maine Agricultural Station. None of the samples was found adulterated.

3989. *Coffee* sent by J. V. Rattlesdorfer, New Haven, contained more ground peas and chicory than coffee.

3990. *Black Tea,* sent by J. V. Rattlesdorfer, was not found adulterated.

4270. "*Solar Baking Powder,* Independent Baking Powder Co., successor, Chicago, Ill." Sent by S. W. Hurlburt, New Haven. A phosphate powder, containing no cream of tartar, tartaric acid or alum.

4578. *Baking Powder,* sent by C. Beers, Danbury; an alum-phosphate powder.

3052. "*Cream Tartar,*" sent by D. M. Welch & Son, New Haven. Adulterated with acid phosphate, gypsum (plaster) and starch.

3068. *Cream Tartar,* from D. M. Welch & Son. Not found adulterated.

4211, 4212, 4213. *Black Pepper,* sent by Miner, Read & Garrette, New Haven. 4211 contained a corn product, charcoal and pepper shells; 4212 contained a wheat product, ground cocoanut shells and cayenne; 4213 was not found adulterated.

3468, 4210. *Black Pepper,* sent by D. M. Welch & Son, New Haven. 3468 contained a wheat product, ground cocoanut shells and cayenne; 4210 was not found adulterated.

4595, 4596. *Black and White Pepper,* sent by the Charles W. Whittlesey Co., New Haven. Both samples were not found adulterated.

4495 to 4498 inclusive. *Black Pepper, Mustard, Ginger and Cloves,* sent by the John T. Doyle Co., New Haven. The pepper was adulterated with a wheat product, the other spices were not found adulterated.

4502. *Vinegar,* sent by V. E. Jacobs, New Haven. Acidity 3.59 per cent., which is below legal standard.

4554. *Vinegar,* sent by E. Schoenberger, New Haven. Acidity, 4.28 per cent., solids 2.28 per cent. Both are above legal standard.

3993. *Lemon Extract,* sent by J. V. Rattlesdorfer, New Haven, contained but a trace of lemon oil and but 40.6 per cent., by weight, of alcohol. Colored with naphthol yellow S.

3992. *Vanilla Extract,* sent by J. V. Rattlesdorfer. Vanillin, 0.38 per cent.; coumarin, 0.08 per cent.; colored with caramel. An artificial extract.

FOOD PRODUCTS EXAMINED FOR THE DAIRY COMMISSIONER IN THE TWELVE MONTHS ENDING JULY 31, 1901.

SUSPECTED BUTTER.

Thirty-five samples were examined. Of these seventeen proved to be genuine butter free from any considerable admixture of oleomargarine.

Eighteen samples were oleomargarine.

METHODS OF EXAMINATION.

Specific Gravity.—This is determined at the temperature of boiling water by means of Westphal's balance, as first described by Estcourt and by J. Bell, Chem. News, Vols. xxxiv, 254, and xxxviii, 267.

The balance is so adjusted that water at 15.5° C. shall represent unity.

With distilled water, at the temperature of boiling, the instrument indicates a specific gravity of .9625. If the specific gravity of fat at the temperature of boiling water is desired, using the weight of an equal volume of distilled water *at that temperature* as a standard, the reading of the instrument must be multiplied by 1.039.

We have also used for this determination a specific gravity spindle made by Greiner of New York City, 6⅜ inches long, reading from .8550-.8700, and graduated to show differences of .0005 in sp. gr.

Volatile Fatty Acids.—These were determined by the Reichert method, the saponification being effected by the method of Leffmann and Beam, as described in the Analyst, xvi, 1891, p. 153. The result of the determination is expressed by the number of cubic centimeters of $^1/_{10}$ normal sodium hydroxide solution necessary to neutralize the acid distilled from 5.0 grams of the fat.

Examination with the Butyro-Refractometer of Zeiss.—All readings were made at the constant temperature of 25° C. All samples in which the critical line is below 54 scale divisions are regarded as pure, though Wollny suggests, to avoid all chance of overlooking slight adulteration with oleomargarine, that all samples should be chemically examined in which the critical line is above 52.5 scale divisions.

The specific gravity of the butter fat, determined as above, in the samples of oleomargarine or adulterated butter, ranged from 0.861 to 0.8609; the position of the critical line expressed in scale divisions of Zeiss' Refractometer ranged from 57.4 to 60.0 at 25° C.

Molasses.

Two hundred and thirty-one samples of molasses, sent by the Dairy Commissioner, have been examined, and of these twenty-five were adulterated with glucose syrup.

Method of Examination.

13.024 grms. (one-half the normal weight) of molasses are dissolved in about 80 cc. of water, 3 cc. of basic lead acetate are added, the volume is made up to 100 cc. and the whole thoroughly mixed and passed through a dry filter. The rotation of the clear and nearly colorless filtrate is determined, in a 200 mm. tube, with a Schmidt and Haensch half-shade double compensation polariscope. The reading, doubled, is the sugar degrees or per cent. No correction is attempted for the volume of the lead precipitate.

To 50 cc. of the filtrate referred to above, are added 5 cc. conc. C. P. hydrochloric acid, and, after thorough mixing, the flask containing the solution is placed in a cold water bath, which is then quickly heated to 68° C. After standing at that temperature for 10 minutes, the contents of the flask are quickly cooled and the solution, filtered from lead chloride when necessary, is examined in a 220 mm. tube, provided with a water jacket. The temperature is noted with the reading. This reading, doubled, gives the sugar degrees after inversion.

Water, heated to 86° C., is then passed through the jacket and a third reading made at that temperature.

The rotatory power of dextrose is not greatly affected by the temperature, but that of levulose diminishes as the temperature rises, so that invert sugar becomes practically inactive at about 86°.

Vinegar.

One hundred and sixty-four samples of vinegar were examined so far as to determine acidity and total solids. Forty-one of these contained less than four per cent.—the legal standard of acid calculated as acetic acid—and twenty-four of the samples contained less than two per cent. of solids, the lowest observed being 1.24 per cent.

Summary.

In the following Table, XXXII, are given the kind and number of Food Products examined by the Station during the preceding twelve months, exclusive of those tested for the Dairy Commissioner, the number of each kind not found adulterated, the numbers found adulterated by addition of a chemical preservative, or by other adulterants, and also the numbers which were marked "compound."

From this it appears that of the 1,256 samples examined, 789 were not found adulterated, 26 were compounds and 441 were variously adulterated.

Table XXXII.—Summary of the Results of Examination of Food Products in 1901.

	Not found adulterated.	Adulterated. With preservative only.	Adulterated. Other adulterants or below standard.	"Compounds."	Total number examined.
Milk	388	14	30	--	432
Cream	14	1	--	--	15
Coffee bean	7	--	--	--	7
" ground	43	--	8	--	51
Black Pepper	35	--	24	--	59
White Pepper	13	--	4	--	17
Cayenne	17	--	3	--	20
Mustard	17	--	14	--	31
Ginger	26	--	5	--	31
Cinnamon	26	--	7	--	33
Cloves	13	--	4	--	17
Allspice	10	--	6	--	16
Cream Tartar	34	--	9	--	43
Jellies	10	2	16	10	38
Jams	2	--	16	10	28
Catsup, Sauces, etc.	20	10	86	--	116
Cordials	2	--	27	--	29
Vanilla Extract	21	--	42	6	69
Vanilla Crystals	1	--	--	--	1
Lemon Extract	14	--	59	--	73
Orange Extract	3	--	6	--	9
Strawberry and Raspberry Extracts	1	--	18	--	19
Macaroni	37	--	--	--	37
Spaghetti	8	--	--	--	8
Vermicelli	7	--	3	--	10
Noodles	4	--	24	--	28
Miscellaneous	16	1	2	--	19
Total	789	28	413	26	1256

THE ANATOMY OF THE FRUIT OF THE COCOA NUT (COCOS NUCIFERA).*

By A. L. Winton.

I. Morphology and Macroscopic Structure.

Since the general structure of the cocoanut fruit has been treated by numerous writers on systematic and economic botany, only such facts are here given as are essential for a clear understanding of the relation of the parts and the microscopic structure.

The flowers are arranged in spikes branching from a central axis and inclosed with a tough spathe usually a meter or more in length (fig. 1). A single female flower is borne near the base of each lateral axis, and numerous male flowers are distributed on all sides of the axis between the female flower and the apex. After the male flowers drop, each naked lateral axis persists and is a prominent appendage of the fruit (figs. 2 and 3, *S*). Only one ovule of the three-celled ovary comes to maturity, but the tricarpelary nature of the fruit is indicated by its triangular shape as well as by the longitudinal ridges and the three eyes or germinating hole of the nut.

The epicarp of the fruit (fig. 3, Epi) is a smooth tough coat, of a brownish or grayish color.

The mesocarp (fig. 3, *Mes*) consists of a hard outer coat but a few mms. thick and a soft portion usually 3-4^{cm} thick on the sides and much thicker on the base. Imbedded in the mesocarp are numerous longitudinally arranged fibers, varying in size from slender hairs to large, sparingly branching and anastomosing, flattened forms, 2-3^{mm} broad. The large fibers are situated chiefly in the inner layers, with their flat surfaces parallel with the surface of the nut.

Oftentimes the inner layers of the mesocarp become impregnated with a brown fluid, which on drying gives the thin tissue a mottled brown appearance.

*European microscopists have studied the foods and adulterants which have come under their observation but have overlooked a number of distinctly American products. The writer has undertaken to fill in some of these gaps by a series of papers, of which this is the second. The first paper, on the anatomy of maize cob, was published in the Oesterreichische Chemiker-Zeitung, 1900, p. 345, and also in the 24th Report of this Station, 1900, p. 186. This second paper has appeared in the American Journal of Science and Arts.

Each paper will describe from the purely scientific standpoint the macroscopic and histological structure of the material investigated, and also in a final chapter point out the application of this knowledge to the detection of adulteration.

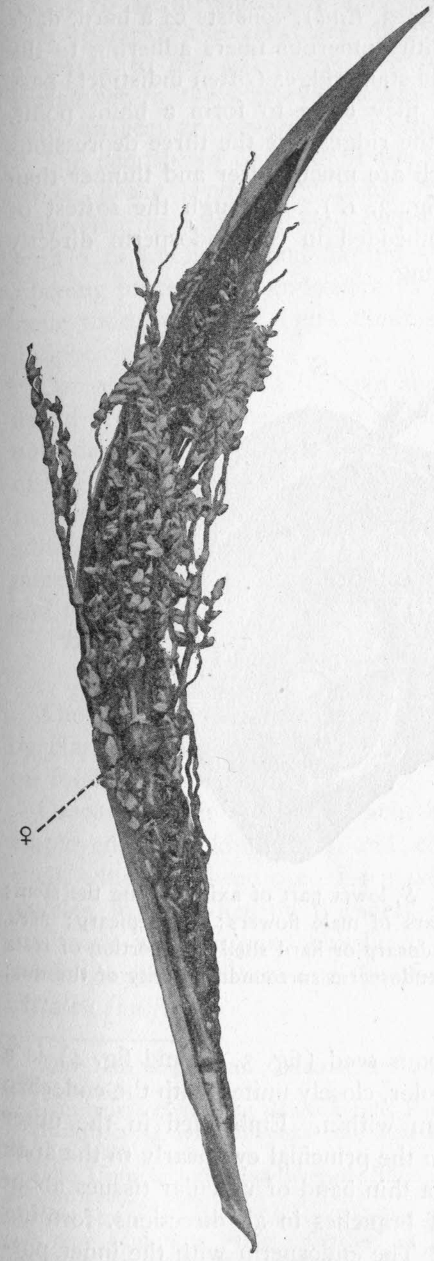

Fig. 1. Inflorescence of the cocoanut showing spathe inclosing the spikes, each with numerous male flowers above and a single female flower near the base. × ⅕.

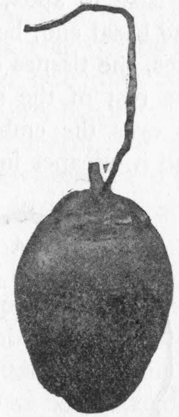

Fig. 2. Half grown cocoanut fruit with calyx, and axis from which the male flowers have fallen. × ⅕.

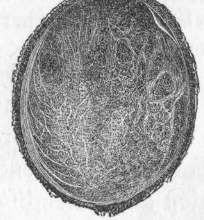

Fig. 4. Inner surface of a cocoanut shell with adhering outer testa. At the left the raphe, from which proceed veins forming a network over the surface. × ⅕.

The endocarp, or shell (fig. 3, *End*), consists of a hard, dark brown coat, 2-6^{mm} thick, with numerous fibers adhering to the surface. Three nearly equidistant ridges (often indistinct) pass from base to apex, where they unite to form a blunt point. At the basal end, between the ridges, are the three depressions or eyes, the tissues of which are much softer and thinner than of the rest of the shell (fig. 3, *K*). Through the softest of these eyes the embryo, embedded in the endosperm directly behind it, escapes in sprouting.

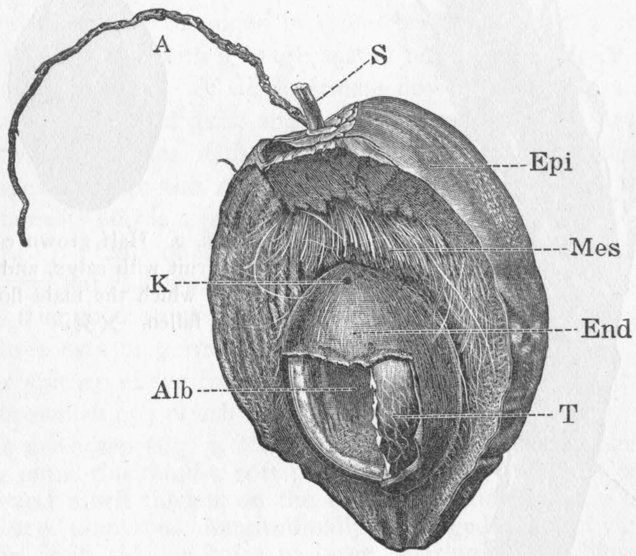

FIG. 3. Ripe cocoanut fruit. *S*, lower part of axis forming the stem; *A*, upper end of axis with scars of male flowers; *Epi*, epicarp; *Mes*, mesocarp with fibers; *End*, endocarp or hard shell; *T*, portion of testa adhering to endosperm; *Alb*, endosperm surrounding cavity of the nut; *K*, germinating eye. × ⅕.

The testa of the anatropous seed (fig. 3, *T*, and fig. 4) is a thin coat of a light brown color, closely united with the endocarp without and the endosperm within. Embedded in the outer portion and extending from the principal eye nearly to the apex is the raphe, consisting of a thin band of vascular tissues about 1^{cm} broad, which sends off branches in all directions, forming a network about the seed. The endosperm with the inner portion of the testa may be separated from the outer testa and

endocarp by introducing a knife blade between the layers. By this operation the veins are split, part of the vascular tissue adhering to the convex surface of the inner testa, and the remainder to the concave surface of the outer testa, so that both surfaces are covered with reticulations.

The endosperm or meat of the cocoanut (fig. 3, *Alb*) is a white, fleshy layer, 1-2^{cm} thick, in which, near the base, is embedded the small embryo. While immature, the nut is filled with a milky liquid and has no solid endosperm, but as the ripening proceeds the endosperm is gradually formed and at the same time the milky liquid diminishes in quantity or entirely disappears.

Cocoanuts yield food for man and cattle, oil, fiber, and other useful products. The epicarp and mesocarp are cut away from nuts designed for export, although invariably a small amount of the mesocarp with its fibers remains attached to the shell. In removing the meat, the outer testa, as has been stated, also adheres to the hard shell, so that cocoanut shells consist not merely of endocarp, but also of a certain amount of mesocarp and testa.

II. HISTOLOGY.

The microscopic structure of the cocoanut seed is described by Hanausek,* Harz,† Moeller,‡ Koenig§ and other authorities on foods and applied microscopy.

Cocoanut fiber (coir), which has long been extensively employed in making mats and cordage, and also cocoanut shell, which has been used for making knobs and other turned articles, were studied by Wiesner|| nearly thirty years ago, but his work was designed chiefly to distinguish the fiber from other commercial fibers and the shell from the similar shell of *Attalea funifera*.

*Die Nahrungs- und Genussmittel aus dem Pflanzenreiche, Kassel, 1884, p. 155.

†Landwirthschaftliche Samenkunde, Berlin, 1885, p. 1120.

‡Mikroscopie der Nahrungs- und Genussmittel aus dem Pflanzenreiche, Berlin, 1886, p. 241.

§Die Untersuchung landwirtschaftlich u. gewerblich wichtiger Stoffe, Berlin, 1898, p. 291.

||Die Rohstoffe des Pflanzen-Reiches, Leipzig, 1873, pp. 436 and 789. (A new edition is being published in parts, but the chapters on the cocoanut have not yet appeared.)

Von Hoehnel* describes briefly the histology of coir, but, like Wiesner, does not appear to have understood the true nature of the stegmata.

Weiss,† Engler and Prantl,‡ and some other authors refer briefly to the microscopic structure of parts of the cocoanut, but their descriptions are of little value in diagnosis.

1. *Epicarp.*

The epicarp or epidermal layer is about .015^{mm} thick and is made up of tabular cells with dark brown contents. In surface view the cells are usually square, rectangular or triangular, with double walls about .005^{mm} thick and are arranged with some regularity in rows.

2. *Mesocarp.*

(a) *Hard ground tissue.* This tissue consists of thick-walled cells which are often tangentially-transversely elongated. In the first few layers the walls are about the same thickness as in the epidermis, without evident pores, but further inward they are more strongly thickened (double walls often .015^{mm} thick) and conspicuously porous. Still further inward they pass into the parenchyma of the soft ground tissue.

(b) *Bast-fiber bundles.* In the hard ground tissue the bundles have no phloem or xylem but are composed entirely of bast-fibers with cell walls often thicker than the lumen. The number of fibers seen in cross section varies from two or three up to a hundred or more. Transitional forms between fibrous and fibro-vascular bundles occur further inward.

(c) *Soft ground tissue.* The thin-walled parenchyma cells of the soft ground tissue are in some parts isodiametric, in other parts longitudinally elongated, and in still other parts transversely-tangentially elongated (fig. 8, *w*). Wherever the brown liquid previously referred to has penetrated the inner layers of the mesocarp, groups of the parenchyma cells here and there, being impregnated with this material, are of a rich brown color and appear thicker-walled than the others (fig. 8, *br*). This

*Die Microscopie der technisch verwendeten Faserstoffe, Leipzig, 1887, p. 52.
†Anatomie der Pflanzen, Wien, 1878, 1 Band.
‡Die natürlichen Pflanzenfamilien, II Theil, 3 Abteilung, p. 22.

brown substance is quickly changed to a reddish color by caustic potash, but is not affected by alcohol, ether or the specific reagents for proteids, fats and resins. No immediate effect is produced by ferric chloride solution, but on long standing the color is changed to olive green.

(d) *Fibers (Coir).* These are fibro-vascular bundles with a strongly developed sheath of bast-fibers. Toward the xylem side of the bundle, particularly in the large fibers, the sheath

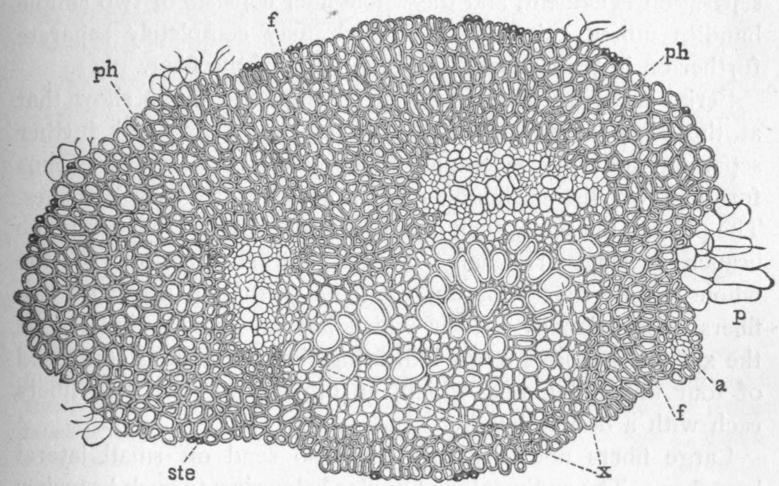

FIG. 5. Transverse section of a large flattened (mesocarp) fiber of the cocoanut. *ste*, stegmata; *f*, sheath of bast fibers; *ph*, two phloem groups; *x*, xylem; *p*, parenchyma of ground tissue; *a*, rudimentary bundle belonging to small branch. × 90.

usually diminishes in thickness and the vascular portion, as seen in cross section, is more or less eccentric, surrounded by a crescent-shaped sheath with the horns connected by a narrower strip.

In the smaller fibers there is but one group of phloem elements, but in the larger flattened fibers there are usually two, or occasionally more, groups separated from each other by a continuation of the sheath (fig. 5). Normally the xylem is near the inner flat side and the two phloem groups are approximately symmetrical with reference to the shorter axis of the elliptical cross section; but often the xylem is near one of the narrow sides and the phloem groups are symmetrical with reference to the longer axis, and still more often the arrangement is diagonal or otherwise irregular.

Mohl* in 1831 noted that the phloem in the stem of *Calamus* was normally divided into two distinct groups, and Kny† as well as other authors have since found the same arrangement in a number of palms. By the study of many sections, the writer has demonstrated that a cocoanut fiber with two phloem groups has also a double xylem, although in most sections no separation is evident, and the whole fiber consists of two simple bundles united side by side, which may completely separate further on in their course by the forking of the fiber.

Serial sections cut through such compound fibers show that at the place of forking the phloem groups are still further separated and the xylem also is divided by bast-fibers, thus forming two distinct bundles which pass into the two branches. The phloem in each branch is at first entire, but further on, if the branch is large it usually divides, and still further on the whole bundle may split up, with the formation again of two fibers. Occasionally a fiber which has no evident division of the xylem has four groups indicating that the fiber is composed of four united bundles, which, on branching, form two fibers each with a double bundle.

Large fibers not only fork but also send off small lateral branches. The rudimentary bundles belonging to such branches may often be seen in cross sections of the trunk fiber below the place of branching (fig. 5, *a*).

a. Stegmata (figs. 5 and 6, *ste*).—As seen in surface view these are circular or elliptical cells from .008 to .020^{mm} in diameter, which extend in longitudinal rows over the surface of the fibers. Longitudinal sections show that the cells are biconvex, fitting into depressions in the bast-fibers, and that the outer walls are exceedingly thin, while the inner and side walls are strongly thickened, thus bringing the cell cavity near the outer surface. Inclosed in each cell and filling it almost completely, is a silicious body, from .006 to .012^{mm} in diameter, with wart-like protuberances on the surface which fit into corresponding depressions in the cell walls (fig. 7). That they are composed

*Palmarum Structura, Translation in Ray. Soc. Reports and Papers, 1849, p. 29.
†Verhandl. d. Bot. Ver. Prov. Brandenburg, Bd. xxiii, 1881, pp. 94-109.

of silica is demonstrated by their incombustibility, their insolubility in hydrochloric and nitric acids and their complete solubility in hydrofluoric acid. Their appearance is particularly striking in tangential sections which have been heated on a cover

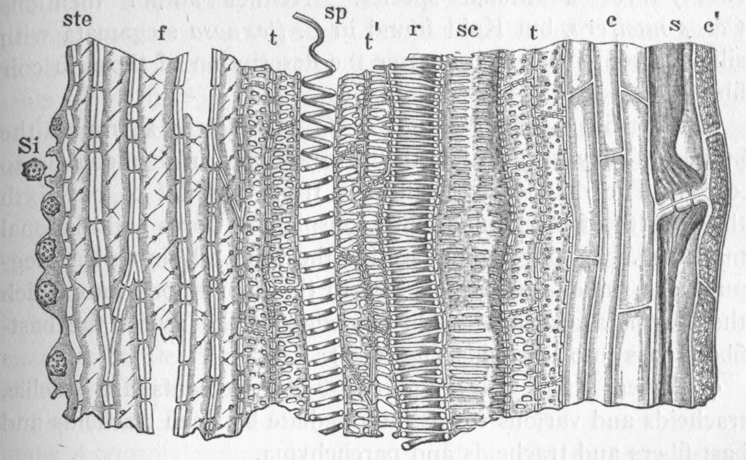

Fig. 6. Longitudinal section of a large (mesocarp) fiber of the cocoanut. *ste*, stegmata; *Si*, silicious body; *f*, bast fibers; *t*, tracheids with small pits; *t'*, tracheids with large pits; *sp*, spiral trachea; *r*, reticulated trachea; *sc*, scalariform trachea; *s*, sieve tube; *c* and *c'*, cambiform cells. × 300.

glass until thoroughly carbonized and finally treated with hydrochloric acid on the slide. The heating should be performed at dull redness, since at a higher temperature the bodies lose their characteristic appearance.

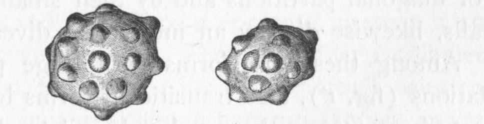

Fig. 7. Silicious bodies from the stegmata of cocoanut fiber. × 1500.

Wiesner* refers to these stegmata as "bast parenchyma," and from his description it would appear that he considered them *silicified cells* and did not understand that they are *sclerenchymatized cells* with *silicious contents.* Von Hoehnel,† who uses,

*Loc. cit., pp. 436-438.
†Loc. cit., p. 52.

however, the term "stegmata," also appears to have fallen into the same error.

Rosanoff* found stegmata in twelve species of palms, and Kohl,† who has made an exhaustive study of the subject, in twenty-three additional species. Neither author mentions *Cocos nucifera,* but Kohl found in *C. flexuosa* stegamata with silicious contents which answer the description of those in coir fiber.

β. Bast-fibers (figs. 5 and 6, *f*) completely surround the bundle. They vary in length up to 2^{mm} and in diameter up to $.03^{mm}$. The double cell walls are from one-half to one-sixth the breadth of the lumina, with conspicuous pores and diagonal markings. In longitudinal section the walls adjoining the stegmata are sinuous in outline, due to the depressions into which the stegmata are fitted. On the edge of the xylem the bast-fibers pass into tracheids (fig. 6, *t*).

γ. Xylem (fig. 5, *x;* fig. 6). The elements are trachæ, tracheids and various forms intermediate between tracheids and bast-fibers and tracheids and parenchyma.

The tracheæ range in diameter up to $.05^{mm}$, the larger (found in large fibers) being reticulated (fig. 6, *r*) or scalariform-reticulated (*sc*), the smaller (found both in large and small fibers) being spiral or reticulated spiral. Among the spiral tracheæ one finds considerable variations both as to their size and the steepness of their spirals. As might be expected, those in the protoxylem often have delicate spirals with turns wide apart. An intermediate form is shown in fig. 6 (*sp*).

The tracheids, distinguished from the tracheæ by the transverse or diagonal partitions and by their smaller size and thinner walls, likewise display an interesting diversity of size and form. Among these are forms with large pits and curious reticulations (fig. *t'*), also transitional forms between tracheids and bast-fibers (*t*) on the one hand, and tracheids and parenchyma on the other.

δ. Phloem. Sieve tubes and cambiform cells make up the phloem (fig. 5, *ph*).

Measured in cross sections, the diameters of the sieve tubes vary up to $.03^{mm}$. In longitudinal sections it may be seen that

*Bot. Ztg., 1871, p. 749.

†Kalksalze und Kieselsäure in der Pflanze, Marburg, 1889, p. 289.

the sieve plates are either at right angles to the walls or oblique and that oftentimes they are covered with callus through which run a few indistinct pores (fig. 6, *s*).

Cambiform cells occur singly, in rows and in groups among the sieve tubes and also at the edges of the phloem. Those among the sieve tubes are for the most part small (about $.003^{mm}$ in diameter), prismatic and with abundant protoplasmic contents (fig. 6, c^1). They correspond to the "*geleitzellen*" of Wilhelm, Tschirsch* and other authors except that the walls adjoining the sieve tubes, so far as the writer has observed, are not pitted.

At the edges of the phloem, particularly adjoining the xylem, the cambiform cells are larger (often $.01^{mm}$ in diameter) and are often empty. The differences between these forms are, however, so slight and perplexing that the writer, following the example of De Bary and Strassburger, prefers to group them all under the head of Cambiform cells.

(e) Intercellular spaces, such as occur in the protoxylem of many monocotyledinous plants, are seldom, if ever, seen in coir fibers, but oftentimes, although less commonly than in the hard shell, the phloem and part of the xylem are destroyed during growth, leaving a channel in the bundle.

3. *Endocarp.*

This coat, known commonly as the shell (fig. 8, *End*), is a dense aggregation of stone cells, among which run longitudinally partially destroyed bundles.

(a) *The stone cells* with their thick, deep yellow walls, branching pores, and dark brown contents, present a striking and characteristic appearance. They are either isodiametric or strongly elongated, the latter (often 0.2^{mm} long) being usually spindle or wedge-shaped, although hammer-shaped, hooked and various other curious forms abound.

A study of sections shows that the elongated cells are arranged in groups, commonly with the longer diameters in tangential-transverse directions and are best seen in cross sections of the shell (fig. 8, *qst*), but in some groups, particularly those adjoining the bundles, they pass longitudinally about the

*See Tschirsch, Angewandte Pflanzenanatomie, Wien, 1889, p. 349.

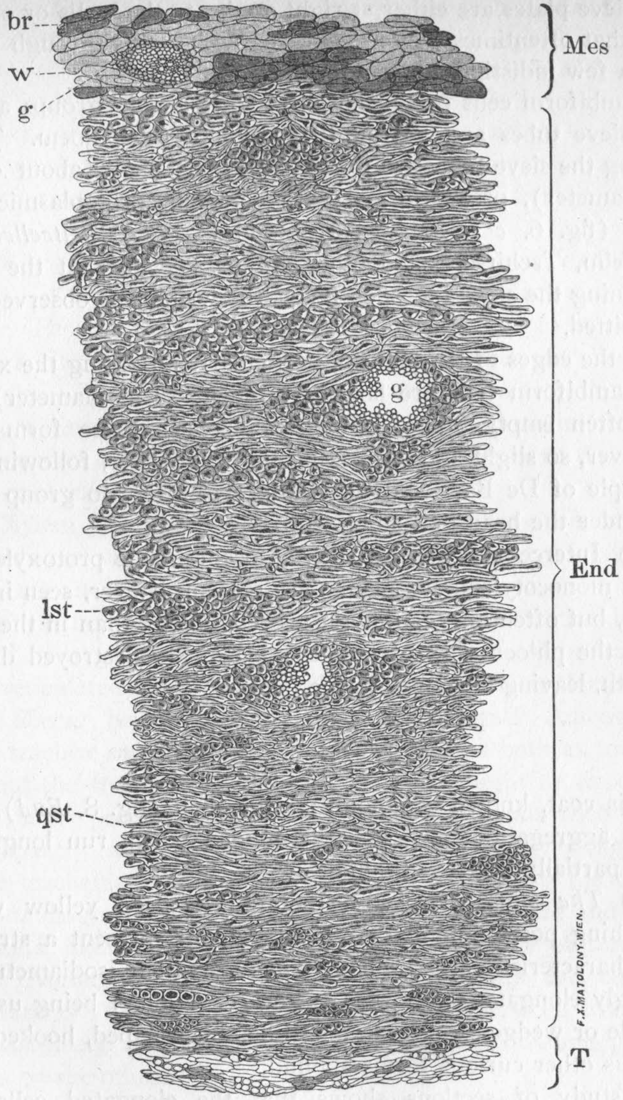

FIG. 8. Transverse section of a cocoanut shell. *End,* endocarp or hard shell; *Mes,* adhering mesocarp; *T,* adhering outer testa; *w,* colorless parenchyma of mesocarp ground tissue; *br,* same as *w* but impregnated with a brown substance; *g,* vascular bundles in the endocarp, with phloem and xylem partially obliterated; *lst,* longitudinally elongated and isodiametric stone cells; *qst,* transversely elongated stone cells. ×60.

shell (fig. 9, *lst*). It is evident from fig. 8 that more than half of all the stone cells are tangentially-transversely elongated. Those which appear isodiametric (*lst*) are partly cells which are isodiametric in three dimensions and partly longitudinally elongated cells in section.

Groups of thinner-walled cells with dark brown contents are occasionally met with.

The brown contents of all the endocarp cells react the same as the brown impregnating material of the mesocarp.

(b) *Vascular bundles* are studied with difficulty in the mature shell. By the rupture of the phloem and part of the xylem during growth, passages are formed which, in shells transversely cut or broken, are evident to the naked eye as minute

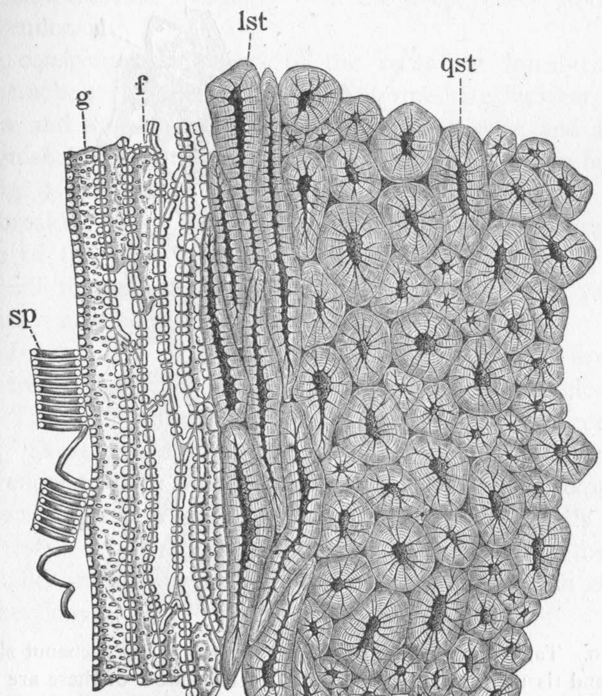

FIG. 9. Longitudinal-radial section of cocoanut endocarp through the stone cells and edge of bundle. *qst,* transversely elongated and isodiametric stone cells; *lst,* longitudinally elongated stone cells; *f,* thick-walled porous cells; *g,* pitted trachea; *sp,* spiral trachea. ×300.

holes. The structure of the bundles is still further obscured by the presence of fungus threads and spores.

In structure the bundles differ from those of the mesocarp fiber, the bast-fibers being replaced by forms intermediate between fibers and tracheids (fig. 9, *f*). The vascular elements are chiefly spiral tracheæ (*sp.*), and pitted tracheæ (*g*), the latter being especially noticeable.

4. *Testa.*

Several microscopists have studied the testa, but, owing doubtless to differences in the material, hardly two of them agree as to the number of coats or the character of the elements.

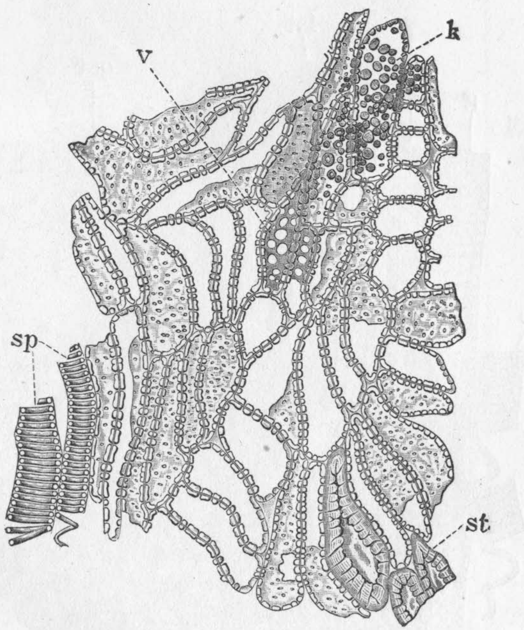

FIG. 10. Tangential section of the outer testa of the cocoanut showing the ground tissue of thick-walled porous cells. Most of these are empty, but a few contain brown contents in the form of globules (*k*) or films with circular openings (*v*). *st*, colorless stone cell; *sp*, spiral trachea. ×300.

The description which follows is based on the examination of numerous specimens.

(a) *Outer testa.* This coat consists of a ground tissue of large, variously shaped cells, crossing one another in all directions (fig. 8, *T*, fig. 10), between which ramify the veins.

Most of the ground tissue cells have colorless double walls, from .004 to .010^{mm} thick, with conspicuous (sometimes large) pores, but in the inner layers they often have thinner walls without evident pores and except for their shape bear no resemblance to the other cells.

As a rule, the cells are empty, but some here and there contain a brown substance apparently the same as is contained in the mesocarp and endocarp, which often takes the form of spheres (fig. 10, *k*), disks, or films with circular openings (*v*).

Colorless stone cells (fig. 10, *st*) are present in the outer layers and contrast strikingly with the deep yellow stone cells of the endocarp.

The conspicuous elements of the veins are spiral tracheæ, pitted tracheæ and elongated cells intermediate between pitted tracheæ and the porous cells of the ground tissue, and are not distinguishable from the same elements of the endocarp bundles. (See fig. 9, *sp*, *g* and *f*.)

In breaking away the meat, the separation is through the middle of the veins and the inner layers of the outer testa, nearly all the ground tissue and about half of the vascular elements remaining on the inner surface of the shell.

(b) *Inner testa.* Firmly attached to the endosperm are from ten to twenty layers of small isodiametric or slightly elongated cells. The double walls are about .003^{mm} thick and free from pores. These cells contain a material varying in color from light yellow to dark brown, which either fills them completely or occurs in globules, films, etc., as in some of the cells of the outer tests. In the layer adjoining the endosperm the cells are smaller and have darker brown contents than the cells in the other layers.

5. *Endosperm.*

Although the microscopic character of the endosperm has been fully explained by Harz, Hanausek and Moeller, a brief description is here given to accompany the descriptions of the other parts of the fruit.

In the outer layers the prismatic cells are nearly isodiametric (about .05^{mm} in diameter), but further inward they are radially elongated, often reaching a length of .3^{mm}. Cell partitions are about .003^{mm} thick, without pores.

The cells contain bundles of needle-shaped fat crystals and lumps of proteid matter, each lump containing, as a rule, a crystalloid. Ether and alcohol readily dissolve the fat crystals and strong potassium hydrate solution saponifies them. The proteid bodies give the usual color reactions with iodine, Millon's reagent and dyes.

III. The Detection of Powdered Cocoanut Shells in Ground Spices.

The adulteration of ground spices with powdered cocoanut shells was brought to notice in 1885 by W. H. Ellis,* public analyst, Toronto, Canada, and has since been frequently detected by A. McGill† of Ottawa and food analysts in different parts of the United States.

The extent to which this fraud is practiced is indicated by the following summary of results obtained by the writer during the years 1896-7 in the examination of samples collected in the State of Connecticut.

	Black pepper.	Cloves.	Allspice.
Samples examined	147	37	24
Samples adulterated (total)	47	17	11
Samples adulterated with ground cocoanut shells	21	7	6

It is stated on credible authority that in Philadelphia at the present time about six hundred tons of shells, obtained as a by-product in the preparation of dessicated cocoanut—an article much used in pastries and confectionery—are annually reduced to a powder in mills of peculiar construction and sold to spice grinders. This powder, without further treatment, is mixed with ground allspice, which it closely resembles in appearance. By cautious roasting the color of ground cloves and nutmegs is matched, and by roasting at a higher temperature a charcoal is obtained which, mixed with starchy matter, is a clever imitation of black pepper.

*Dept. Inland Revenue, Rep. on Adult. of Food for 1885, Ottawa, 1886, pp. 67, 79.

†Laboratory of the Inland Rev. Dept., Bull. No. 20, 1890, pp. 7-11.

Powdered cocoanut shells appears to be a distinctively American adulterant. The leading treatises on the microscopy of foods in the German, French and English languages, even those of recent publication, make no mention of it, and a number of prominent European food chemists and microscopists have declared to the writer that they had never heard of its use. On the other hand, cocoanut cake (the residue from the oil presses), which in Europe is commonly employed, both as a cattle food and as an adulterant of human foods, is almost unknown in America.

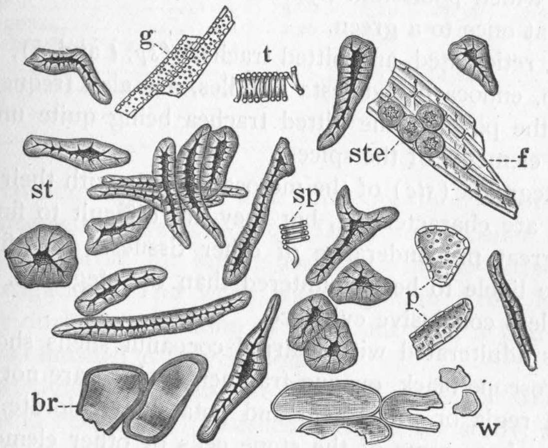

Fig. 11. Cocoanut shell powder. *st*, dark yellow stone cells with brown contents; *t*, reticulated trachea; *sp*, spiral trachea; *g*, pitted trachea; *w*, colorless, and *br*, brown, parenchyma of mesocarp; *f*, bast-fibers with stegmata (*ste*). × 160.

All the tissue elements of the mesocarp, the endocarp and the outer testa are present in cocoanut shell powder, but the stone cells of the endocarp make up the bulk of the material (fig. 11, *st*). These cells are characterized by their porous, brown-yellow cell walls, their dark brown contents, which become a reddish brown on treatment with potassium hydrate solution, and the predominance of peculiar elongated forms. They differ in one or more of these characteristics from the stone cells of pepper, allspice, clove stems, walnut shells, almond shells, Brazil-nut shells, hazel-nut shells, peach stones and olive stones.

The outer testa or lining of the shell also forms a considerable part of the powder, the most striking elements being the thick-walled, porous cells (*p*) and the vascular elements.

Colorless cells of the mesocarp ground tissue (*w*) are not distinguishable from the parenchyma of many other plants, but when impregnated with the brown substance which has been described they are striking objects (*br*). Potassium hydrate changes the color of these brown cells to a reddish brown, but ferric chloride does not produce any immediate effect, thus distinguishing them from the brown cells of allspice seed, the color of which potassium hydrate removes and ferric chloride changes at once to a green.

Spiral, reticulated, and pitted tracheæ (*sp, t* and *g*), from the mesocarp, endocarp and testa bundles, are also frequently met with in the powder, the pitted trachea being quite unlike any vascular elements of the spices.

The stegmata (*ste*) of the mesocarp fibers with their silicious contents are characteristic, but they are difficult to find owing to the great preponderance of other tissues. Bast-fibers (*f*) are more liable to be encountered than the stegmata, but they furnish less conclusive evidence.

Spices adulterated with charred cocoanut shells show under the microscope black, opaque fragments which are not bleached by aqua regia or nitric acid and potassium chlorate. Except in cases where some of the stone cells or other elements have escaped charring, this material cannot be distinguished from other forms of charcoal.

Chemical analysis is a valuable adjunct to the microscopic examination and often determines approximately the extent of the adulteration, but since other nut shells have a similar composition, the microscope is essential for the identification of the particular adulterant present. As was pointed out by the writer* five years ago, the crude fiber obtained in the process of analysis is particularly suited for the microscopic detection of stone cells and other tissues.

The radical difference in composition between cocoanut shells and the spices to which they are added is shown by the following results by Winton, Ogden and Mitchell.†

*Conn. Agr. Expt. Sta., Rep. 1896, p. 34.
†Ibid., Rep. 1898, pp. 198-211.

	Black pepper. (Av. of 14 analyses.)	Cloves. (Av. of 8 analyses.)	Allspice. (Av. of 3 analyses.)	Nutmeg. (Av. of 3 analyses.)	Cocoanut shells. [1 analysis.)
	%	%	%	%	%
Water	11.96	7.81	9.78	3.63	*7.36*
Total ash	4.76	5.92	4.47	2.28	*0.54*
Ash soluble in water	2.54	3.58	2.47	0.86	*0.50*
Ash insoluble in hydrochloric acid	0.47	0.06	0.03	0.00	*0.00*
Volatile ether-extract	1.14	19.18	4.05	3.02	*0.00*
Non-volatile ether-extract	8.42	6.49	5.84	36.70	*0.25*
Alcohol extract	9.62	14.87	11.79	10.77	*1.12*
Reducing matters by direct inversion calc. as starch	38.63	8.99	18.03	25.56	*20.88*
Starch by diastase method	34.15	2.74	3.04	23.72	*0.73*
Crude fiber	13.06	8.10	22.39	2.51	*56.19*
Total nitrogen	2.26	0.99	0.92	1.08	*0.18*
Oxygen absorbed by aqueous extract	----	2.33	1.24	----	*0.23*
Quercitannic acid equivalent to O. absorbed	----	18.19	9.71	----	*1.82*

In conclusion, the author take this opportunity to thank his highly esteemed instructor, Prof. Dr. Josef Moeller of Graz University, Austria, for kindly assistance in the early part of this investigation. The work was begun in Prof. Moeller's laboratory during the autumn of 1899, but after a year's interruption was finished at this Station.

Acknowledgment is also due Prof. E. Gale of Mangonia, Florida, who generously furnished material for study, and also Herr F. X. Matalony of Vienna, who skillfully reproduced on wood the author's drawings.

MICROSCOPIC INVESTIGATION OF FRUITS.

By A. L. Winton.

The following adulterants used in fruit preserves, viz: glucose sirup, chemical preservatives, artificial colors, starch and some other materials may be detected by chemical analysis; but vegetable matter of organized form, such as the pulp of inferior fruits and vegetables, foreign seeds, etc., can be identified only by microscopic examination. A thorough knowledge of the histology of the fruits themselves is essential for the prosecution of this work.

A number of botanists and food analysts have studied the microscopic structure of edible fruits, but the former have not considered the subject from the diagnostic standpoint while the latter have too often shown a lack of knowledge of vegetable histology. Furthermore, a number of fruits have not been investigated at all and parts of those which have been investigated have escaped attention.

In the Summer of 1901, the writer began a study of some of the fruits grown in the United States. Although the primary object of this work was to secure data for use in the detection of adulteration, other points of scientific interest have not been overlooked.

Investigations of the following fruits, with thirty-three drawings, have already been completed: the cultivated strawberry (*Fragaria Chiloensis* Ehrh.), the American wild strawberry (*F. vesca* L.), the American red raspberry (*Rubus strigosus* Michx.), the black raspberry (*R. occidentalis* L.), the blackberry (*R. nigrobaccus* var. *sativus* Bailey), the dewberry (*R. villosus* Ait.), the red currant (*Ribes rubrum* L.), the black currant (*R. nigrum* L.), the American gooseberry (*R. oxycanthoides* L.), the European gooseberry (*R. Grossularia* L.), the American cranberry (*Vaccinium macrocarpon* Ait.), and the huckleberry (*Gaylussacia resinosa* Torr and Gray).

Owing to delay in securing reproductions of the drawings, it was found impracticable to include the papers describing this work in this report, but it is proposed to publish them soon in a scientific journal and subsequently in the report of this Station for the ensuing year.

FIRST REPORT

OF THE

STATE ENTOMOLOGIST OF CONNECTICUT

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

I herewith transmit my first Report, as State Entomologist, covering the time from July 1st, 1901, when the law creating this office went into effect, to December 31st, 1901. Though this includes a period of only six months, it is desirable that such reports be made at the close rather than in the middle of a season's work. The results of certain experiments which were made before the passage of the Law Concerning Insect Pests, are contained herein, as it is advisable to include in one report all the entomological work of the season.

The account of receipts and expenditures covers only three months, July 1st to September 30th, 1901, in order to make the fiscal year in the future correspond with the State fiscal year.

Respectfully submitted,

W. E. Britton.

Report of the Receipts and Expenditures of the State Entomologist for the Period from June 1st, 1901, to September 30th, 1901.

Receipts.

Advanced by William H. Brewer, Treasurer		$550.00

Expenditures.

Laboratory assistance	$150.00	
Printing	59.25	
Postage	21.95	
Stationery	5.35	
Telephone and Telegraph	1.05	
Express	.25	
Library	6.25	
Scientific apparatus and supplies	166.23	
Office supplies	3.72	
Traveling, nursery inspection	7.05	
Traveling, orchards, gardens, etc.	6.90	
	$428.00	
Balance on hand	122.00	
		$550.00

Memorandum—This account of the State Entomologist has been duly audited by the State Auditors of Public Accounts.

State Provision for Entomological Work.

The damage caused by the San José scale-insect has been the inciting cause of the enactment of laws, in more than half the states of the union, aiming to prevent the further spread of this and other pests. In some cases the laws aim only to control the pest by rigid inspections and by restricting the shipment of nursery stock. In others, provision is made for the investigation of the habits of insect pests of all kinds, and for testing remedies.

Since 1897, in the absence of any Connecticut laws requiring it, the Station had been called upon to inspect nurseries and to issue certificates where the circumstances warranted it; for without some such arrangement Connecticut nurserymen found themselves debarred from shipping stock into those states where inspection laws were in force.

This arrangement afforded no real protection to purchasers of nursery stock in Connecticut, as has been pointed out.* The rapid spread of the San José scale, and the increased interest in fruit growing in the State, made it evident that some means of protecting Connecticut fruit growers must be devised. The matter was discussed informally by the leading orchardists and nurserymen, who expressed a desire for legislation which would provide that the nurseries be kept clear of insect pests, and which would also assist the fruit growers by testing methods of destroying the San José scale, and by investigations concerning other insect pests.

At the annual meeting of the Connecticut Pomological Society at Hartford, February 7th, 1901, resolutions were adopted calling attention to the destruction caused by the San José scale, and recommending that a law be enacted to protect the fruit interests of the state from this dreaded pest. A bill was introduced into the legislature and thoroughly discussed at a hearing before the joint committee on Agriculture on March 19th. The discussion led to the drafting of a substitute bill which met the views of the fruit growers represented and of the committee. This was passed on June 4th and approved by the Governor on June 10th. The text of the law is given below:

*See Bulletin 135, p. 5, and Report of the Conn. Pomological Society for 1901, p. 107.

The Insect Pest Law.*

Chapter 122.

AN ACT

Concerning Insect Pests.

Be it enacted by the Senate and House of Representatives in General Assembly convened:

SECTION 1. The board of control of the Connecticut Agricultural Experiment Station, at New Haven, shall designate and appoint a man qualified by scientific training and practical experience to be state entomologist during the pleasure of the board, and to be responsible to said board for the performance of his duties as prescribed in this act. The state entomologist shall have an office at the Experiment Station in New Haven, but shall receive no compensation other than his regular salary as a member of the station staff. He may appoint such number of deputies, not exceeding three, as he may deem necessary or expedient.

SEC. 2. It shall be the duty of the state entomologist, either personally or through his deputies, to visit any orchard, field, garden, nursery, or store-house, upon the request of the owner, to advise treatment against pests. He may inspect any orchard, field, or garden, in public or private grounds, which he may know or have reason to suspect is infested with San José scale or any other serious pests; may from time to time issue such circulars and bulletins as in his judgment are needed to convey information about pests, which publications may be issued as bulletins of the said experiment station; may also conduct such experiments and investigations regarding injurious insects as will tend toward a better understanding of them and the remedies for their attacks; may diffuse such information by means of correspondence, lectures, and published matter; and may employ such assistance in his office, laboratory, or in the field, and purchase such apparatus and supplies as he may deem necessary for the successful prosecution of his duties. He shall keep a detailed account of expenses and shall publish each year a report of such expenses, and of the work done under this act.

SEC. 3. All nursery stock shipped into the state from some other state, country, or province, shall bear on each box or

*The law was printed in Bulletin 134.

package a certificate that the contents of said box or package have been inspected by a state or government officer and that said contents appear to be free from all dangerous insects or diseases. In case nursery stock is brought within the state without such a certificate, the consignee may return it to the consignor at the latter's expense, or may call the state entomologist to inspect the same and deduct the costs of such inspection from the consignor's bill for such stock. This section shall be deemed to be a part of every contract made in this state for the sale of nursery stock to be shipped into this state.

SEC. 4. All nurseries or places in the state where nursery stock is grown, sold, or offered for sale, shall be inspected at least once a year by the state entomologist or one of his deputies, and if no serious pests are found, a certificate to that effect may be given. If such pests are found, the owner shall take such measures to suppress the same as the state entomologist shall prescribe. If such measures are not immediately taken by the owner of such nursery or place, such certificate shall be withheld, and any nurseryman who does not hold such a certificate after the first annual inspection as herein prescribed, who shall sell or otherwise dispose of nursery stock in the state, shall be fined not more than fifty dollars. The form of certificate as well as the season for inspecting nurseries may be determined by the state entomologist. The state entomologist or any of his deputies shall at all times have the right to enter any public or private grounds in the performance of any duty required by this act.

SEC. 5. The sum of three thousand dollars annually for two years is hereby appropriated for carrying out the provisions of this act, and the comptroller is hereby directed to draw his orders therefor quarterly on the treasurer in favor of the treasurer of the Connecticut Agricultural Experiment Station, who shall hold the same subject to the order of the state entomologist.

SEC. 6. This act shall take effect July 1, 1901.

Approved June 10, 1901.

SCOPE OF THE LAW.

A careful examination of the law shows that it was conceived in a broad spirit, and that it aims to provide for research and the diffusion of information which shall enable orchardists and nurserymen to rid their own premises of insect pests, and to keep them clean, rather than to authorize any condemnation or destruction of private property by a state officer.

The law gives the state entomologist only advisory power; he cannot order the destruction of trees no matter how badly they are infested, and he has no police duties to perform.

It provides for the annual inspection of all nurseries in the state in order to keep them in the best possible condition. If found infested, the entomologist will advise the proper methods to destroy the pests, and if the owner refuses to comply, the certificate will not be granted.

After the first inspection every nurseryman is required by the law, Section 4, to have a certificate from the state entomologist before selling nursery stock within the state, under penalty of fifty dollars fine.

The law also requires that all nursery stock shipped into the state shall be accompanied by a certificate of inspection by a state or government officer. Failure to observe this rule should be reported in each case to the state entomologist.

The law provides for the dissemination of knowledge by means of publications, lectures, correspondence, etc., and the entomologist is expected to visit any orchard, nursery, storehouse, garden or field, when called upon to make an examination of conditions, and to advise treatment.

The state entomologist, and his deputies, are given the right to enter, at any time, any public or private grounds in the performance of their duties.

None of the appropriation provided for in this bill can be used to pay the salary of the state entomologist, but may be used to pay the salaries of deputies (not to exceed three in number) or for assistance in the field and laboratory as is deemed necessary. The entomologist's salary is paid by the experiment station.

ORGANIZATION AND PROGRESS OF THE WORK.

At a meeting of the board of control, held at the station on July 10th, 1901, the writer was appointed state entomologist. The office, laboratory, microscopes, and other apparatus previously used in this department, were placed at the disposal of the entomologist for the new work. Though the law went into effect July 1st, the money appropriated for insect work was not available until the end of the first quarter, October 1st. The board of control authorized the treasurer of the station to advance money to the state entomologist so that the work could be immediately begun. An excellent photographic outfit was purchased and an expert photographer was employed for nearly six weeks to prepare illustrations of insects for future use in publications and lectures. Over two hundred negatives have been made showing the various aspects of insect life, injury to plants, and apparatus for destroying insects. Over one hundred and fifty lantern slides have now been prepared for use in lectures. Most of these are from original negatives, though a few were purchased. A small acetylene lantern was procured for exhibiting the slides at farmer's institutes, grange meetings, etc.

Between July 1st, when the law became operative, and December 31st, 1901, twenty-six nurseries were inspected and twenty-five certificates granted to nursery firms, as follows:

Name of Firm.	Location.	Inspection Finished.	Certificate Number.
Atwater, C. W.	New Haven	Oct. 8	52
Barnes, J. R.	Yalesville	Oct. 29	62
Bowditch, J. H.	Pomfret	Oct. 11	55
Burr & Co., C. R.	New Canaan	Sept. 27	47
Butler & Jewell Co. The	Cromwell	Dec. 14	65
Cheshire Nursery Co.,	Cheshire	Oct. 30	63
Comstock & Lyon	Norwalk	Oct. 28	61
Conine, Frank E.	Stratford	Oct. 7	50
Conway, W. B.	New Haven	Sept. 24	41
Crane, Stephen	Norwich	Oct. 9	53
Elizabeth Park Nursery	Hartford	Oct. 25	59
Elm City Nursery Co.	New Haven	Nov. 14	64
Gardner, R. H.	Cromwell	Oct. 10	54
Gurney & Co., H. H.	New Canaan	Sept. 27	46
Hale, J. H.	So. Glastonbury	Oct. 16	58
Hoyt's Sons, Stephen	New Canaan	Sept. 27	45
Hunt & Co., W. W.	Hartford	Oct. 3	49
Jackson, B. A.	So. Norwalk	Oct. 28	60
Jackson, E. B.	Stamford	Oct. 12	56
Longden, C. E.	North Haven	Sept. 24	44
Pierson, A. N.	Cromwell	Sept. 17	43
Platt, Frank S.	New Haven	Sept. 24	42
Purinton, C. O.	Hartford	Oct. 15	57
Veitch Co., The Robert	New Haven	Oct. 7	51
Wallace, W. E.	Hartford	Oct. 3	48

Two of the above-named firms are florists and do not handle ordinary nursery stock; frequently they have occasion to ship hardy herbaceous plants, and unless accompanied by certificates, these shipments may be "held up" in other states. The form of certificate used the past season is here given:

No...... Date.......... 190..

THE CONNECTICUT AGRICULTURAL EXPERIMENT STATION.

OFFICE OF STATE ENTOMOLOGIST,
New Haven, Conn.

CERTIFICATE OF INSPECTION.

This is to certify that the stock at the nursery and premises of .... of .... Conn., has been carefully examined in compliance with the provisions of Chapter 122 of the Acts of the General Assembly at the January Session of 1901, and that no indication has been found of the presence of the San José Scale or other serious pests.

This certificate is invalid after 190

.... *State Entomologist.*

Although the majority of nurseries were in good general condition, in more than half of them the San José scale-insect was found. Only two or three were badly infested; the others were infested but slightly, the insect being usually upon stock which had been obtained from outside the state and had been planted out to remain for one or more seasons in the nursery. Several hundred trees were destroyed by the owners as advised by the state entomologist. In other cases the trees were fumigated under the writer's supervision. The owners of infested nurseries have invariably been ready to act upon the advice of the state entomologist, and have been active in attempting to rid their plantations of the insect. The writer here desires to express his appreciation of this coöperation, which is so necessary in order to make the law effective for the object for which it was enacted.

The state entomologist will endeavor to inspect, either personally or through his deputies, every nursery in Connecticut during September and October, and before the shipping season begins. He will, at any convenient time, upon request, visit any orchard, field, garden, nursery, storehouse, or greenhouse in the state, as the law provides, to investigate or give information about any insect attacks. Specimens received by mail will be identified, and such information regarding their habits and possible remedial treatment as may be of value will be returned to the writer.

Up to July 1st, 1901, the time that the law went into effect, the San José scale had been found in 78 localities. These were mentioned in Bulletin 135, which is reproduced in this report. On December 31st, 1901, the list had been increased to 99 localities. Several extensive orchards had been found infested and in many city yards the fruit trees and ornamental shrubs were dying or already dead from its attacks.

Between July 1st and December 31st, 1901, the writer has visited 15 orchards, gardens, etc., to advise treatment, lectured at 4 agricultural meetings, identified 52 insects, and written 269 official letters.

Publications.

Bulletin 134, The New Law Concerning Insect Pests (6 pages), giving the text of the new law and a statement regarding the work planned, was issued in an edition of 10,500 copies and distributed in August.

Bulletin 135, The San José Scale-Insect: Its Appearance and Spread in Connecticut (14 pages, 5 plates), containing a general account of the insect and a brief history of its discovery and spread in the state, was distributed in December. An edition of 11,000 copies was printed.

Bulletin 136, Preliminary Experiments in Spraying to Kill the San José Scale-Insect, Season of 1901 (12 pages, 1 plate), giving an account of the experimental spraying during 1901 to kill the scale, was distributed in February, 1902, in an edition of 10,500.

Bulletins 135 and 136, with slight changes, are included in the body of this report.

Identification of Insects.

The entomologist will, so far as he is able, identify all insects which are submitted to him. It is important that the distribution of species in Connecticut be studied; specimens should, therefore, be accompanied with a statement of the exact locality and date of capture.

One hundred and seven samples of insects have been received at the station for identification, during the period of fifteen months from November 1st, 1900, to January 1st, 1902. These are given in the following list, which contains the names of the insects, locality, and food plants.

Notice to Correspondents.

In writing for information, it is of the greatest importance that specimens of the insects and of their injuries accompany the inquiry when possible. In fact it is usually necessary for the entomologist to have these before he can intelligently prescribe a treatment. Moreover the common names of insects are not constant, but vary with different localities. It is often impossible to know from the description what insect is indicated, but if specimens are sent the identity can be established. When plenty, a dozen specimens should be forwarded, and some of their food plant enclosed with them if the insects are alive.

Insects may be sent safely by mail if enclosed in a strong tin, wooden or paste-board box, which will not be crushed in transit. Do not attempt to send insects in a letter, as they are usually crushed beyond all recognition when received. It is unnecessary to punch holes in the box, because most insects can obtain a sufficient quantity of air without this precaution.

INSECTS SENT FOR IDENTIFICATION.

Date.	Name.	Host.	Locality.	Remarks.
1900				
Nov. 3	San José Scale,—*Aspidiotus perniciosus* Comst.	Japan plum	Bridgeport	On twigs.
" 3	Twice Stabbed Lady Beetle, *Chilocorus bivulnerus* Muls.	Japan plum	"	Pupa skins present.
" 3	Cabbage Plusia, *Plusia brassicæ* Riley	Lettuce	Hamden	Larvæ feeling in green house.
" 7	San José Scale, *Aspidiotus perniciosus* Comst.	Apple	Hartford	Twigs completely encrusted.
" 14	—— *Datana integerrima* G. & R.?	Black Walnut and Butternut	Warehouse Point	Cast larval skins, in masses on tree trunks. Caterpillar quite destructive to Black-walnut, butternut, pear and other trees.
" 21	Bee Moth, *Galleria mellonella* L.	Bee hives	" "	Pupa stage only.
" 22	Scurfy Bark-Louse, *Chionaspis furfurus* Fitch	Pear	Milford	Egg stage.
" 26	Putnam's Scale, *Aspidiotus ancylus* Putm.	Mountain Ash	Norwalk	Partially grown females.
" 28	" " " "	" "	New Haven	From same stock as preceding.
" 30	San José Scale,—*Aspidiotus perniciosus* Comst.	Rose	Bridgeport	Large proportion were dead.
Dec. 3	" " " "	Peach & Plum	Fairfield	2000 peach trees infested.
" 4	" " " "	Peach	Hartford	Abundant in city.
" 11	" " " "	Peach, Pear and Apple	Meriden	Twigs were covered.
" 11	Oyster-shell Bark-Louse, *Mytilaspis pomorum* Bouché	Apple	"	Egg stage.
" 11	Scurfy Bark-Louse, *Chionaspis furfurus* Fitch	"	"	" "
1901				
Jan. 4	Drug Store Beetle, *Sitodrepa panicea* L.	Radish seeds	New Haven	Infesting stored seeds.
" 8	Scurfy Bark-Louse, *Chionaspis furfurus* Fitch	Apple	Stafford Springs	Egg stage.
Feb. 8	San José Scale, *Aspidiotus perniciosus* Comst.	Peach	Greenwich	Twigs covered.
" 15	—— *Aphodius granarius* L.		Westville	Infesting greenhouse. Breeds in manure.
" 23	—— *Lecanium Hemisphæricum* Tar.?	Sword Fern	Suffield	Both larvæ and eggs present.
" 26	Oyster-shell Bark-Louse, *Mytilaspis pomorum* Bouché	Pear	Meriden	Egg stage.
" 26	San Josè Scale, *Aspidiotus perniciosus* Comst.	Pear, Plum, Peach, Apple and Currant.	"	On twigs.
Mar. 4	Oyster-shell Bark-Louse, *Mytilaspis pomorum* Bouché	Apple	"	" " Egg stage.
" 4	Scurfy Bark-Louse, *Chionaspis furfurus* Fitch	Pear	Kibbe	" " " "

INSECTS SENT FOR IDENTIFICATION.

Date.	Name.	Host.	Locality.	Remarks.
Mar. 7	Putnam's Scale, *Aspidiotus ancylus* Putm.	Currant	Norwalk	On twigs.
" 9	San José Scale, *Aspidiotus perniciosus* Comst.	Japan Plum	Cromwell	Mostly dead.
" 11	" " " "	Currant	Bridgeport	Wood and scales dead.
" 14	" " " "	Peach	Stamford	Small twig partly covered.
" 19	Putnam's Scale, *Aspidiotus ancylus* Putm.	Currant	Westville	Both sexes present.
" 20	Scurfy Bark-Louse, *Chionaspis furfurus* Fitch	Apple	Madison	Egg stage.
" 20	San José Scale, *Aspidiotus perniciosus* Comst.	Peach	Groton	Twigs thoroughly coated.
" 23	" " " "	"	Southport	" " "
April 1	" " " "	Apple	Bridgeport	" " "
" 9	—— *Achorutes diversiceps* Lint.	Soil	Woodbridge	In great numbers on moist earth.
" 11	San José Scale, *Aspidiotus perniciosus* Comst.	Apple	New Haven	About 75 per cent. dead.
" 12	Scurfy Bark-Louse, *Chionaspis furfurus* Fitch	"	Preston	Egg stage.
" 12	Oyster-shell Bark-Louse, *Mytilaspis pomorum* Bouché	"	Milford	" "
" 19	Hair Worm, *Mermis albicans?*	Soil	Bridgeport	
" 20	Snowy Tree Cricket, *Œcanthus niveus* Harr.	Peach	Yalesville	Eggs laid in peach twigs.
" 20	*Lecanium sp.?*	Bay	New Haven	In greenhouse. Immature.
" 25	Scurfy Bark-Louse, *Chionaspis furfurus* Fitch	Currant	Hartford	Egg stage.
" 25	San José Scale, *Aspidiotus perniciosus* Comst.	"	"	Twig and insects dead.
" 25	Gall fly, *Rhodites radicum* Sack.?	Blackberry	"	Larvæ form galls on stem.
May 2	San José Scale, *Aspidiotus perniciosus* Comst.	Plum	Saybrook	Branch well coated.
" 3	" " " "	Plum and Pear	Shelton	Were sprayed with kerosene, insects nearly all dead.
" 3	Oyster-shell Bark-Louse, *Mytilaspis pomorum* Bouchè	Grape	Higganum	Egg stage. Mostly dead.
" 3	Scurfy Bark-Louse, *Chionaspis furfurus* Fitch	Apple	Shelton	" "
" 7	" " " " "	"	South Norwalk	" "
" 7	San José Scale, *Aspidiotus perniciosus* Comst.	"	"	On same twigs as preceding.
" 22	" " " "	Plum	Cromwell	Nearly all dead.
" 25	" " " "	Japan Plum	Milford	Mostly dead. Males emerging.
" 27	*Calosoma scrutator* Fabr.		Westville	
June 20	Currant Aphis, *Myzus ribis?*	Currant	Norwalk	Under surface of leaves covered with aphids.
" 21	Plum Aphis, *Aphis sp.?*	Japan Plum	Southbury	Badly infested.

INSECTS SENT FOR IDENTIFICATION.

Date.		Name.	Host.	Locality.	Remarks.
June	27	Elm Scale, *Gossyparia ulmi* Geoff.	Elm	New Haven	Young tree badly infested.
"	28	Tulip Tree Scale, *Lecanium tulipiferæ* Cook	Tulip Tree	South Windsor	About one-fourth size.
July	6	Brown Colaspis, *Colaspis brunnea* Fabr.	Geranium	Bristol	Eating leaves in garden.
"	6	San José Scale, *Aspidiotus perniciosus* Comst.	Currant Pear, Peach	Milford	Young scales crawling.
"	19	" " " "	Apple	Meriden	" " "
"	19	Orange Dog, *Papilio cresphontes* Cram.	*Fraxinella*	New Haven	Caterpillar eating leaves.
"	24	Pea Louse, *Nectarophora pisi* Kalt.	Sweet Peas	Bridgeport	Flowers and stems infested.
"	24	——— *Orthosoma brunneum* Forst.		New Haven	
"	24	——— *Chrysochus auratus* Fabr.		"	
"	24	Dragon fly, *Anax junius* Drury		"	
"	25	Striped Blister-Beetle, *Epicauta vittata* Fabr.	Beet & Potato	Stepney Depot	Causing considerable injury.
Aug.	2	Oyster-shell Bark-Louse, *Mytilaspis pomorum* Bouché	Japan Walnut	Westville	Few on bark.
"	2	Scurfy Bark-Louse *Chionaspis sp.?*	" "	"	Both sexes and young present.
"	6	Squash Lady-bird, *Epilachne borealis* L.	Squash	West Cheshire	Larvæ feeding upon leaves.
"	6	Striped Blister-Beetle, *Epicauta vittata* Fabr.	Cabbage and Potato	"	Adults " " "
"	6	Ash-grey " " *cinerea* Forst.	Cabbage and Potato	"	" " " "
"	7	" " " " "		West Cornwall	
"	7	San José Scale, *Aspidiotus perniciosus* Comst.	Apple	Bridgeport	Twig badly infested.
"	7	Scurfy Bark-Louse, *Chionaspis furfurus* Fitch	"	"	On same twigs as preceding.
"	7	Oyster-shell Bark-Louse, *Mytilaspis pomorum* Bouchè	Ash	"	Twig well coated.
"	8	" " " "	Willow	Mt. Gretna, Pa.	" " "
"	22	——— *Retinia?*	Red Pine	Rainbow	Larvæ eating inside of a web near terminal bud.
"	23	Red Humped Caterpillar, *Œdemasia concinna*, S. & A.	Apple	Pomfret Center	Feeding on foliage.
"	27	White Fly, *Aleyrodes vaporariorum* West.	Aster and Chrysanthemum	Bridgeport	Larvæ and adults present.
"	30	Tent Caterpillar, *Clisiocampa Americana* Harr.	Crabapple	Milford	Eggs on twig.
"	30	Hag Moth Caterpillar, *Phobetron pithecium* S. & A.	Pear	"	Larvæ eating foliage.

INSECTS SENT FOR IDENTIFICATION.

Date		Name.	Host.	Locality.	Remarks.
Aug.	30	——— *Cœlodasys sp.?*	Pear	Milford	Larvæ eating foliage.
Sept.	3	Hag Moth Caterpillar, *Phobetron pithecium* S. & A.	Apple	Stepney	" " "
"	6	San José Scale, *Aspidiotus perniciosus* Comst.	Pear	Southport	Newly hatched and mature scales.
"	6	Fall Web-worm, *Hyphantria cunea* Drury	Elm	Stratford	Half-grown larvæ eating leaves.
"	6	Hickory Tussock Moth, *Halisidota Caryæ* Harr.		"	Nearly full-grown larva.
"	9	Yellow-necked Caterpillar, *Datana ministra* Drury	Apple	New Preston	Larvæ feeding on foliage.
"	10	Hag Moth Caterpillar, *Phobetron pithecium* S. & A.	Rubber Plant	Clarks Corner	Single larva, full-grown.
"	10	San José Scale, *Aspidiotus perniciosus* Comst.	Peach	West Hartford	Twigs badly infested.
"	14	Scurfy Bark-Louse, *Chionaspis furfurus* Fitch	Pear	New Haven	
"	18	Orange Dog, *Papilio cresphontes* Cram.	Orange	Woodbridge	Larvæ eating foliage of a house-plant set out of doors.
"	21	San José Scale, *Aspidiotus perniciosus* Comst.	Apple	Apponaug, R. I.	Twigs badly infested.
"	28	Giant Hornet, *Vespa crabro* L.	Pear	Whitneyville	Eating ripe fruit.
Oct.	5	Saddle-Back Caterpillar, *Empretia stimulea* Clem.	Corn	Yalesville	Larva eating leaves. No letter of explanation.
"	5	Scurfy Bark-Louse, *Chionaspis furfurus* Fitch	Apple	Branford	Eggs are now being formed.
"	9	" " " " "	"	Kent	Eggs not formed.
"	10	*Scutigera forceps* Rafin.		New Haven	Nuisance in dwelling house.
Nov.	7	Quince Curculio, *Conotrachelus cratægi* Walsh.	Quince	"	Larvæ inside the fruit.
"	19	Mole Cricket, *Gryllotalpa sp.?*	Orange	Bayamon, P. R.	Destroyed thousands of seedlings.
"	19	San José Scale, *Aspidiotus perniciosus* Comst.	Apple	Riverpoint, R. I.	On Twigs. Some dead.
"	19	Scurfy Bark-Louse, *Chionaspis furfurus* Fitch	"	" "	Egg stage.
"	20	San Josè Scale, *Aspidiotus perniciosus* Comst.	Pear	Cheshire	On Twigs.
"	29	" " " "	Plum and Crabapple	Southport	" "
Dec.	3	*Chrysomphalus (Aspidiotus) ficus* Ash.	*Ilex crenata*	Westville	On leaves. Plants imported from Japan.
"	3	*Ceroplastes sp.?*	" "		On leaves. Plants imported from Japan, material immature.
"	16	White Marked Tussock Moth, *Notolophus leucostigma* S. & A.	Apple	" Pomfret Center	Egg masses.
"	16	Apple Aphis, *Aphis sp?*	"	"	Eggs fastened around buds.
"	16	Oyster-shell Bark-Louse, *Mytilaspis pomorum* Bouchè	Lilac	Southport	Egg stage.

THE SAN JOSÉ SCALE-INSECT; ITS APPEARANCE AND SPREAD IN CONNECTICUT.*

No other insect has caused so much destruction in fruit orchards throughout the country as the San José Scale (*Aspidiotus perniciosus* Comst.). This scale was first noticed by fruit shippers near San José, Cal., and was described by Prof. J. H. Comstock, in 1880. It was at that time doing much damage in California, and Prof. Comstock regarded it as the most destructive scale-insect which he had seen.

For several years the original habitat of this insect was undetermined, but recent observations point toward China as the probable country of its origin.†

Introduction into the Eastern States.

Though it caused much damage to fruit trees in California for several years, the scale was not known to exist in the Eastern States, until discovered in August, 1893, at Charlottesburg, Va. In March, 1894, an infested locality was found at Riverside, Md. In both cases, the introduction of the insect was traced to New Jersey nurseries, which had received the scale on nursery stock from California. Another infested area was discovered in March, 1894, at De Funiak Springs, Fla. Shortly afterwards Indiana, Pennsylvania, New Jersey, New York, Georgia, Ohio, Delaware and, in the summer of 1895, Alabama, Louisiana, Connecticut and Massachusetts were added to the list of infested states. At the present time, the San José Scale exists in nearly every portion of the United States, the extreme Northern states alone, perhaps, being exempt.

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* Published as Bulletin 135, December, 1901. It is here reproduced in slightly amended form.

† At a meeting of the Biological Society of Washington, D. C., held Nov. 16th, Dr. L. O. Howard stated "that he had received a letter from Mr. C. L. Marlatt, announcing the discovery of the long-sought original habitat of the San José scale-insect; this was found to be in China, in the region to the South of the Great Wall. The scale-insect was preyed upon by a species of ladybird beetle, living examples of which were now on their way to the United States."—Science, Vol. XIV, No. 362, p. 895, Dec. 6, 1901. See also Report of the Secretary of Agriculture for 1901, page xcvii.

Discovery and Distribution in Connecticut.

Ten years ago the San José or pernicious scale-insect was introduced into Connecticut on nursery stock from New Jersey. It escaped notice, however, until June 12th, 1895, when it was discovered at New London by Dr. W. C. Sturgis, botanist of this Station. The insect had then been multiplying for four years in the orchard and garden of Mr. J. L. Raub, and several trees had been killed by it. A study of the locality was made and a bulletin was issued, calling attention to the presence of the insect in Connecticut, describing its appearance and injuries, and giving the best remedies known at that time. (See Bulletin No. 121, July, 1895.)

Soon after, specimens were received from Hartford and Bridgeport. During 1896, additional centers of infection were found at Darien, New Haven, Groton, Mystic, Farmington, New Britain, Plantsville, and in the following year, Meriden, Wallingford, Hamden, Woodbridge and Greenwich were added to the list. The scale was found in Ivoryton, Nichols, Cheshire, Burnside and Rowayton during 1898, and in several new localities in New Haven, Hartford and Bridgeport. Previous to July 1st, 1901, when the Insect Pest Law became operative, the San José scale had been found in seventy-eight localities in this State. The names of the towns and the number of infested localities in each town are as follows:

Ansonia—1, Berlin—1, Branford—1, Bridgeport—6, Burnside—1, Cheshire—1, Cromwell—2, Darien—2, East Haven—1, Fairfield—1, Farmington—1, Greenwich—2, Groton—2, Hamden—1, Hartford—8, Ivoryton—1, Lebanon—1, Lyme—1, Meriden—3, Milford—3, New Britain—1, New Canaan—1, New Haven—12, New London—3, Nichols—1, Norwich—1, Old Mystic—2, Plantsville—1, Rowayton—1, Saybrook—1, South Glastonbury—1, Shelton—1, South Norwalk—3, Southport—1, Stamford—1, Stratford—2, Terryville—1, Wallingford—1, Waterbury—1, Woodbridge—2.

In a few of the places noted, the insect was discovered before it had infested more than one or two trees. The immediate destruction of these infested trees has probably wiped out the pest from a very few localities, but in most cases the scale had spread to a serious degree before it was discovered, and many trees have been killed and a still greater number badly injured by its attacks.

Nursery Inspection in Connecticut.

Inasmuch as this insect has been distributed chiefly by means of nursery stock, several states previous to 1896 passed laws requiring that all nursery stock shipped into these states should be accompanied by a certificate of inspection issued by some authorized inspector. In the absence of any provision for the inspection of nursery stock in this State, Connecticut nurserymen were debarred from shipping stock into the states above referred to. During the season of 1897, the Station was first requested by Connecticut nurserymen to examine their stock and grant certificates, if not found to be infested. The Station complied as well as it could with the means at its command, and as requests for inspection grew more numerous, early in 1899 the Board of Control formally adopted regulations regarding such inspection and the granting of certificates. A circular embodying these regulations was printed and mailed to about seventy nurserymen, seedsmen and dealers in plants. In May, 1899, a bulletin on Inspection and Care of Nursery Stock, containing the Inspection Rules, was published and distributed. Up to the time the present law went into effect, about fifty inspections had been made and thirty-nine certificates granted. While this arrangement enabled the Connecticut nurserymen to ship into other states, it did not protect the buyers of nursery stock living within the State. If a nursery was badly infested, so that a certificate could not be granted, the owner could sell his plants and trees in Connecticut, where a certificate was not required. There was also nothing to prevent the shipping of infested stock into this State from those states which had no nursery inspection laws.

Legislation.

The fruit growers of Connecticut, represented by the State Pomological Society, urged the passage of a law regarding insect pests, chiefly because of the damage caused by the spread of the San José scale. The question was discussed at the annual meeting of the society in February, 1901, at Hartford, and the present law is the outcome of this agitation. This law was published in July, in Bulletin No. 134, of this Station. The law provides for the study of other pests as well as the San José scale. At the time the Connecticut law was enacted, at least twenty-five other states had passed similar measures.

Life History of the San José Scale.

Both the males and females pass the winter in an immature state, and do not reproduce until the latter part of June in this latitude. The present year, young were first observed on June 27th. The female does not lay eggs, but brings forth living young. The newly-born scales of both sexes crawl about for a few hours upon the twigs. They are provided with legs, eyes, antennae and mouth-parts. After they have found a suitable place, they settle upon the bark, insert their beaks and begin to suck the juice from it. Legs and antennae now disappear in both sexes, and the females lose their eyes. At first there is a white waxy substance exuded, which has somewhat the appearance of wool. A little later this seems to melt down and the insect casts its skin. The skin, together with the waxy substance, forms the beginning of the shell or covering. After feeding for about four weeks, the insect reaches the full-grown stage. If a female, it then begins to bring forth its young, continuing for a period of about six weeks. The number of young produced by a single female varies from less than one hundred in the early part of the season to nearly six hundred in late summer. The male feeds until full-grown, passes through the pupa stage, and finally the adult comes forth from under the shell, provided with eyes, wings, legs, antennae and organs of reproduction, but with no mouth-parts nor digestive system. He can, therefore, eat nothing after reaching the adult stage. His only mission is to mate with the female and die. The female, on the other hand, after becoming established upon the twig, loses legs, antennae, and eyes, never again to be possessed of these organs, while its mouth-parts, digestive system and reproductive organs become very strongly developed. It cannot therefore move about, but feeds upon the juices of the plant and reproduces its kind. There are three complete generations each season in this latitude, and probably four in favorable seasons.

General Appearance of the Insect.

Usually the insect appears upon the bark as a greyish, rough coating, scarcely noticeable to the naked eye. At first there are but few individuals, generally found clustered around the buds and at the branching of the twigs. Plate III, a, shows how the scales collect in a groove or hollow in one side of a twig, as if they had sought a sheltered situation. As the trees become more thoroughly infested, the bark may be completely covered, and sometimes there are several layers of scales covering the bark. In such cases leaves and fruit are usually attacked. The

Fig. 1. Appearance of San José scale on peach twig. a. mature females: b. young females: c. immature males. About twice natural size. *Wood-cut from author's drawing.*

young scales locate upon both sides of the leaf, along the ribs (see Plate V, b), where they cause a reddish discoloration. This discoloration also occurs on fruits, and on the twigs, especially where there are but few individuals, and it is apparent not only on the outside, but extends through the bark to the wood.

Where the insect is found upon the fruit, it seems to prefer the calyx and the stem cavities. Upon slightly infested trees the fruit is not attacked, but on trees which are badly infested the fruit is often so thoroughly covered as to present a very disgusting appearance. (See Plates IV and V.) If we examine the insect through a pocket lens, magnifying perhaps ten diameters, we see that it is distinctly circular in outline, somewhat raised above the bark, especially in the center where there is a small nipple, differing in color from the other portion. If infested twigs are much handled, the outer layer is rubbed away from the nipple, leaving it a bright yellow color. Concentric circles are usually apparent between this nipple and the outside edge. The scaly covering is formed at the edge in concentric layers or additions. The covering of the male is different in shape from that of the female. While that of the female is nearly circular in outline, the armor of the full-grown male scale is nearly always elongated, with the nipple near one end, and the lines of formation are eccentric instead of concentric. (See Fig. 1.)

The color of the shell or covering varies greatly, sometimes being a light grey, sometimes being nearly black. It frequently turns dark if the insects are killed when half grown. If killed when fully grown, the shells often assume a light grey color, and finally drop from the twigs. If we lift this shell or covering with a pin or point of a knife, we will see underneath a small yellow object, oval or circular in outline, which appears like a bit of yellow jelly. This is the insect proper and is shown in the illustration on Plate III, a.

Food Plants.

According to Howard* and Lintner† the scale occurs on the following plants: Apple, pear, quince, peach, plum, cherry, mountain ash, hawthorn, Japanese quince, linden, *Euonymus*, almond, apricot, *Spiræa*, raspberry, rose, cotoneaster, gooseberry, currant, flowering currant, persimmon, acacia, lilac, elm, osage

* Bulletin No. 3, New Series, Division of Entomology, U. S. Department of Agriculture, Washington, D. C., p. 38.

† Bulletin of the New York State Museum, Vol. 3, No. 13, p. 295.

orange, English walnut, pecan, weeping willow and laurel-leaved willow.

In addition to the above-mentioned food plants, Rolfs and Quaintance* give chestnut, black walnut, Carolina poplar, Lombardy poplar, cut-leaved birch, flowering cherry, flowering peach, grape, *Catalpa*, and sumac.

In Connecticut, the writer has found it upon apple, quince, pear, peach, cherry (sweet), plum (European, Japanese and purple-leaved), hawthorn, mountain ash, Japanese quince, *Spiræa*, rose, currant, gooseberry, poplar, honey locust, choke cherry, shad-bush or June berry, cut-leaved white birch, dogwood, Japanese walnut, elm, grape, California privet, and several species of willow. In Hartford the scale has already attacked the wild choke-cherry and shad bushes in sprout-lands. While the insect usually attacks plants belonging to the Rose family, there is reason to believe that it may attack any species adjacent to infested trees. Of the orchard trees, Japanese plum, pear, apple, quince and peach, are most often infested, while the cherry and European plum are less frequently attacked.

The purple-leaved plum is perhaps the most subject to attack of all the ornamental plants. Mountain ash, hawthorn, and *Cydonia* are, however, frequently injured by it.

How the Scale Spreads from Tree to Tree.

The young scales crawl about for a few hours on the bark, and if the trees stand so close that the branches interlace, of course they can readily crawl from one to the other. They are scarcely able to crawl long distances from the trunk of one tree to another over the rough ground, but are often blown about on fallen leaves and may reach a different section of the orchard in that way. In cultivating nurseries, the workmen brush against the young trees, and it is quite possible for some of the young insects to be carried to other trees along the nursery rows.

In one case, an orchard became infested by hitching a horse to one of the trees, after the team had been in an infested orchard three miles distant.† The throwing about of infested fruit may aid in distributing the pest. Also where parings of infested fruit are thrown out into gardens, there is danger that near-by trees may become infested.

*Coccidæ Americanæ, Decades I and II, No. 15.

† Bulletin No. 3, New Series, Division of Entomology, U. S. Department of Agriculture, Washington, D. C., p. 50.

As a rule, however, the insect is carried to distant trees either by other insects or upon the feet of birds.

Effect upon Trees.

The effect on the vitality of the tree is not apparent until the twigs become nearly covered by the insect. Then it may be noticed that the tree seems unthrifty, but the scale is so inconspicuous that frequently the tree loses some of its branches or dies before the cause of the trouble is discovered. The illustration on Plate II shows a peach tree which has been severely injured, and the branches are dead, but the trunk is still alive and making an effort to grow a new top. This form of injury is one often seen, and frequently the owner does not discover the cause until his trees reach this condition. A plum tree killed by the scale is shown on Plate I. The length of time required to kill a tree depends on various factors. In certain seasons the species multiplies much more rapidly than in others, depending undoubtedly upon the weather and the abundance of natural enemies. The writer has known of several localities where ornamental plants were attacked and no measures taken to destroy the scale, yet for two or three years the insect has not spread to any appreciable extent. On the other hand, in certain orchards, it has spread with great rapidity in spite of vigorous combative measures. In Mr. Raub's garden at New London, large peach trees were killed by the scale in four years.

Remedies.

All infested trees which are worthless or of little value should be destroyed, as the owner cannot afford to treat them; he had better obtain new trees.

Spraying.

There have been many different applications used in Connecticut to kill this scale-insect. The most successful, perhaps, is either crude oil, applied just before the leaves are put out in the

Spring, or a mixture of kerosene and water (20 to 25 per cent. kerosene), applied at the same time. The crude oil possesses one advantage. A portion of it stays on the bark for several months, so that it would seem impossible for the young scales to become established. Kerosene, on the other hand, evaporates readily and, after a few weeks, can not be detected by odor or by the appearance of the twigs. Experiments conducted by us during the past season, show that either the crude oil, or 20 per cent. kerosene and water, if thoroughly applied, will kill the insects without causing any serious injury to the trees. An account of these experiments will appear in a forthcoming bulletin. It is not safe to apply any form of petroleum on a damp, cloudy day. It must be used in pleasant weather, and must be applied in the form of a fine spray.

We have found the "Kerowater" barrel pump, made by the Goulds Mfg. Co., Seneca Falls, N. Y., to give satisfaction in orchard work. For a few small trees in the garden there is probably nothing better than the "Success" bucket pump made by the Deming Co., Salem, Ohio. These pumps are not kept in stock by local dealers, but must be ordered from the manufacturers. The "Vermorel" is the best nozzle we have employed for kerosene spraying, but a cap with small aperture should be used. In infested orchards this spraying is likely to be adopted as the best practical way of holding the pest in check. Fumigating is here too expensive.

According to experiments made in New Jersey, certain grades of crude oil are liable to cause injury to the trees. If the oil has a specific gravity of not less than 43° (Beaumé), there is little danger. It need not be above 45° however. As the term "crude petroleum" is rather vague in meaning, it is necessary to specify, in ordering, what grade of oil is required. In order that Connecticut fruit growers may obtain the proper grade of oil for insecticide purposes, I have arranged with the Standard Oil Company to furnish it. Orders should be sent to the Providence Department of the Company, Mr. P. M. Watt, Manager, 136 South Water St., Providence, R. I. This oil is not kept in stock at the distributing stations, but shipments can be made quickly from New York. The present price is 9½ cents per gallon, including barrel, but of course the price is subject to changes. In ordering, call for "Insecticide Oil."

A solution of whale-oil soap (2 lbs. of soap to 1 gallon of water) sprayed upon the trees is regarded as the best remedy in many localities. It is probably less liable to injure trees than the kerosene or crude oil, and may be applied at any time during the winter. But it is an expensive treatment for large orchards, and from our observations in Connecticut it does not seem to be as effective in destroying the insects as kerosene or crude oil. It is also difficult to apply in the form of a spray. Whale-oil soap fairly uniform in composition may be obtained from the manufacturers, James Good, 514-518 Hurst St., Philadelphia, Pa., and Leggett & Bro., 301 Pearl St., New York.

The above-mentioned treatment applies only to dormant trees. If the insect is discovered during the Summer when the trees are not dormant, it may be held in check for the season by spraying with 15 per cent. kerosene and water, or whale-oil soap solution (1 lb. to 5 gallons of water), which will kill most of the young scales which are crawling upon the bark.

Fumigating.

In nurseries where the trees are dug up in shipping season, the scales upon them can easily be destroyed by fumigating with hydrocyanic acid gas. A tight box, tent, or room, is required for this purpose, and our leading nurserymen are now provided with some sort of equipment for fumigating their nursery stock. In fact, some of their large orders reach them with the request that the stock be fumigated before being sent out: even when it is not known to be infected. The formula which we have been using in Connecticut requires for each 100 cubic feet of space,

Cyanide of potash (97 per cent.)	25 grams, ⅚ oz. (by weight)
Sulphuric acid (Sp. G. 1.83)	1¼ oz. (liquid measure)
Water	1⅞ oz. (liquid measure)

The enclosed space should be computed with care, and the chemicals measured out accordingly. The house should of course be filled with the trees before preparing the chemicals. A stoneware jar of suitable size makes a good generator. The water should first be put into this jar and the acid poured in slowly with constant stirring. The jar should be set inside, and within easy reach of the door or cover. The cyanide is then dropped into the jar quickly, and the house closed from the outside. The person should leave at once, as the fumes are extremely poisonous and might cause death if one should breathe them. The trees should be left for half an hour, when the house may be opened in order to let the fumes escape. It is not safe for persons to enter for several minutes. While this treatment is not certain to kill every individual scale-insect, it is one of the surest methods that we know of destroying them. Small orchard trees can be fumigated in this manner, by covering them with a gas-tight tent, beneath which the gas is generated, but for large orchard trees, an expensive outfit is required to handle the tents. There is also some difficulty in computing the space. Chiefly on account of the expense, however, this has not been practiced to any extent in Connecticut. The fumigation of nursery stock must be, from now on, a common practice. The materials may be obtained from any wholesale druggist. A fumigating house is shown on Plate XI.

Summary.

(1) The San José Scale appeared and caused much destruction of fruit trees in California twenty years ago. China is probably the country of its origin.

(2) It was first found in the Eastern states in 1893, and now occurs in nearly all the states of the Union, except perhaps, the extreme Northern ones.

(3) The scale was brought into Connecticut on nursery stock ten years ago, but not discovered until 1895. Seventy-eight infested localities had been found up to July 1st, 1901, when the new Insect Pest Law went into effect.

(4) The Station began the work of inspecting nurseries in 1897, at the request of nurserymen. This enabled them to ship stock into other states where inspection laws existed. Fifty inspections were made and thirty-nine certificates granted under this arrangement. Twenty-five other states had enacted inspection laws, before the Connecticut law was passed.

(5) The full-grown female scale gives birth to living young, which crawl about for a short time and then settle upon the bark. There are three or four generations each season. They feed by sucking the juices from the tree. Each female may produce from less than one hundred to six hundred young.

(6) The scale is inconspicuous and is seldom noticed until the vitality of the tree is impaired, at which time the bark is usually coated with a roughish grey substance. The reddish discoloration may be found around each individual. Leaves and fruit are also attacked. The female scale is nearly circular in outline, while the male is somewhat elongated. If the scale is lifted, the insect proper may be seen underneath, by the aid of a lens, as a yellow object.

(7) Common fruit trees and plants of the Rose family are usually preferred by the insect, but it is liable to attack almost any variety of tree or plant that may be growing near infested trees.

(8) Though the young scales crawl short distances, they are usually carried from one tree to another by other insects, or upon the feet of birds. They may also be carried upon fallen leaves, fruit, or the clothing of persons, etc.

(9) The vitality of the tree is gradually lessened by the hordes of insects sucking its sap. The pest is seldom noticed until some of the twigs die. Entire trees have been killed in four years in Connecticut by the scale.

(10) Spraying the trees just before leaves appear in the Spring, with crude oil, or with a mechanical mixture of kerosene oil and water, using 20 per cent. kerosene, is the best remedy that we can now recommend for large orchard trees. Whale-oil soap and water, in the proportion of 2 lbs. of soap to 1 gallon of water, sprayed upon the dormant trees, is also an effective treatment. Growing trees may be treated with 15 per cent. kerosene and water, or whale-oil soap (1 lb. in 5 gallons of water). For nursery stock, fumigating with hydrocyanic acid gas is the cheapest and most effective treatment.

PRELIMINARY EXPERIMENTS IN SPRAYING TO KILL THE SAN JOSÉ SCALE-INSECT. SEASON OF 1901.*

The contradictory results obtained by different experimenters, even within the limits of a single state, regarding the effect on trees of crude petroleum and kerosene, indicate that these materials should be tested in each locality before we can wisely recommend their use. It is certain that trees have been injured and even killed by applications of these oils, while in hundreds of other cases no injury could be detected. It is quite probable that climatic influences, such as temperature, humidity, altitude, exposure, etc., may be responsible for the varying results. To study some of these points as well as to note the effects on the insect, careful tests were made the past season in three different localities, all situated near the coast.

In each of the experiments at Westville, Stratford, and East Haven, the twigs were examined before insecticides were applied, and the percentages of living scales noted. A month or six weeks after spraying, twigs were again taken from these trees and the percentages of living scales again determined, thus giving some idea of the effect of the treatment upon them. It is not claimed that the percentages exactly represent the conditions of the insects on the whole tree in each case, as it is difficult to obtain twigs that can fairly stand for all conditions of exposure, etc., to which the tree is subjected. On some twigs the scales were nearly all dead, while on others most of them were alive. As a number of twigs were selected in each case and as judgment was used in making this selection, it is believed that the average figures are approximately correct, and show the results of the treatment much more accurately than any mere estimate not based upon actual enumerations.

The kerosene used was taken from a barrel purchased for illuminating purposes, branded "Devoe's Brilliant Oil," and claimed to have a fire test of 150°.

* This matter was printed as Bulletin 136 and distributed in March in an edition of 10,500 copies. It is here reproduced with appropriate emendations.

The crude oil was obtained from the Standard Oil Co. and shipped to us from Providence, R. I., after being ordered from Philadelphia, Pa., according to arrangements made by Professor J. B. Smith of New Jersey. This oil had a specific gravity of very nearly 43° Beaumé. Anyone desiring crude oil for insecticide purposes, may obtain it from Mr. P. M. Watt, Manager, Providence Department, Standard Oil Co., 136 South Water St., Providence, R. I., and it should be ordered as "Insecticide Oil."

The soap used in these tests was the "Welcome," a brand in common laundry use. Any similar hard soap would doubtless answer the purpose quite as well.

The Babbitt's lye was the commercial product put up in tin cans for household use and labeled "Babbitt's Potash or Lye." It consists of soda, however, instead of potash.

The extensive orchard work, both at Westville and Stratford, was done with the "Kerowater" barrel pump made by the Goulds Mfg. Co., Seneca Falls, N. Y.

In the more careful tests, where only a few trees were sprayed, the "Success" bucket pump was used. This pump is manufactured by the Deming Co., Salem, Ohio.

WESTVILLE EXPERIMENTS.

The first experiments were conducted on dormant trees at Westville. The applications were made on April 12th, which was a bright day with a moderate breeze. The materials used were: 1, kerosene and water in mechanical mixtures (containing 15 and 20 per cent. of kerosene), 2, crude oil, and 3, Babbitt's lye—one pound to four gallons of water. With the exception of a peach tree sprayed with crude oil, all the trees were drenched, great care being taken to cover every portion of the bark.

These tests on a few trees were made by the writer with the greatest care. The owner sprayed his entire orchard, using the 20 per cent. mixture of kerosene and water on most of the trees, and a 25 per cent. mixture on the remainder.

Plate VI (*b*) shows the appearance in July of a peach tree sprayed with crude oil, and (*a*) shows at the same time a tree sprayed with 20 per cent. kerosene in water. Both trees were sprayed on April 12th.

Table I shows the number and kinds of trees treated, materials applied, what percentage of the total number of scale-insects found on the twigs were living at the time they were examined, condition of trees at time of application, and the percentage of insects found alive after the application, percentage probably killed by the treatment, and the effect of the treatment upon the foliage, etc.

By consulting the table, the reader will see that in case of the pear tree drenched with the crude oil less than one per cent. of living insects was found when examined on July 3d. This may be somewhat misleading, but it should be remembered that the figures represent only a single tree. The percentage of living insects was even lower (.043 per cent.) on one of the pear trees treated with the kerosene and water mixture having 20 per cent. of kerosene, though the average of the three trees was much higher (3.07 per cent.). The results also indicate that 15 per cent. of kerosene in the kerosene and water mixture is fatal to most of the scales at this time of the year and under these conditions. Crude oil does not evaporate as readily as kerosene and remains on the bark for several months, thus preventing many young scales from becoming established.

Babbitt's lye of the strength used, and on the single pear tree, was less effective in destroying the scales than crude oil or the kerosene and water mixture containing 20 per cent. of kerosene.

Experiments at Stratford.

After the foliage appeared, an orchard in Stratford was found to be infested with scales, and experiments were made there, to note the effect of the insecticides upon both the foliage and insects. Spraying was done on June 19th, in pleasant weather. The application used consisted of 15 per cent. kerosene in water on a large number of trees. On a single tree each, mixtures of crude oil and water containing 30, 20, and 15 per cent. of crude oil were used. The entire orchard, containing over three hundred trees, was sprayed, more than two-thirds (220 trees) with 15 per cent. of kerosene in water, and the remainder (85 trees) with 15 per cent. of crude oil in water, the trunks and bases of the branches being covered with the insecticide, but care was taken that it should not reach the foliage.

Table I.—Westville Experiments. Dormant Trees Sprayed April 12th, 1901.

Number of trees treated.	Kinds of trees.	Condition of trees before treatment.	Treatment and materials applied.	Percentages of living insects at time of treatment.	Percentages of living insects on June 3d.	Percentages of insects probably killed by treatment.	Effect of treatment on trees. Examined June 3d.
1	Peach.	Badly infested	No treatment	76	83.6	0	
1	"	Moderately infested	15 per cent. kerosene in water.	79.8	8.4	71.4	No perceptible effect.
3	"	"	20 " " "	84.3*	5.8*	78.5*	" "
1	"	Slightly infested	Crude oil. Surface of trunk and branches moistened	80	5.4	74.6	No injury.
1	Pear.	Moderately infested	15 per cent. kerosen in water.	82	3.9	78.1	" "
3	"	"	20 " " "	81*	3.07*	78*	" "
1	"	Badly infested	Crude oil. Tree drenched	83	.1	82.9	Injury very slight. A few buds were destroyed.
1	"	Moderately infested	Babbitt's lye. 1 lb. to 4 gal. water	85	12.6	72.4	No injury.
1	Crab-apple.	Badly infested	20 per cent. kerosen in water.	89.3	8.7	80.6	" "

* These figures represent the average percentages from three trees.

At this time the first brood of scales had not appeared.

From an examination of Table II, it may be seen that the various mixtures of crude oil with water caused injury to the foliage and fruit, to such an extent as to prohibit its use on peach trees in leaf, though it must be admitted that it was rather more effective in killing the insects than the kerosene and water mixtures. The soap and water injured the foliage about as badly as crude oil and water. The kerosene and water mixture, containing 15 per cent. of kerosene, caused practically no injury on peach trees in foliage.

East Haven Experiments.

The third series of experiments was carried out at East Haven on trees in foliage, June 26th. 15 and 10 per cent. of kerosene mixed with water, and the same proportions of crude oil and water, and the soap solution (one pound of soap to eight gallons of water) were used. The next day after applying these insecticides (June 27th), the young insects began to appear, not having been seriously injured before birth by the applications.

The tests at East Haven (see Table III) gave results very similar to those obtained at Stratford as regards the effect of kerosene and crude oil mixtures on both the San José scale insect and the peach trees. Soap and water injured the leaves as much as crude oil, though less destructive to the scale.

Other Records.

A purple-leaved plum tree, growing in New Haven and badly infested with the scale, was treated on July 24th with a kerosene and water mixture containing 15 per cent. of kerosene. The weather was fair with a moderate breeze. The treatment was very thorough, and the mixture made to cover every portion of the tree until it dripped from the branches. On August 28th, twigs were cut from the tree to ascertain the effect of the treatment. Of three hundred and eight (308) individuals examined, only three were alive. The tree shed a few leaves but did not appear to be damaged to any serious extent.

During the latter part of the winter, currant twigs received from Bridgeport were found to be infested with the San José

Table II.—Stratford Experiments. Trees in Foliage, Sprayed June 19th, 1901.

Number of trees treated.	Kinds of trees.	Condition of trees before treatment.	Treatment and materials applied.	Percentages of living insects at time of treatment.	Percentages of living insects on July 9th.	Percentages of insects probably killed by treatment.	Effect of treatment on trees. Examined July 9th.
2	Peach	1 badly infested; 1 not infested	15 per cent. kerosene in water. Entire tree drenched.	Not taken.	Not taken.	Not taken.	A few leaves and young fruits dropped. Practically no injury.
3	"	Badly infested	15 per cent. kerosene in water. Entire tree drenched.	91.4	33.3	58.1	A few leaves and young fruits dropped. Practically no injury.
1	"	"	15 per cent. crude oil in water. Entire tree drenched.	88.6	24	64.6	Caused injury to lower leaves, fruits and a few tender shoots.
1	"	"	20 per cent. crude oil in water. Entire tree drenched.	87.5	11	76.5	Took off most of the foliage. New leaves are putting out.
1	"	Badly infested. Entire top had been cut off and only trunk and new shoots remained.	30 per cent. crude oil in water. Entire tree drenched.	Nearly all dead on twig examined.	Not taken.	Not taken.	Tree severely injured.
3	"	Badly infested	1 lb. soap in 8 gal. water. Entire tree drenched.	80.8	27	53.8	Severe injury. Nearly all the fruit spoiled and lower leaves gone. New shoots killed. Only leaves on topmost branches remain.
220	"	Moderately infested	Trunk and branches (not the foliage) sprayed with 15 per cent. kerosene in water.	Not taken.	Not taken.	Not taken.	Practically no injury. A few leaves dropped.
85	"	Moderately infested	Trunk and branches (not the foliage) sprayed with 15 per cent. crude oil in water.	Not taken.	Not taken.	Not taken.	Some injury. Leaves and young fruit were killed where the spray came in contact with them.

scale. The owner sprayed his plants carefully, on March 12th, using a soap emulsion of kerosene containing 25 per cent. of kerosene. The weather was fair, and in most cases the twigs were so covered that the emulsion dripped from them. Fifteen gallons of the mixture covered five hundred currant bushes, and was applied with a Garfield knapsack sprayer. Twigs were examined at the Station, on May 22d, and it was found that less than one per cent. of the scale-insects were alive.

This form of treatment does not require the special pump for mixing kerosene and water, but the emulsion may be applied with any spray pump.

Effect on Trees.

The peach leaves were somewhat injured by the insecticides. It is known that peach foliage is very susceptible to most spraying mixtures, and that Bordeaux mixture, which is commonly used on the foliage of most fruit trees, cannot be used safely upon peach trees in this climate. Crude oil in all the percentages used caused injury, though the 15 per cent. mixture was scarcely more injurious than the mixture containing 10 per cent. of oil.

The soap and water caused as much injury as the crude oil, but was not as effective in killing the scales. Leaves injured by the applications became ragged and perforated, portions of the tissue being killed and falling away, much resembling those attacked by the shot-hole fungus. These leaves turned red and dropped later. In some cases the young fruits were killed by the application, and these shriveled and afterwards dropped; the young twigs were also killed but the hardened growth remained uninjured. At first it was thought that the kerosene and water mixtures had caused injury, but only a few leaves dropped and it is doubtful if the trees were really injured at all; much less so, unquestionably, than would be the case were the scales allowed to multiply unchecked.

We are not yet able to make any statement regarding the effect on trees of repeated applications of kerosene or other mineral oils. Further experience is necessary to determine this point. Thus far, however, it seems fairly safe to apply kerosene and water in a 15 per cent. mixture to fruit trees in foliage, and

Table III.—East Haven Experiments. Trees in Foliage, Sprayed June 26th.

Number of trees treated.	Kinds of trees.	Condition of trees before treatment.	Treatment and materials applied.	Percentages of living insects at time of treatment.	Percentages of living insects on Aug. 2d.	Percentages of insects probably killed by treatment.	Effect of treatment on trees. Examined July 3d.
2	Peach.	Partly dead. Badly infested.	15 per cent. kerosene in water	72.7	28	44.7	Injury very slight; not worth considering.
2	"	1 partly dead, badly infested; 1 in good condition moderately infested.	10 " "	82	34	48	No perceptible injury.
2	"	1 unthrifty with "yellows," 1 quite vigorous, both moderately infested	15 Crude oil in water	76.7	23	53.7	A few tender shoots, leaves and young peaches killed.
2	"	Quite vigorous. Moderately infested	10 " "	83.5	20	63.5	Slight injury to new growth leaves and fruit.
2	"	1 partly dead, badly infested; 1 in fair condition, moderately infested.	1 lb. soap in 8 gals. water	86.5	73	13.5	This application seemed to injure foliage and fruit as much as 15 per cent. crude oil in water.

our experience indicates that the scale may be held in check to a considerable extent by so doing, especially if the application be made after the breeding season of the insect begins, or during the latter part of the summer.

We were not able to detect any considerable injury to the dormant trees by any of the insecticides applied just before the buds opened in the spring.

Effect of the Treatment upon the Scale-Insect.

It may be seen from the tables that both the crude oil and 20 per cent. kerosene mixture were effective in destroying the scale when applied to dormant trees late in the spring. The same materials did not kill the scales as satisfactorily when applied in June. We are unable to give a reason for this, but it may be due to the condition of the insects, which at the time of spraying in April were mostly females, nearly mature, and about ready to give birth to their young. In both cases, at East Haven and Stratford, the treatment killed a much smaller percentage of the insects than similar applications to dormant trees in April, or to trees in foliage during the latter part of July. Had the spraying been done a few days later, and when the young were crawling, it would unquestionably have killed nearly all the young scales, and even the spraying late in July was very effective in destroying both the young and mature insects.

Summary.

(1) Contradictory results regarding the effect of mineral oils on trees rendered it essential that tests be made in each locality before the use of such oils be recommended. Such experiments have been conducted the past season in three localities near the coast.

(2) Twigs were taken from each tree and the insects examined before treatment; another examination was made a month or six weeks later and percentage of living insects noted in each case to determine the effect of the treatment.

(3) Crude oil, kerosene and water, with 15 and 20 per cent. of kerosene, and Babbitt's lye, one pound to four gallons, was used on dormant trees at Westville just before the leaves appeared in spring. Kerosene and water mixtures, and crude oil and water mixtures, that contained oil in proportions from 10 to 30 per cent., and soap and water (one pound of soap to eight gallons of water), were used on peach trees in foliage at Stratford and East Haven.

(4) Crude oil having a specific gravity of 43° Beaumé, and a kerosene and water mixture containing 20 per cent. of kerosene, were both effective in destroying the San José scale where applied to dormant trees just before growth started, and did no apparent harm to the trees. Babbitt's lye in the strength used was much less effective.

(5) The scale may be held in check on peach trees in foliage by spraying with kerosene and water mixture containing 15 per cent. of kerosene without serious injury to the trees, but was not as effective in destroying the scale when applied during the latter part of June as when applied a month later. 15 and 10 per cent. of crude oil mixed with water caused injury to peach foliage and is not to be recommended: the same may be said of common soap and water (one pound to eight gallons).

(6) Kerosene emulsion containing 25 per cent. of kerosene is effective in destroying scales on dormant trees and may be applied with any form of spray pump.

CARNATIONS INJURED BY THE VARIEGATED CUT-WORM.

Peridroma saucia Hübn.

During January, 1901, caterpillars of this species attacked a bench of carnations, which were grown for experiment in the station forcing house. Leaves were not eaten to any extent. Each of a few flowers had a hole eaten into the calyx and the lower portions of the petals eaten off, allowing the detached portions to drop to the ground. The unopened buds were the chief objects of attack, and about 60 of them were ruined. In each case a hole was eaten in the side of the bud and the contents devoured.

The night watchman was instructed to hunt for these cut-worms while making his rounds of the houses.

The first larva was found January 25th, and during the next two weeks several were taken from the plants. Some of these soon pupated and the adults emerged on March 27th.

The cut-worms appeared only in that part of the bench which was filled with street sweepings, which had been composted for a short time before filling the house. As the caterpillars were nearly full-grown when discovered, and as the plants in the house had not been previously injured, as would have been the case if they had developed from the egg stage inside the house, it seems probable that they were brought into the house in the larval stage with the soil. The fact that carnations growing in ordinary compost nearby were uninjured, indicates that the street sweepings contained the cut-worms when brought into the house.

The eggs are nearly hemispherical in shape and strongly ribbed, the ribs radiating from the center. They are laid in compact masses, containing about 60 eggs, often in rows, on the twigs or the under sides of the leaves of various plants. The larvæ are from one and one-half to one and three-fourths inches in length when full-grown. Up to this time they have molted five times, and in the full-grown stage of the larva there is great variation. A dark form is dull brown, more or less indistinctly marked with grey, with interrupted lines along the sides of the body. The cut-worms which attacked the carnations in the greenhouse were of the pale form, being of a dirty-grey color, with very faint markings. Plate VII shows this pale form about natural size, in both the extended position in which they feed, and in the resting position in which they spend the day coiled up beneath the surface of the ground.

The next stage is simply a naked brown pupa, found in the soil, yellow in color when first formed, and gradually changing to a dark mahogany-brown.

The adult is a moth of a brownish-grey color, having a wing-expanse of from one and three-fourths to two inches. There is great individual variation in the markings of the fore-wings. The hind-wings have no characteristic markings. They are usually white or light-grey near the body, shading into brown near the margins, and edged with a white fringe.

There are two broods each year, but the second is usually not extensive and does little damage. The winter is passed usually in the larval, but sometimes in the pupal stage, and, since much variation exists regarding the time of appearance and length of the breeding period, it is difficult to separate the two generations.

This is one of several species known as climbing cut-worms, which sometimes devour the foliage and injure the young fruit of apple, pear, peach, plum, cherry, and other trees. It is known to feed upon nearly all kinds of cultivated plants, both under glass and out of doors, and was reported as injuring carnations near New York City in 1894, Chicago in 1895, and at New London, Conn., in 1898;* in or near Philadelphia in 1890,† and in 1892.‡ Sirrine included this species in an article on insects infesting carnations, published in the *American Florist,* March 3, 1900.§ Dr. Felt had previously recorded an attack on carnations by the variegated cut-worm in a paper printed in *Country Gentleman,* May 11th, 1899.||

It caused much destruction in fields and gardens in the north-western states during 1901, by devouring the foliage of all plants. Its attack resembled that of the army worm, and it was so abundant in the infested region that a square yard of ground contained hundreds of caterpillars. In serious outbreaks various mechanical measures, like ditching or rolling the land, may be put in practice to destroy the cut-worms. Paris green or arsenate of lead may be applied to the vegetation in their path, and thus great numbers may be killed.

In gardens and tilled fields cut-worms may be combated by placing poisoned bait on the ground short distances apart, a few days before the young plants appear. The bait may consist of fresh clover, or other succulent plants, which have been sprayed with Paris green, or of a bran mash to which poison and a little sugar have been added. If this method is practiced for a week or so before the crop occupies the ground, most of the cut-worms will be destroyed. Hand-picking at night will probably remain the most desirable remedy in greenhouses, as it is not advisable to poison the flowers, leaves or buds of plants which go to market. A thorough search during the day will disclose many of the worms coiled up beneath the surface

* Bulletin 29, New Series, Division of Entomology, U. S. Dept. of Agriculture, 1901.

† Insect Life, Vol. II, p. 376.

‡ Idem, Vol. IV, p. 405.

§ Experiment Station Record, Vol. XI, p. 1065.

|| Fifteenth Report N. Y. State Entomologist, p. 594, 1899.

of the ground near the infested plants. It is possible that the poisoned bran mash would be effective even in greenhouses.

In connection with the variegated cut-worm was found another and smaller species that devoured the petals of the blossoms. Only two or three specimens were captured and the identity of the insect was not established.

A report was sent to the station in November, 1901, that chrysanthemums in the extensive greenhouses of a commercial grower were being injured by climbing cut-worms. Though no specimens were seen by the writer, the injury was probably caused by the variegated cut-worm. The remedy that was being practiced was hand-picking at night, though the owner writes that he has often trapped the caterpillars by placing damp tobacco stems on the bench or ground among the infested plants. The cut-worms crawl into the tobacco stems to rest during the day and may be shaken out in the morning and destroyed.

The following publications which have appeared in recent years contain good accounts of the variegated cut-worm.

Bulletin 29, New Series, Division of Entomology, U. S. Dept. of Agriculture, Washington, D. C., 1901; Bulletin 104, Cornell Experiment Station, Ithaca, N. Y., 1895; Bulletin 47, Washington Experiment Station, Pullman, Wash., 1901. The Fifth Report of the New York State Entomologist, page 200 (Albany, N. Y., 1888), has also a short account of the species, with bibliography up to that date.

Plate VII shows the variegated cut-worm in the larval and adult stages, and also some carnation buds injured by the larvæ.

ABUNDANCE OF THE ELM LEAF-BEETLE.

Galerucella luteola Müll.

The ravages of the elm leaf-beetle were especially serious in portions of the State during 1901. According to the daily papers, much injury was done to the trees in Hartford, Norwich, and other places. In New Haven the attack was probably more serious than it has been since 1896, when many trees were sprayed in the central portion of the city. In South Norwalk, where the beetle did much damage a few years ago, the trees were scarcely injured at all the past season.

The larvæ came down the trees in great numbers to transform about the middle of July. As the destruction of the pupæ tend to decrease the number of beetles for the next season, this was advised in the following press bulletin, issued July 15th, and printed in nearly all of the papers of the state:

NEW HAVEN, CONN., July 15, 1901.

In many Connecticut towns and cities, and especially in New Haven, the elm leaf-beetle has this season caused much injury to elm trees that might have been prevented by spraying poison on the foliage early in May to kill the adult beetles. Failing to do this, another spraying about the first of June would have prevented injury from the caterpillars. It is now too late to apply poison, as the injury has been done and the caterpillars are crawling down the trees in great numbers seeking a sheltered place in which to transform. All do not come down the trunk, however, as many drop from the branches to the ground, while some lodge in crevices of the rough bark of the trunk and larger branches, and there undergo their change to the pupa stage. But a large proportion may be found on the ground at the base of the tree, where they may be collected by the quart in some cases. It is an easy matter to destroy these pupæ, and it should be done at once, thus greatly diminishing the crop of egg-laying beetles for next year.

Where the city authorities are not prepared to act, citizens and residents should do so, each looking after the trees on and in front of his own property or residence.

To kill the insects, spray the ground under the tree and the trunk and lower branches if possible, with a soap or mechanical emulsion of kerosene and water, containing 10 per cent. of kerosene. This will kill all pupæ with which it comes in contact, and will not injure the trees or grass. Whale oil and common soaps are also effective if dissolved in water (one pound in five gallons) and applied as a spray. If a pump is not available, the soap solution may be sprinkled on the insects with a watering pot. By prompt and thorough concerted action on the part of both public officials and residents, much can be done in this way to prevent injury to the elm trees next season.

W. E. BRITTON, *State Entomologist.*

Before the publication of the above notice the writer had been asked to visit Norwich and look into the condition of the trees. The trip was made on July 16th, and the trees were found to be in a serious condition. The writer was taken through the principal streets by Mayor Thayer and Mr. W. F. Blackstone, two gentlemen much interested in the welfare of the trees.

A defective gas main had been laid, and afterwards replaced, for a distance of about one and one-half miles of the chief residential street of the city, and along this street many trees had died.

That the escaping gas killed many trees, there can be no doubt. Many fine elms on Broadway were dead and many others had lost their foliage, though the wood seemed to be still alive. Nearly all the elms appeared to be unthrifty. The maples, on the other hand (the street contains both elms and maples), were fairly thrifty, and the fact that these were not killed by gas led the writer to conclude that the elm leaf-beetle was to a considerable extent responsible for the damage. It is well known that illuminating gas escaping from pipes beneath the surface of the ground will kill any kind of a tree, and it has not been observed that the maple is less susceptible to its effect than other trees.

After a thorough inspection of the trees in Norwich, the writer was asked to make an additional statement for publication that would apply more particularly to local conditions. The following, therefore, was given out and appeared in the Norwich evening papers:

A personal examination of the elm trees along some of the principal resident streets of Norwich shows that the elm beetle has caused a great deal of damage this season. The caterpillars are now coming down the trees in large numbers, and should be destroyed immediately. A week or ten days from now the adult beetles will come forth and fly away. Hence immediate action is necessary. Spraying the trunks and larger branches of the trees, and also the ground under the trees, with kerosene, using either the soap emulsion or the mechanical mixture, each containing 10 per cent. of kerosene, is the best means of killing the beetles in this stage.

Kerosene emulsion may be prepared with soap as follows: Take one-half pound common hard soap and dissolve in boiling water. While this is still hot, add one gallon of kerosene and stir violently or churn it through a force pump for about five minutes, until the whole forms a creamy mass, which thickens upon cooling. For use, dilute nine times with cold water.

The mechanical mixture is made by using a special form of pump, which mixes the two liquids under pressure. The trees along Broadway have unquestionably been injured by gas escaping from the main. They have also suffered great injury from the beetles, and the combined effect of gas and beetles has killed some of the trees. All residents should coöperate with the city authorities to kill as many of the beetles as possible right away.

It is hoped that the municipal authorities of Connecticut will be on the alert the coming season, and in readiness to spray the elm trees with poison if the beetles should be dangerously abundant, and thus prolong the lives of the trees, which, with their various other troubles, already have a precarious existence.

A SERIOUS INJURY TO HICKORY TREES BY THE HICKORY BARK BORER.

Scolytus quadrispinosus Say.

On August 1st, in answer to a request, the writer visited "Sachem's Wood," New Haven, to examine the hickory trees, which were in an unsatisfactory condition.

Many trees had died, and many more were fast losing their vitality. The foliage was falling from the supposedly healthy trees and the ground was literally covered with fresh and dried leaves. The many dead leaves still on the trees gave them a brown and scorched appearance. An examination of the twigs revealed great numbers of small black beetles, nearly one-fourth of an inch in length, which were boring holes in the axils of the compound leaves (see fig. 2), cutting them off in many cases so that they fell to the ground. In some instances the twig was eaten to such an extent that it broke off (see Plate VIII, b). The trunks of the dead and dying trees were the breeding grounds of the beetles, and larvæ, pupæ, and adults were numerous under the bark. The adults were emerging from the bark through small circular holes, which were so abundant that the tree appeared to have been filled with shot.

Specimens were sent to Washington for identification, and the beetle found to be *Scolytus quadrispinosus* Say. The late Dr. C. V. Riley studied this insect in Missouri in 1872, and believing it to be a new species, described it as *S. caryæ*.* Later it was found to be identical with Say's *quadrispinosus*.

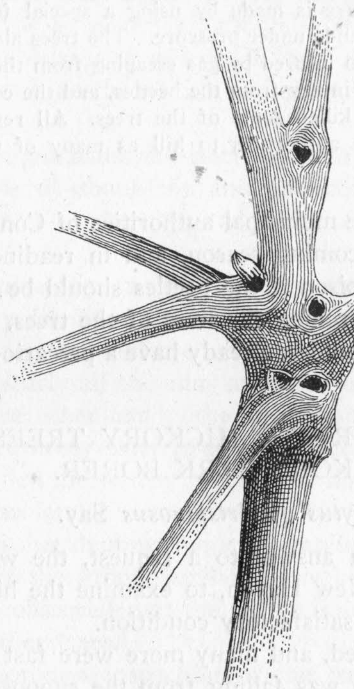


Fig. 2.—Hickory twig, showing where the beetles have made tunnels in the axils of the compound leaves. *Drawing made from an original photograph.*

The following account of the method of attack is copied from Dr. Riley's report:

"Boring through the bark, the insect forms a vertical chamber next to the wood, from half an inch to an inch in length, on each side of which it deposits its eggs, varying in number from twenty to forty or fifty in all. The larvæ, when hatched, feed on the inner bark, each one following a separate track, which is marked distinctly on the wood. Some trees contain them in such numbers that the bark is almost entirely separated from the wood. In many cases the upper part of the tree is killed a year or two before the lower part is attacked. . . . Both sexes bore into the tree—the male for food, and the female mostly for the purpose of laying her eggs. In thus entering the tree, they bore slantingly and upward, and do not confine themselves to the trunk,

* Fifth Annual Report, State Entomologist of Missouri, p. 103, 1873.

but penetrate the small branches and even the twigs. The entrance to the twig is usually made at the axil of a bud or leaf, and the channel often causes the leaf to wither and drop, or the twig to die or break off."

Packard* considers this the most destructive bark borer attacking the hickory.

Both sexes are dark brown or nearly black, the thorax darker than the wing-covers. There are numerous hairs upon the head, forming a brush which may perhaps be useful in cleaning out the galleries. This brush is more strongly developed in the male than in the female and is well shown in the left hand figure of the beetle on Plate VIII, a. Thorax and wing-covers are about equal in length, and the abdomen, which is shorter than the wing-covers, is truncated in a peculiar manner. The abdomen and thorax are more or less hairy on the ventral surface in both sexes, and some specimens have dorsal hairs on the front portion of the thorax and at the posterior extremity of the wing-covers.

On the end of the truncated abdomen, in the male there are four spines, which fact evidently suggested the specific name. The female, however, is not provided with these spines and the ventral portion of the abdomen is smooth. The beetles vary considerably in size in both sexes. Those examined by the writer were somewhat larger than the specimens studied by Riley and described as *S. caryæ* in the Fifth Report of the State Entomologist of Missouri, page 107. Riley gives the length as from .15 to .20 inch, while the specimens which the writer observed varied from .20 to .25 inch.

The brood gallery, which is formed between the bark and the wood, consists of a short vertical tunnel from which branch at right angles from twelve to seventeen smaller galleries on either side. These side tunnels are excavated by the young, each making a separate burrow, and though often very near each other never seem to cross, and are nearly parallel on each side of the central chamber. As the larvæ increase in size the tunnels diverge somewhat so as not to run into each other.

Miss Hillhouse states that 110 dead and dying trees were marked and cut, and that later several more were removed from the grove. From what we know of the habits of the *Scolytidae*,

* Fifth Report, U. S. Entomological Commission, p. 285, 1890.

it hardly seems probable that the beetles attacked perfectly sound trees in the beginning. But wherever a tree is injured by accident or weakened by any cause, an excellent breeding-place for the beetles is formed. In the summer of 1900, the drought was extremely severe in the vicinity of New Haven, and many trees suffered. The writer observed several hickories in the city parks that lost some of the branches or the entire top. The hickory trees on the Hillhouse place are in part situated on a dry knoll and it seems probable that some of these were injured by the drought. These injured trees were attacked by the beetles, which multiplied to such an extent that the adults in search of food attacked the twigs and branches of the more vigorous trees, thus weakening them sufficiently to enable the species to breed in the trunks. Finally a large number of good trees perished.

It was recommended that as many of the insects as possible be destroyed in the wood and bark of the trunk and that the remaining trees be kept in the best possible state of vigor by fertilizing, removing dead wood, etc. It is doubtful whether anything more than general preventive measures can be employed against these bark borers. Possibly in case of a severe attack upon thrifty trees it might be worth while to spray the foliage, twigs, and branches, as well as the bark of the trunk, with a thick whitewash to which Paris green had been added. Some of the beetles thus might be killed while feeding upon the twigs or when tunneling into the bark of the trunk to make the brood galleries.

SEVERE ATTACK OF THE FALL WEB-WORM.

Hyphantria cunea Drury.

The fall web-worm was very abundant during the season of 1901, and during August and September defoliated a great many trees including nearly all kinds of fruit, shade, and forest trees. The attack was not local, but extended all over the State and into Massachusetts and New York.

In September the writer observed defoliated trees in the forests along the Shepaug river valley, along the Air Line and Shore Line railroads, and through the central portion of the State. Along the Northampton railroad, many trees had lost their leaves, and at New Canaan several hickory trees were bare the last of September. One of these is shown on Plate IX. Elms, birches, sycamores, and hickories were attacked at Simsbury and it seemed to make very little difference what the kind of tree.

The young caterpillars spin a web around two or three leaves and feed within the web, eating away the green portion of the leaf, the frame-work remaining. As the larvæ increase in size the entire branch is included in the web and the entire substance of the leaves is devoured, including veins. The fall web-worm is an American species and occurs all over the eastern part of the United States. It is not at all particular as to its food plants, and Howard states that the records of the Division of Entomology show about 120 species of forest, shade, ornamental and fruit trees upon which it feeds.* There are said to be two broods each year south of New York. The writer has not followed out the life-history of the species, but the observations made during 1901 indicate that it was also double-brooded in Connecticut.

It is an easy matter to remove the nests when small, from fruit trees, by cutting off the ends of the branches. Even this will be unnecessary if the foliage is kept well poisoned until late in the season.

COMMON SOAP AS AN INSECTICIDE.

It has long been known that soap-suds are useful in destroying plant lice, and the housewife as well as the gardener and florist has used them on plants with success. Our experience with soap as an insecticide began in the greenhouse by using "Ivory" soap, one-fourth pound dissolved in one gallon of water, and applied to chrysanthemums to kill black lice, to *Ageratum* to destroy *Aleyrodes* or white fly, to carnations to kill red spider, and to cinerarias, *Hibiscus* and cigar plant (*Cuphea*) to kill green lice. Whether the plants were dipped or whether the suds were applied as a spray, they destroyed the insects, but some of the plants were injured.

The mixture was then diluted one-half, and on January 12th all the carnation plants were sprayed to kill red spider, with satisfactory results. Wherever the spray came in contact with

* Farmers Bulletin, No. 99, p. 20, U. S. Department of Agriculture.

it, red spider was killed. But it is well nigh impossible to thoroughly cover thick-growing plants, so some lived to perpetuate the pest in the house. Later the plants were given a careful spraying once each week, and red spider was kept in check nicely even where it had thoroughly infested the plants. Lice and *Aleyrodes* were readily killed by the mixture, which is not only easily prepared but lacks the disagreeable odor peculiar to many insecticides, especially whale-oil soap and tobacco water.

As the soap does not dissolve readily in cold water, the best method is to cut the soap in thin slices and dissolve in boiling water, then add enough cold water to make the right proportions. The mixture thickens to a jelly-like substance on cooling and must therefore be applied warm. It may be sprayed upon the plants, or small potted plants may be dipped into a pailful of the mixture.

Bars of fresh "Ivory" soap were found to have an average weight, exclusive of the wrapper, of 258 grams, or about 9 ounces, while the small size weighed 152 grams, or 5.3 ounces. Thus in common practice, the soap need not be weighed nor the water measured, but half of a cake of laundry size or four-fifths of a small-sized cake will answer for a pailful. The common-sized pail holds two and one-half gallons when filled to the brim, but it cannot be conveniently carried if charged with more than two gallons.

"Welcome" soap was next given a trial and found to be fully as effective as "Ivory" when dissolved in the same proportions, and to dissolve somewhat more readily. It does not thicken as quickly on cooling. The bar of laundry-size weighs 317 grams, or about 11 ounces. One of these cakes may therefore be divided into three pieces and each dissolved in a pail of water.

The tomato house has each winter for several years been infested with white fly (*Aleyrodes vaporariorum* West.) and many remedies have been used, none of which have proved more effective than soap and water. Fir-tree oil was equally so, but is too expensive for general use. The tomato plants were sprayed about every week for three months with "Welcome" soap dissolved in water at the rate of one pound in 8 gallons. The spray seemed to kill all larvæ and adults with which it came in contact. During the operation many adults fly from the plants, but are hit by the spray when in mid-air and killed.

Continued applications of soap and water to the tomato plants for three months, without washing off the soap, finally coated the leaves to an injurious extent and the practice was abandoned. Other kinds of plants which were frequently sprayed with water from the hose were uninjured, and it is apparent that the long-continued use of the soap without washing it off is the reason for the injury. We still use this remedy for the same purpose, but either do not apply it so frequently or else the plants are sprayed occasionally with clear water.

Since then soap and water has been used here to kill *Aphis* on apple, plum, and cherry trees, and a great variety of plants, *Lecanium* on ferns, red spider, thrips, and newly-hatched scale-insects, especially oyster-shell and scurfy bark-louse, and San José scale. It is not effective in killing the mature individuals which are covered by the shell or armor, but readily kills the newly-hatched individuals.

Doubtless any laundry soap would answer the purpose quite as well as the kinds used, and for effectiveness, cheapness, convenience and cleanliness in preparing and using, soap and water should take a high rank among contact insecticides, especially for use in dwellings, greenhouses and gardens.

MISCELLANEOUS INSECT NOTES.

The Saddle-back Caterpillar—Empretia stimulea Clem.—was more abundant than usual and was observed in several localities. The caterpillar is dark-brown in color with a light green blanket or "saddle" upon its back, with a circular brown spot in the center. This spot is surrounded by a narrow ring of white. There is a light-green spot near the anterior end and three such spots near the posterior end of the body. There are two fleshy appendages covered with spines near each end, and a row of spiny tubercles along either side of the body. These spines are poisonous to the touch. This insect belongs to the family *Limacodidæ*, the larvæ of which have no legs and are called "slug-caterpillars." The adult is a brown moth. The caterpillars, which are usually not very abundant, feed upon the leaves of the apple, pear, and other fruit trees. Spraying with Paris green is the remedy.

The Hag-moth Caterpillar—Phobetron pithecium, S. & A.—is another of the "slug-caterpillars" and feeds upon the foliage of apple and pear. This was also comparatively abundant the past season, as it is not usually a common insect here. In some respects this caterpillar is even more curious than the saddle-back caterpillar. Instead of being furnished with spines, there is a row of curious fleshy appendages along each side of the body and a double line of rosettes on the back, all brown in color. Lintner states* that there are four appendages on each side of the body, but I have found them very irregular in number, size and shape. But as the appendages are very easily detached, it is quite possible that some had been broken off. The adult is a yellowish-brown moth, having a wing-expanse of about one inch. The male is smaller than the female and varies slightly in color. This species is too rare to do much damage, but the foliage can be protected from it by coating the leaves with Paris green or some other arsenical poison.

The Red-humped Caterpillar—Œdemasia concinna S. & A.—feeds on the foliage of fruit trees, often defoliating them. The common name was suggested by the fact that the fourth segment of the body of the caterpillar forms a dorsal projection or hump and is of coral-red color. Plate X a, shows this caterpillar in its characteristic position with tail elevated. The body is striped with yellow, black, and white, and the segments bear spines.

In length, the caterpillars vary from one and one-fourth to one and one-half inches. The adult is a light-brown moth, having a wing-expanse of over an inch. There is only one brood each year. The arsenical poisons are a remedy where this caterpillar is abundant.

The Yellow-necked Caterpillar—Datana ministra Drury—was more abundant in Connecticut during 1901, than for several years. All kinds of fruit trees were defoliated and the species also attacked forest and shade trees. Young trees seem to be preferred by this insect. The larvæ are gregarious when young, and may often be seen in large clusters containing thirty or forty.

Except when feeding, the head and tail of each larva is elevated as shown in the illustration, Plate XI, b.

* Fifth Report, N. Y. State Entomologist, p. 184.

The caterpillars are about one and three-fourths inches long and striped with yellow and black. Their bodies are covered with long scattered hairs. The adult is a light-brown moth with dark-brown markings on the fore wings, and has a wing-spread of about two inches. There is one brood each year and the larvæ appear during August and September. On account of the gregarious habit of the caterpillars, it is an easy matter to cut off the twig upon which they are feeding, and this can be done while they are small and before much injury is done. They may then be crushed or burned. They may also be destroyed by applying kerosene to the soft-bodied caterpillars when clustered on the twigs. Fifteen per cent. of kerosene in water, applied with a "kerowater" pump, will not injure the foliage.

If the leaves have been sprayed with Paris green, they will not be injured by this insect.

The Walnut Caterpillar—Datana integerrima G. & R.—was more common than usual the past season. Black walnut, butternut, and hickory are the favorite food plants of the species, and the writer observed hickory trees attacked in New Haven, entirely defoliated in North Haven, and butternuts partially defoliated in Milford. Specimens were received from Morris Cove, East Haven, where the caterpillars were feeding upon the foliage of black walnut shade trees. The caterpillars are gregarious like the yellow-necked caterpillar when feeding upon the branches. When full grown they gather in large numbers upon the trunks of the trees.

The larvæ are from one to one and one-half inches long, body black, with long whitish hairs. Specimens were sent to Dr. H. G. Dyar of the United States National Museum at Washington, D. C., and he reported the species to be *D. integerrima.* It is often mistaken for *D. angusii,* but Dr. Dyar states that the latter is comparatively rare, while the former is the common one on walnut and hickory trees.

A small striped beetle—Chrysomela elegans Oliv.—attacked the leaves and flower stems of *Coreopsis lanceolata* growing in the writer's garden during the first week in June. Hand-picking was practiced every morning for about a week, and from a few plants a large number of beetles were gathered. These fed upon the leaves mostly, though the stems and petals and calyx lobes of the blossoms were not unmolested. Among the beetles collected, there were a few specimens of *C. similis* Rog., feeding with *C. elegans,* but only one of the former to fifty of the latter.

Poisoning the foliage would of course preserve it, but hand-picking is the best remedy in a small flower garden.

The Orange Dog Caterpillar—Papilio cresphontes Cram.—was quite abundant during the season, and the caterpillar was found feeding upon the leaves of orange trees placed out of doors and of the gas plant, *Dictamnus fraxinella,* of gardens. It is a curious caterpillar of chocolate-brown and cream colors. The adult is a large black and yellow swallow-tail butterfly, closely allied to our celery butterfly, and is common in the Southern states. Only two specimens have been previously taken here during the past seven years. Connecticut is about the northern limit of the species.

The European giant hornet—Vespa crabro L.—was sent to the Station in September from Whitneyville, where it was reported as causing considerable injury to ripe pears by eating into them. Specimens were sent to Washington, and the identification verified. The species was brought into this country many years ago, and became established near New York City. It has since spread very slowly and even now is not found very far from the place where it was first discovered. It is occasionally seen in New Jersey and on Long Island. It was quite common on pears in the garden at the Station late in the season. It will probably not become sufficiently abundant to do much injury.

The green pea louse—Nectarophora pisi Kalt.—was considerably less abundant than in 1900 and 1899. In Connecticut it does not appear on peas until about June 1st, and the early varieties are then well along toward maturity and are not very seriously injured. The late varieties and the sweet peas are nearly ruined. Pea vines may be saved in the garden by spraying with kerosene emulsion or soap and water, but this is too expensive for the field, and there mechanical methods must be employed.

Brushing the vines and knocking off the lice just before cultivating seems to be the most practicable of any means yet devised of holding this pest in check.

The pear psylla—Psylla pyricola Först.—caused less injury during the past season than for several years. Expecting another attack, we prepared for it by spraying all the pear trees at the Station on June 4, with kerosene and water (15 per cent. kerosene) mechanically mixed. The trees were not injured in the slightest, and unquestionably many of the insects were killed, though not present in dangerous numbers.

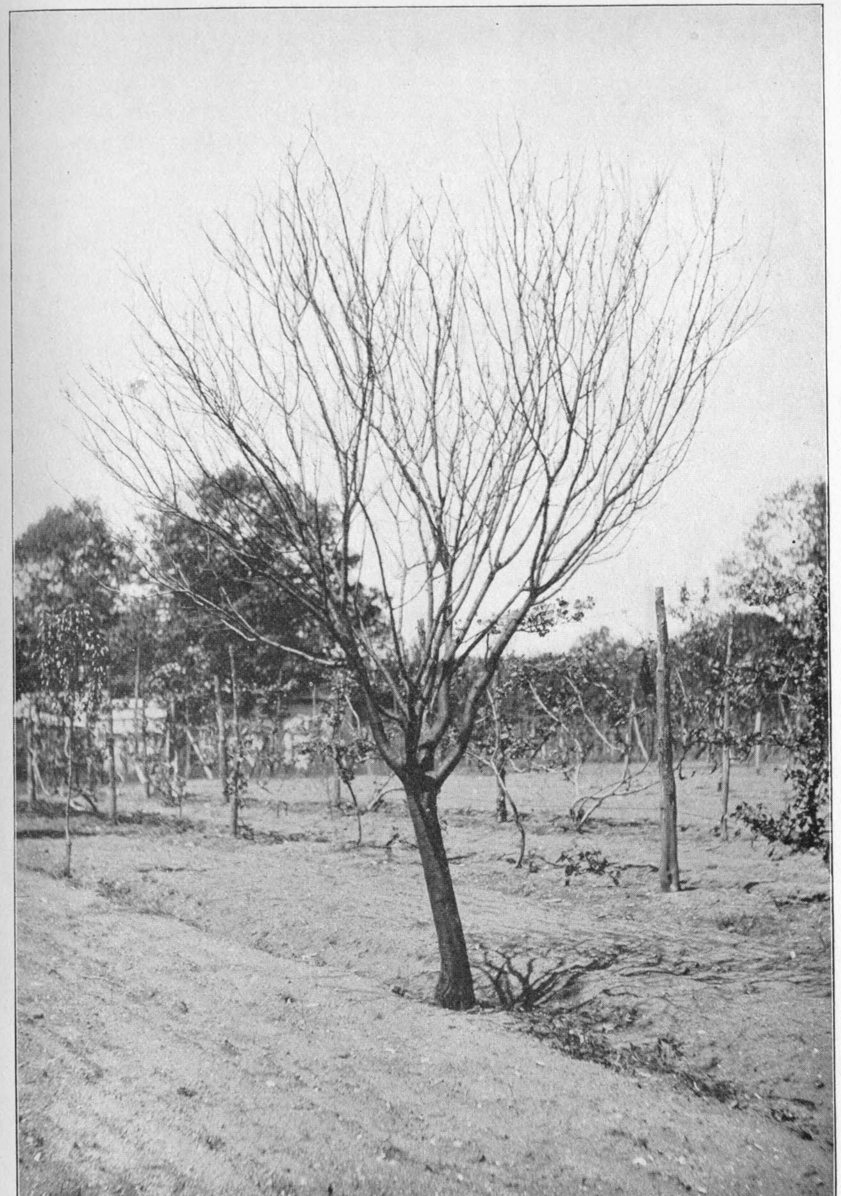
The tulip tree scale-insect—Lecanium tulipiferae Cook.—is becoming quite common on wild and cultivated tulip trees about the State. The females are nearly one-third of an inch in diameter when full-grown, are hemispherical in shape and of a dark-brown color. The males are much smaller, light-grey in color and more elongated. After the adult males emerge, the empty shells remain upon the twigs. There is only one brood each year. The species seems to be viviparous, and the young appear about September 1st. These live through the winter in a partially grown stage. The lower branches of the tulip tree are the ones first affected, and as these are killed, those higher up are attacked. Honey dew is given off and in this substance grows a fungus which blackens the twigs and leaves. The magnolia is also a food plant of this species of *Lecanium.* A thorough spraying with soap and water, one pound dissolved in eight gallons, should free shade trees from this insect.

The snowy tree cricket—Œcanthus niveus Harr.—is very abundant throughout the State and causes slight injury to raspberry and blackberry canes by laying eggs in them. The canes often break off at the point where the eggs are deposited. Berry canes are not the only twigs selected by the insect for ovipositing, for the writer has found the eggs in grape-vine canes, and in the twigs of fruit trees. In some of the nurseries last fall they were common in peach branches, and apple twigs have frequently been chosen for the purpose. The adult insect feeds principally upon animal matter and therefore does not injure plants. There is no way to prevent the injury caused by egg-laying, but the twigs should be gathered in early spring and destroyed.

The maple borer—Plagionotus speciosus Say—is a serious enemy of maple trees in New Haven. On Prospect street especially, some young trees have been ruined and many severely injured. The adults emerge about the first of July, and for two weeks may be found on the trunks and larger branches of the trees, where they are laying eggs. The eggs soon hatch and the young larvæ begin to tunnel in the trees, usually eating partly in the bark and partly in the sap-wood, pursuing an upward spiral course. Sometimes two or more tunnels combine to girdle the tree. Shade trees should be examined during each September and the borers destroyed. Their presence is indicated by the castings or sawdust and the larvæ may be dug out, or killed by inserting a few drops of carbon bisulphide and stopping up the hole.

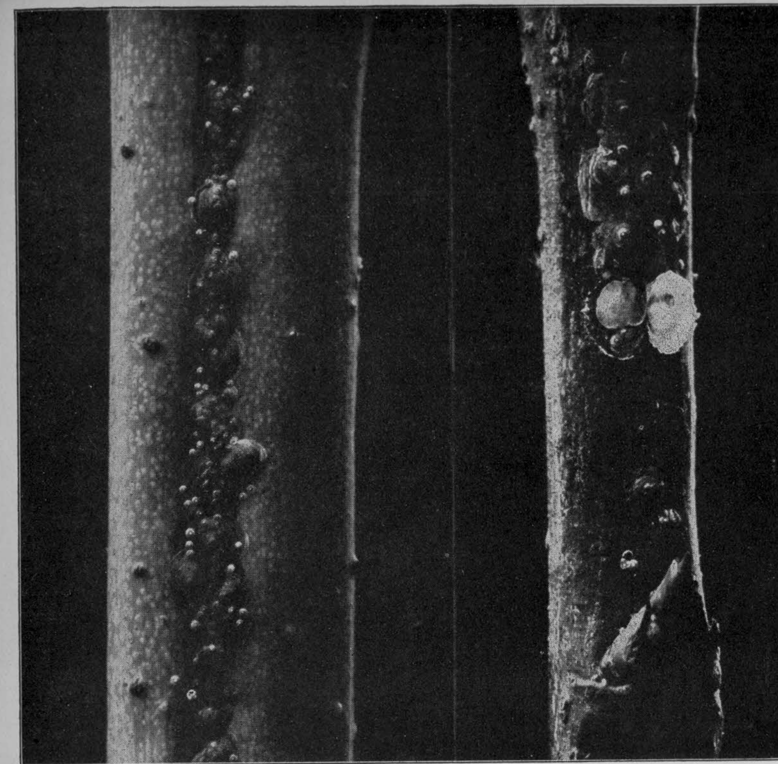
"Moth traps"—Manufacturers of certain kinds of "moth traps" have advertised extensively in the papers, claiming that orchards and gardens can be kept free from pests by the use of their devices for catching insects.

By these claims they have been able to sell many traps to orchardists and farmers. Several official entomologists, as well as other experimenters, have at different times and places made careful tests of "trap lanterns," "moth traps," etc., and the results of the trials disprove many of the manufacturer's claims. In some cases the traps caught more beneficial than injurious insects and therefore reputable entomologists have no hesitation in stating that more harm than good may be done by employing these "moth traps." Certainly such contrivances cannot be substituted for the ordinary spraying operations to fight insects in orchards.

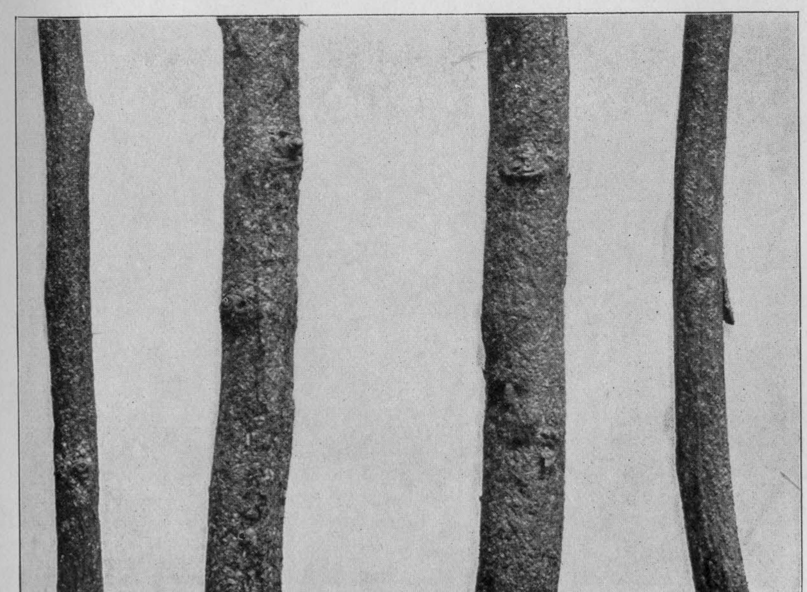


Plum Tree killed by the San José Scale-Insect. *Photo. by W. E. Britton.*

Peach Tree severely injured by the San José Scale-Insect. *Photo. by W. E. Britton.*

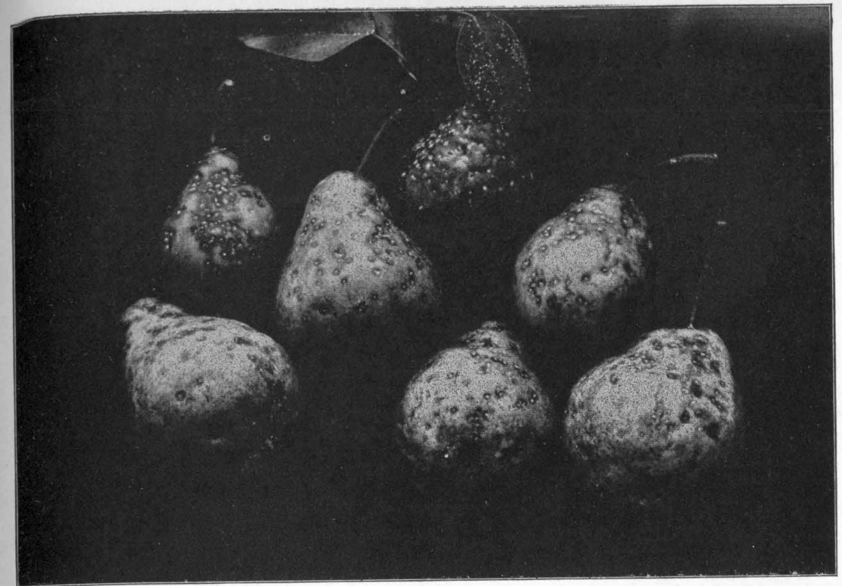


(*a*) Infested Peach Twigs. Mature females and young scales clustered in a groove of the twig may be seen at the left. A female with the shell or covering raised is shown at the right. Considerably enlarged. *Photo. by H. A. Doty.*

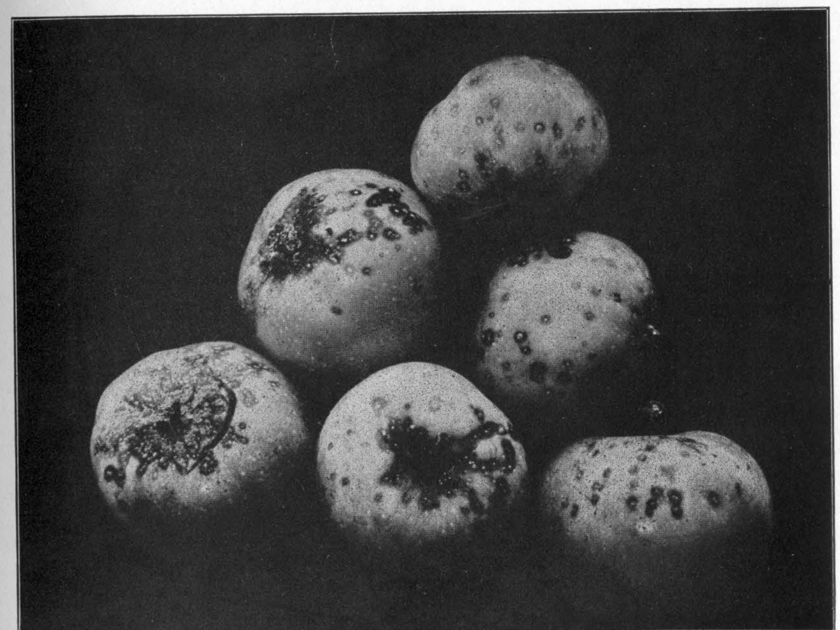


(*b*) Plum Twigs nearly coated over by San José Scale. Natural size. *Photo. by W. E. Britton.*

Appearance of Infested Twigs.

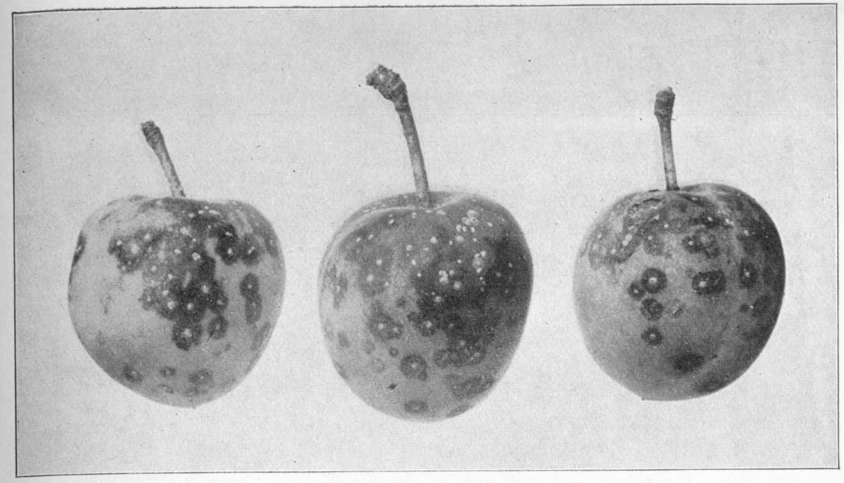


(*a*) Pears badly infested. *Photo. by H. A. Doty.*

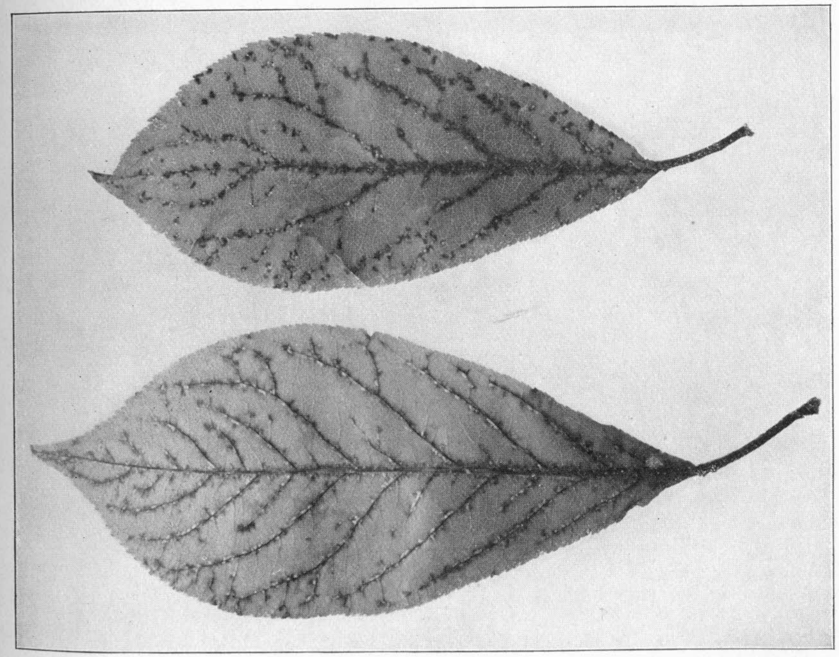


(*b*) Infested Apples showing the discoloration around the Insects. *Photo. by H. A. Doty.*

Appearance of Infested Fruit.



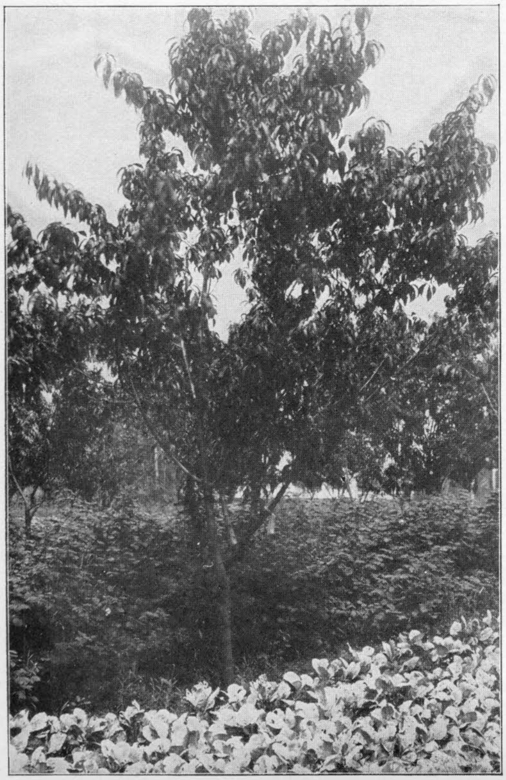
(*a*) Plums showing the reddish discoloration caused by the Insects. *Photo. by H. A. Doty.*



(*b*) Leaves, showing the tendency of the Insects to locate near the veins. *Photo. by H. A. Doty.*

Infested Leaves and Fruit of Japanese Plum.

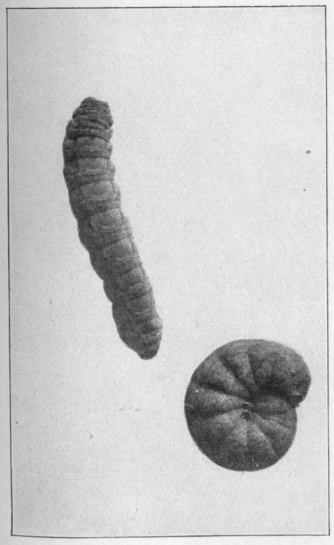
PLATE VI



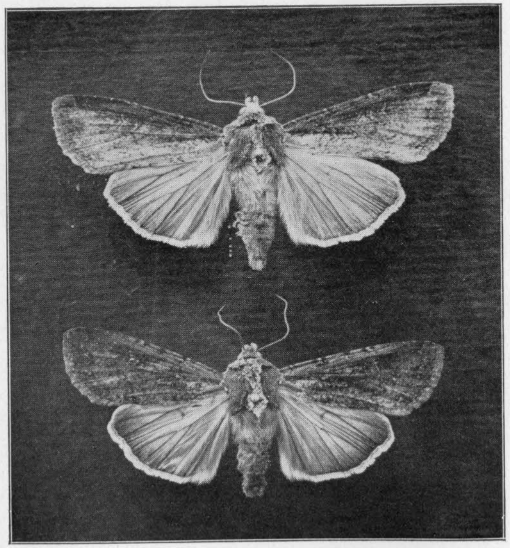
(*a*) Peach Tree sprayed April 12th, with a mechanical mixture of kerosene and water, containing 20 per cent. of kerosene. *Photo. in July by W. E. Britton.*

(*b*) Peach Tree sprayed April 12th with crude petroleum. *Photo. in July by W. E. Britton.*

(*a*) Buds injured by the cut-worm. *Photo. by W. E. Britton.*

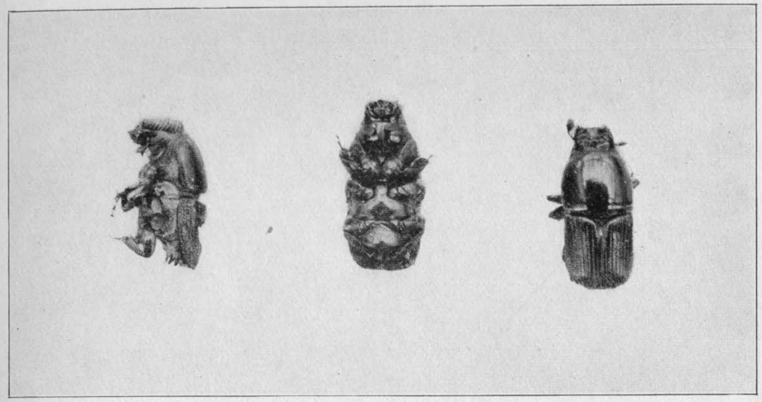


(*b*) Cut-worms or larvæ.
Photo. by W. E. Britton.

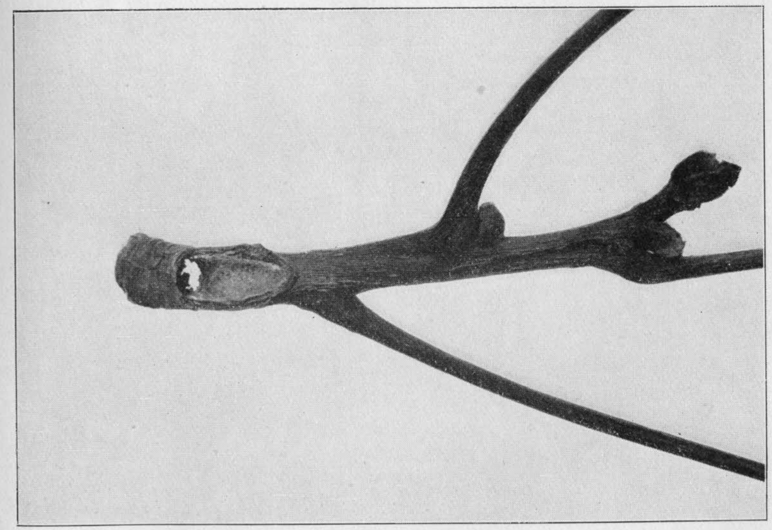


(*c*) Moths or Adults.
Photo. by H. A. Doty.

The Variegated Cut-Worm (Peridroma saucia) and its injury to Carnations—Figures all natural size.

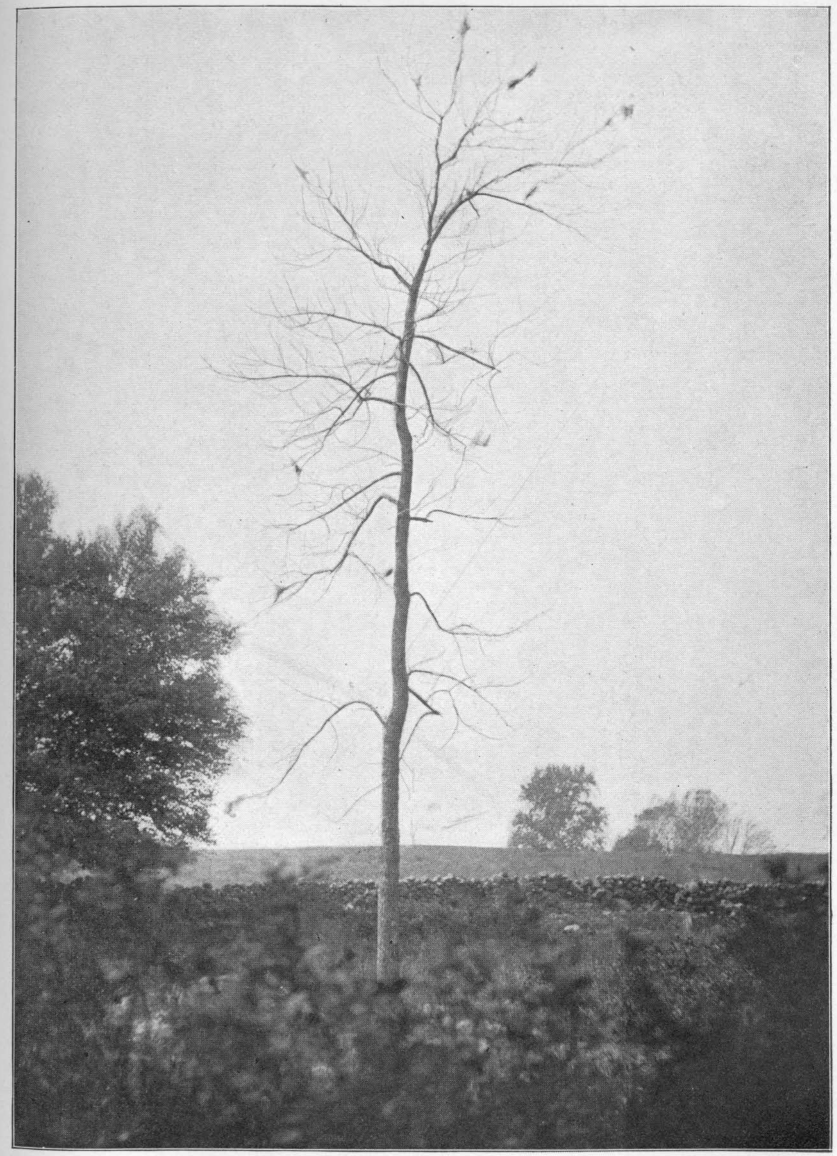


(*a*) Adult Beetles. Considerably enlarged. *Photo. by H. A. Doty.*

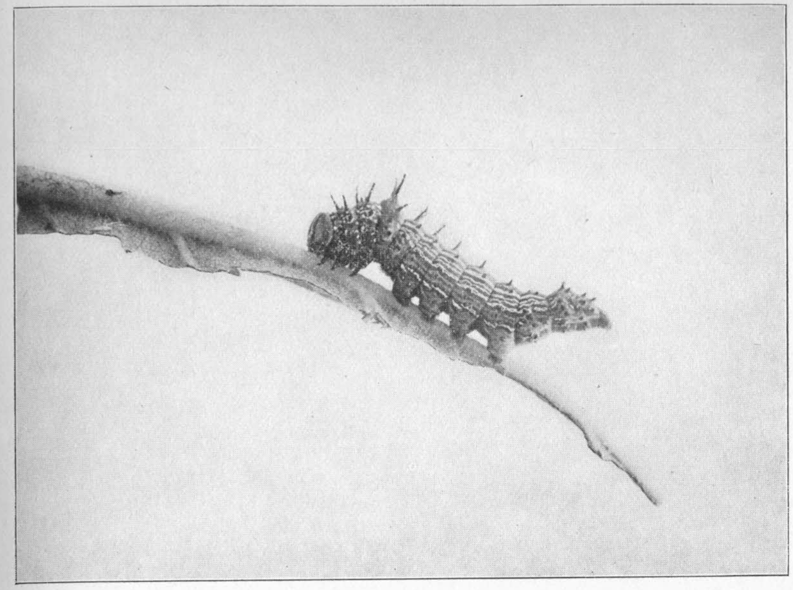


(*b*) Hickory twig cut off by the beetles. Natural size. *Photo. by H. A. Doty.*

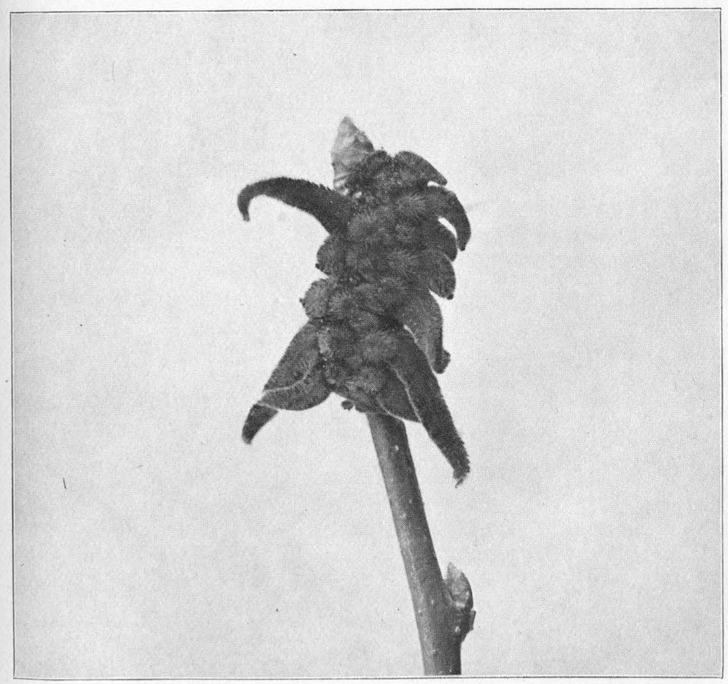
The Hickory Bark Borer (Scolytus quadrispinosus) and its work.



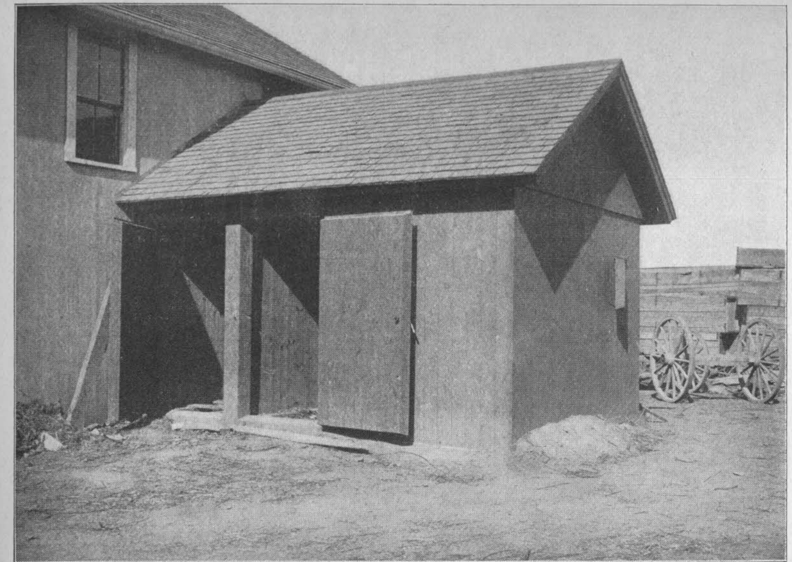
Hickory tree defoliated by the Fall Web-worm *(Hyphantria cunea)*.
Photo. by Mr. Tuttle.



(*a*) The Red-humped Caterpillar (*Œdemasia concinna*) in characteristic feeding position. Natural size. *Photo. by H. A. Doty.*



(*b*) The Hag-moth Caterpillar (*Phobetron pithecium*). Slightly enlarged. *Photo. by H. A. Doty.*



(*a*) A Connecticut fumigating house. *Photo. by W. E. Britton.*

(*b*) The Yellow-necked Caterpillar *(Datana ministra)* in characteristic attitude. The caterpillar at the left is full-grown: those in the cluster are half-grown. Natural size. *Photo. by H. A. Doty.*

EXAMINATION OF APPARATUS FOR DETERMINING BUTTER-FAT IN MILK AND CREAM.

By A. L. Winton.

The General Assembly at the January session 1901, passed the following:

AN ACT

Concerning the Purchase of Milk and Cream.

General Assembly,
January Session, A.D. 1901.

Be it enacted by the Senate and House of Representatives in General Assembly convened:

Section 1. No person or corporation buying or purchasing milk or cream and making payments therefor based on the results of the Babcock test shall use any bottle or pipette for the purpose of determining the relative or proportional amount of butter fat of any milk or cream, unless such bottle or pipette shall have been tested and stamped as accurate by the Connecticut Agricultural Experiment Station or by the Connecticut Agricultural College.

Sec. 2. Every person or corporation that shall use any bottle or pipette for the purpose named in section one of this act, unless the same is stamped as therein prescribed, shall forfeit to the use of the state the sum of five dollars for each bottle or pipette so used. It shall be the duty of the state's attorneys in the several counties to collect forfeitures under this act.

This act was approved June 3d, and on June 6th, a copy of the law was mailed by the Station to every creamery in the State, with the following note of explanation:

The Connecticut Agricultural Station will test and stamp bottles and pipettes which are used by persons and corporations within Connecticut for the purpose named in the above act, under the following conditions:

The apparatus to be tested should be sent in a package, bearing on the outside the name of the shipper with all charges prepaid. A letter should be sent at the same time addressed to the Agricultural Station, New Haven, Conn., advising of the shipment, and stating *what kind of apparatus has been sent and the number of pieces of each kind.*

The glassware will be returned by express, at the expense of the owner.

The Station will use all care in packing, but will not be responsible for any loss by breakage in shipment.

The apparatus will be tested as promptly as possible, and in the order in which it is received.

Each piece found to be accurate will be marked: "Ct. Ag. St." Each piece found inaccurate will be marked: "Bad."

Until further notice, this work will be done without charge.

It is absolutely necessary that all apparatus should arrive in perfectly clean and dry condition.

If not in this condition, the Station cannot test it.

E. H. JENKINS, *Director.*

METHODS OF TESTING AND MARKING THE APPARATUS.

The methods used are those described by Farrington and Woll.*

(A.) MILK AND CREAM TEST BOTTLES.

1. *Calibration with mercury.* A weighed quantity of pure mercury, corresponding to the total number of fat per cents. marked on the scale (27.18 grams for 10 per cent. milk bottles, 81.54 grams for 30 per cent. cream bottles, etc.), is introduced into the clean dry bottle to be tested and the neck is closed with a soft cork of uniform diameter. The bottle is then inverted and the length of the mercury column compared with the total length of the graduated portion of the neck; directly, if the cork has been introduced to the first line of the graduation, otherwise by means of accurate dividers.

The operation is repeated with a half quantity of mercury.

As the top of the mercury is a meniscus and the bottom, adjoining the cork, a plane: the total length of the column ought to be a little more than that of the corresponding graduation. The necessary correction, which varies with the tube diameter, may be ascertained by experiment or from the table of Winkler.†

2. *Calibration with a measured quantity of water.* The bottle is filled with distilled water so that the bottom meniscus is at the zero mark of the scale. The neck above the liquid is carefully dried with a piece of filter paper. A measured quantity of water, corresponding to the total number of fat per cents. marked on the scale (one, two or three c.c. at a time) is drawn into the neck from an accurate burette, comparing the bottom meniscus with the scale after each addition. The volume

*Testing Milk and its Products. Madison, 1897, pp. 43-47.

† Ztschr. anal. Chem. **40**, 403.

marked off for 5 per cent. of fat, both on milk and cream bottles, should be exactly one c.c.

Two burettes are used, one for milk bottles, the other for cream bottles, each having approximately per unit of length, one-half the cubic capacity of the neck of the bottles to be tested.

3. *Calibration with a weighed quantity of water.* The bottle, filled to the zero mark with distilled water, as described for Method 2, is weighed on a chemical balance. Distilled water of the same temperature, sufficient to fill half the graduated portion of the neck (or any other desired fraction) is then added and the bottle weighed again. After filling to the top mark of the scale, a third weighing is made. Each 5 per cent. of the scale should correspond to 1 gram of water at 15.5° C.

Method 1, although it has the advantage that the mercury does not wet the glass, is complicated by the fact that the bottom of the column is a plane and the top a meniscus varying in curvature with the diameter of the neck. Method 2 is free from this difficulty, but is too laborious for ordinary use. In our experience, Method 3 is not only accurate, but the most convenient of the three, as no correction for temperature or meniscus is required and the accuracy of different portions of the scale may be determined by one measured portion of water. It has been our practice to test bottles first by Methods 1 or 3, and re-test those found bad or doubtful by Method 2.

Milk bottles with an error less than 0.2 per cent. for the whole graduation, and cream bottles with an error of less than 0.5 per cent. for 30 per cent. graduation, are passed as accurate, provided the tube is uniform in diameter and correctly marked.

(B.) PIPETTES.

The pipette, which has previously been thoroughly cleaned and dried, is tightly closed at the lower (constricted) end with the finger and filled to the mark with water from an accurate burette. If the volume of water used is within 0.2 c.c. of the required volume (17.6 c.c. for milk and 18 c.c. for cream pipettes) the pipette is considered accurate. Pipettes found inaccurate by this method are re-tested by determining the weight of water at 15.5° C. required to fill them to the mark.

(C.) MARKING APPARATUS.

The glassware is marked by the sand-blast, following in all essential details the process devised by Mr. C. H. Jones, Chemist of the Vermont Experiment Station, to whom we are indebted for many valuable suggestions.

Operating in this way, we were generally able to test, mark and return invoices of glassware within forty-eight hours after their receipt.

COMPLIANCE WITH THE LAW.

The following individuals and creameries, in compliance with the law, have sent apparatus used in testing milk or cream by the Babcock method to be examined at this Station:

Andover Creamery Co.	Andover.
Aspetuck Valley Creamery	Northville.
Milo D. Beach	Litchfield.
Bosrah Creamery	Fitchville.
Bridgewater Hills Creamery Co.	Bridgewater.
A. A. Brush	New Fairfield.
Canton Creamery Association	Collinsville.
Colchester Creamery Association	Colchester.
East Canaan Creamery	East Canaan.
East Haddam Creamery Co.	East Haddam.
Ellington Creamery Co.	Ellington.
Glastonbury Creamery Co.	Glastonbury.
Goshen Creamery Co.	West Goshen.
Granby Creamery Co.	Granby.
M. B. & F. S. Hubbell	New Haven.
Geo. C. Ives	Torrington.
Jewett City Creamery	Jewett City.
Lebanon Creamery Co.	Lebanon.
Ned's Brook Creamery Co.	Canton.
New England Dairy Co.	New Haven.
Edward Norton	Goshen.
Pomperaug Valley Creameries	Pomperaug Valley.
J. B. Sanford	Redding.
Riverside Creamery Co.	Warehouse Point.
Scotland Dairy Co.	Willimantic.
Simsbury Dairy Co.	West Simsbury.
Somers Creamery Co.	Somers.
Suffield Creamery Co.	Suffield.
Tangwauk Creamery Co.	North Stonington.
Vernon Creamery Co.	Rockville.
Wapping Creamery Co.	Manchester.
Windsor Creamery Co.	Windsor.

The summary of the work done is as follows:

	Number. tested.	Number. found inaccurate.
Pipettes	222	6
Milk-test bottles	463	10
Cream-test bottles	1810	42
Total	2495	58

OBSERVATIONS ON THE FERTILIZATION OF PEACH ORCHARDS.

BY E. H. JENKINS.

An experiment on this subject was begun in 1896, in the orchard of Mr. A. E. Plant of Branford. It has been described in the Reports of this Station for the years 1899 and 1900.

We here add the data obtained in the year 1901 with such explanation as is necessary to make them intelligible, reserving discussion of the results for the present.

There are six plots included in the test, each containing 48 trees. These plots have been fertilized as follows, each year, since 1896:

A 65 pounds of muriate of potash, 160 pounds of acid phosphate.
B " " " " " "
and 170 pounds of cotton seed meal.
C 65 pounds of muriate of potash, 160 pounds of acid phosphate.
D 130 " " " " "
E 260 " " " " "
F 260 " high grade sulphate of potash, 160 pounds of acid phosphate.

Three and one-half bushels, 167 pounds, of slaked oyster shell lime have been annually applied to the northern half of each plot.

Until 1901, crimson clover has been sown each year, in August, on plots C, D, E and F, and has been plowed under in May. The sowing was omitted by an oversight this year.

It will be seen that Plot A has abundance of potash and phosphoric acid, but gets no nitrogenous fertilizer. Plot B has each year about 500 pounds of cotton seed meal per acre, containing 35 pounds of nitrogen, while all the other plots receive their nitrogenous fertilizer in form of crimson clover as a green manure.

Plots C, D, E should show the effects of heavy dressing with muriate of potash and F should show the comparative effects of a heavy dressing of high grade sulphate.

The southwest corner of the field, on Plot A, is the dampest part of the lot, in spite of an underground drain, and we believe Plot A is the least favorably placed of all the plots.

Each year a certain number of the trees have died and have been replaced by new ones in the Spring. No case of yellows was found in the orchard until 1900.

Each Spring a census of the trees which died during the last year has been made, which is as follows:

NUMBER OF DEAD TREES FOUND IN THE SPRING.

	1896.	1897.	1898.	1899.	1900.	1901.	Total.
Plot A	2	12	2	1	10	4	31
B	3	6	1	1	2	3	16
C	.	3	1	1	7	3	17
D	0	1	2	0	8	3	14
E	0	1	0	0	0	0	1
F	0	0	0	0	0	2	2
	7	23	6	3	27	15	81

Plot A has suffered most, losing considerably more than one-half of the trees on it in six years. This we believe, is partly due to the excess of water in the soil. Plot B has lost 16 trees, one-third of the original number; D has lost less than one-third, E and F one and two trees respectively.

In 1898 there was a fine set of fruit buds, but most of the very young fruit fell later in consequence of cold storms at, and just after, setting time.

In 1899 there was an excellent set of fruit in the large orchard of which the trees above referred to form a part, while in most orchards of the State, every flower bud was killed during the winter.

The crops were as follows:

PEACH CROP OF 1899. NUMBER OF BASKETS.

Plot.	A	B	C	D	E	F
No. of baskets	65	117	81	110	155½	140½
No. of trees in bearing exclusive of Early Rivers	20	31	23	27	36	30
Average number of baskets per trees in bearing	3.2	3.8	3.5	4.1	4.3	4.7

The yield of peaches in 1900 was also a very good one. The drought during the summer was severe, but by constant cultivation from late June until harvest the crop was carried through successfully.

The crops were as follows:

PEACH CROP OF 1900. NUMBER OF BASKETS.

Plot.	A	B	C	D	E	F
No. of baskets	140¼	212½	151½	190¾	279	243¾
No. of trees in bearing	25	35	29	33	44	40
Average number of baskets per tree in bearing	5.6	6.3	5.2	5.8	6.3	6.1

Immediately after harvest, one tree on B and two each on C, D and F were pulled out and burned because affected with peach yellow. In the large orchard adjoining, the loss from yellows this year was not quite 3 per cent.

The yield of peaches in 1901 was much smaller than in 1900. The season was a wet one with much warm, foggy and rainy weather during harvest, so that the loss from rot was very large.

The crops were as follows:

PEACH CROP OF 1901. NUMBER OF BASKETS.

Plot.	A	B	C	D	E	F
No. of baskets	66½	99	73¾	112¾	168	172½
No. of trees in bearing	20	30	26	31	40	37
Average number of baskets per tree in bearing	3.3	3.3	2.8	3.6	4.2	4.6

Immediately after harvest, 15 trees were pulled out of the experimental orchard and burned, because they showed signs of yellow. Two were Early Rivers, the others were Champions. Two came from Plot B, three from C, three from D, five from E and two from F.

It is noteworthy that no trees affected with yellows were found on the half plots which had been limed each year. In the adjoining orchard 320 trees, or about 11 per cent. of the whole number, were pulled because of yellows.

TESTS OF THE VITALITY OF VEGETABLE SEEDS.

By E. H. Jenkins.

Since November, 1899, six hundred and eighty-nine samples of seeds, chiefly of garden vegetables, have been tested as to their vitality. This work has been done in the interest of seedsmen and of purchasers, and has been executed for the most part by Mr. Churchill.

The methods of testing adopted by the Association of American Agricultural Colleges and Experiment Stations have been closely followed, and the standard germinating chambers have been used.

Table I presents the average, maximum and minimum vitality of all the seeds tested at the Station by the newly adopted methods. The age of the seeds given in the table is that reported by the seedsmen or growers who sent the samples. The samples were in all cases drawn by the persons sending them. Since the samples were sent by the seedsmen for their own information, and it was understood that the results of the tests were not to be published as representing the character of their goods, there was no motive for any misrepresentation as to the age of the seed. The samples for the most part undoubtedly represented cleaned seed as prepared for market.

The "percentage" of beet seed and mangel wurzel sprouting, as given in the table, is considerably over 100. To test the vitality of beet seed, one hundred "seeds" are put in the germinating apparatus and all the sprouts are counted. As each beet "seed" is a fruit which may contain from two to six separate seeds, it is evident that the possible number of sprouts may be 600. To count the actual number of seeds in the one hundred fruits examined, which would make a true percentage statement of sprouting power possible, would be extremely laborious; but the form of statement here followed is sufficiently intelligible and is justified by usage.

Table I.—Germination Tests of Seeds of Garden and Field Crops.

	Age of Seed in years, when tested.	Number of samples.	Average percentage by number of Seed sprouting.	Maximum.	Minimum.
Beans	0–1	7	86.5	100.0	56.7
	1–2	15	91.1	100.0	72.0
	2–3	8	87.0	100.0	59.0
	3–4	15	92.3	99.0	83.0
Beets	0–1	33	128.0	211.0	55.5
	1–2	25	135.6	230.0	44.5
	2–3	7	140.8	192.0	73.5
Brussels Sprouts	1–2	1	77.8	----	----
	3–4	2	18.4	36.0	0.8
Cabbage	0–1	30	82.8	95.8	44.0
	1–2	28	71.1	96.5	28.3
	2–3	5	68.3	88.0	43.0
	3–4	4	62.8	91.5	27.0
	4–5	2	64.9	85.8	44.0
	6–7	1	63.8	----	----
Carrots	0–1	34	60.2	90.8	35.0
	1–2	35	43.8	91.3	14.5
	2–3	5	43.6	54.2	31.0
Cauliflower	0–1	2	77.5	84.5	70.5
	1–2	9	56.6	93.5	27.5
	2–3	3	59.6	75.5	48.8
	3–4	1	77.3	----	----
Celery	0–1	28	55.0	83.5	8.3
	1–2	32	26.8	63.8	1.3
	2–3	10	55.5	79.3	9.8
	3–4	5	55.4	63.5	27.3
Corn, Sweet	0–1	3	83.4	99.0	32.9
	1–2	13	74.5	98.0	37.5
Corn Salad	1–2	1	63.0	----	----
Cress	0–1	3	61.5	91.3	35.5
	1–2	3	51.2	69.8	40.0
Cucumbers	0–1	14	86.4	99.0	57.0
	1–2	30	73.6	99.0	18.0
	2–3	2	81.2	83.0	79.5
	3–4	3	37.0	75.0	6.4
	4–5	1	79.0	----	----
Dandelion	0–1	1	70.3	----	----
	1–2	2	38.7	54.5	2.30

TABLE I.—*Continued.* GERMINATION TESTS OF SEEDS OF GARDEN AND FIELD CROPS.

	Age of Seed in years, when tested.	Number of samples.	Average percentage by number of Seed sprouting.	Maximum.	Minimum.
Egg Plant	0–1	3	45.8	58.5	40.0
	1–2	1	58.5	----	----
Endive	0–1	2	50.1	53.8	46.5
	1–2	5	42.6	54.0	34.0
Kale	0–1	3	90.2	96.0	80.5
	2–3	1	6.0	----	----
	3–4	1	45.8	----	----
Kohl Rabi	1–2	4	67.8	72.3	58.8
Leek	0–1	5	81.3	86.0	76.3
	1–2	7	69.1	79.3	53.3
	2–3	1	35.5	----	----
Lettuce	0–1	44	69.2	100.0	4.3
	1–2	43	78.7	100.0	8.8
	2–3	14	76.2	98.8	23.8
	3–4	2	47.1	87.8	6.4
	4–5	1	82.0	----	----
	5–6	1	10.3	----	----
Mangel Wurzel	0–1	2	190.0	203.0	177.0
	1–2	8	89.4	176.0	20.0
	2–3	4	103.5	181.0	21.0
Musk Melon	0–1	10	77.5	100.0	28.0
	1–2	22	71.1	99.0	18.0
	2–3	6	33.2	92.5	2.5
	3–4	11	36.7	81.0	10.0
Onion, Connecticut grown	0–1	288	76.2	97.5	36.8
	1–2	87	61.8	92.8	0.8
	2–3	24	21.9	68.3	0.5
	3–4	1	59.5	----	
California grown	0–1	56	90.0	97.5	55.8
	1–2	24	76.0	98.0	41.5
	2–3	7	66.1	91.5	22.3
	3–4	1	10.0		
Parsley	0–1	3	67.0	73.3	58.8
	1–2	10	29.5	72.0	7.8
Parsnip	0–1	10	48.0	63.5	34.3
	1–2	4	15.6	42.8	2.5
	2–3	1	30.3	----	----

TABLE I.—*Continued.* GERMINATION TESTS OF SEEDS OF GARDEN AND FIELD CROPS.

	Age of Seed in years, when tested.	Number of samples.	Average percentage by number of Seed sprouting.	Maximum.	Minimum.
Peas	0–1	1	45.5		
	1–2	1	77.2	----	----
	3–4	2	98.5	99.0	98.0
Pepper	0–1	7	76.0	89.5	61.0
	1–2	13	51.5	76.5	7.5
Pumpkin	0–1	6	74.0	95.0	40.0
	1–2	9	59.1	92.0	1.1
	2–3	1	97.3	----	----
Radish	0–1	28	88.9	99.8	72.0
	1–2	25	66.8	98.8	4.8
	2–3	18	33.1	71.5	1.8
	3–4	15	24.9	69.5	0.0
Salsify	0–1	3	67.0	80.5	41.0
Spinach	0–1	23	82.8	94.3	59.5
	1–2	13	82.6	88.3	64.3
	2–3	3	63.4	91.5	40.0
Squash	0–1	12	87.4	100.0	68.8
	1–2	9	91.6	98.0	75.0
	3–4	13	38.8	89.0	0.5
Sunflower	1–2	1	97.5	----	----
Tomato	0–1	27	85.4	96.5	73.8
	1–2	21	80.5	96.0	55.3
	2–3	2	58.3	65.5	51.0
	3–4	3	70.2	96.2	43.5
Turnips	0–1	9	95.4	98.8	88.8
	1–2	9	87.4	98.0	40.3
	2–3	3	91.0	93.3	89.5
	3–4	4	59.7	94.5	28.0
Watermelon	0–1	7	82.7	100.0	56.3
	1–2	21	47.0	88.0	0.0
	2–3	12	32.7	85.0	0.1
	3–4	2	21.5	42.0	1.0
	4–5	1	15.0	----	----
	5–6	1	69.5	----	----

Vitality of Onion Seed as affected by the Age of the Seed.

Since November 1, 1896, the Station has examined 344 samples of onion seed, less than one year old, of the crop of 1896, and of every succeeding crop. The results appear in Table II, together with those of tests of onion seeds, which were more than one year old when examined. In the samples examined, the percentage by number of seed which sprouted was as follows:

TABLE II.—VITALITY OF ONION SEED.

	Connecticut grown.		California grown.	
	No. of samples.	Per cent. sprouted.	No. of samples.	Per cent. sprouted.
Seed stated to be less than 1 year old	286	76.2	56	90.0
Seed stated to be between 1 and 2 years old	87	61.8	24	76.0
Seed stated to be between 2 and 3 years old	24	21.9	7	66.1
Seed stated to be between 3 and 4 years old	1	59.5	1	10.0

While the number of samples examined of California-grown seed is not large enough to make a close comparison, it is quite evident that a larger percentage of the California seed germinates than of the Connecticut seed.

Table II also shows that onion seed more than one year old, as a rule, has much less sprouting capacity than new seed, although in Table V are numerous cases of onion seed more than a year old which sprout as well as most new seed. Whether the plants produced from old seed are as vigorous and productive as those from fresh seed is quite another question, on which laboratory germination tests can give no light.

Comparison of the Vitality of Crops of Connecticut-grown Onion Seed in the years 1894–1901.

The average sprouting capacity of Connecticut-grown onion seed, as determined for a number of years at this Station, has been as follows:

TABLE III.—VITALITY OF CROPS OF ONION SEED.

	No. of Samples Tested.	Average Percentage Sprouted.
In 1880	14	87.0
1894	25	82.9
1895	13	85.5
1896	44	72.4
1897	39	77.9
1898	68	69.3
1899	62	89.0
1900	77	88.5
1901	60	71.0

The sprouting capacity of onion seed of the 1899 and 1900 crops was higher than in either of the previous years named, but the sprouting capacity of the 1901 seed is very unsatisfactory.

The Sprouting Capacity of Different Varieties.

The average sprouting capacity of four varieties, of which a considerable number of samples has been tested, is as follows (only those samples are here included which were alleged to be less than one year old at the time of testing):

TABLE IV.—SPROUTING CAPACITY OF DIFFERENT VARIETIES OF ONION SEED.

Variety.	No. of Samples Tested.	Average Percentage of Sprouting Seed.
Yellow Globe	144	77.1
Red Globe	128	81.2
White Globe	77	80.5
White Portugal	27	68.7
Wethersfield Red	9	81.6

The three globe varieties and the Wethersfield Red are essentially alike in sprouting capacity, but the White Portugal appears to be distinctly inferior to them in this regard.

TABLE V.—GERMINATION TESTS MADE IN 1901 OF ONION SEED RAISED IN CONNECTICUT.

Variety.	Station No.	Age of Seed in years at time of testing.	Percentage of Seeds by number. Sprouted in 14 days.	Percentage of Seeds by number. Remained hard.	Number of days within which one-half of the sprouting Seed germinated.
Yellow Globe, Crop of 1901	2638	0–1	80.8	6.0	4
	2640	0–1	77.5	5.5	4
	2677	0–1	90.3	2.0	5
	2678	0–1	85.5	4.0	5
	2679	0–1	62.8	5.0	4
	2680	0–1	84.3	4.1	4
	2685	0–1	82.0	4.5	4
	2686	0–1	58.8	10.2	4
	2687	0–1	49.8	8.7	4
	2689	0–1	79.8	2.5	4
	2691	0–1	96.5	0.7	3
	2702	0–1	77.3	1.7	3
	2703	0–1	58.3	1.5	3
	2707	0–1	51.3	1.1	3
	2710	0–1	53.3	3.2	3
	2727	0–1	54.3	3.1	3
	2737	0–1	82.8	0.7	4
	2758	0–1	56.8	18.0	5
	2806	0–1	85.0	1.5	4
	2808	0–1	49.5	2.5	3
	2871	0–1	82.5	2.5	4
	2875	0–1	85.5	1.7	4
	2878	0–1	52.8	1.0	3
	2929	0–1	84.6	14.1	3
Crop of 1900	2639	1–2	84.5	1.5	4
	2650	1–2	40.3	6.2	4
	2653	1–2	62.8	11.0	4
	2655	1–2	43.0	12.0	4
	2656	1–2	75.0	6.0	4
	2676	1–2	82.3	8.0	6
	2694	1–2	80.3	6.0	4
	2736	1–2	69.5	3.2	4
	2930	1–2	91.0	4.8	3
Red Globe, Crop of 1901	2632	0–1	69.5	2.3	4
	2670	0–1	71.5	3.1	3
	2671	0–1	87.3	3.7	4
	2683	0–1	74.3	3.5	4
	2688	0–1	71.8	4.5	4
	2690	0–1	82.5	1.8	3
	2704	0–1	68.3	3.0	3
	2708	0–1	69.5	4.7	3
	2714	0–1	40.5	24.0	4
	2729	0–1	73.5	4.5	3
	2757	0–1	89 3	5.0	4
	2805	0–1	63.3	4.8	3
	2809	0–1	67.5	4.2	3

TABLE V.—*Continued.* GERMINATION TESTS MADE IN 1901 OF ONION SEED RAISED IN CONNECTICUT.

Variety.	Station No.	Age of Seed in years at time of testing.	Percentage of Seeds by number. Sprouted in 14 days.	Percentage of Seeds by number. Remained hard.	Number of days within which one-half of the sprouting Seed germinated.
Red Globe, Crop of 1901	2872	0–1	66.5	3.2	3
	2874	0–1	94.1	2.7	3
	2879	0–1	66.5	4.5	3
	2928	0–1	89.0	4.1	3
Crop of 1900	2633	1–2	68.3	5.0	4
	2634	1–2	74.8	3.0	4
	2651	1–2	58.8	11.5	4
	2661	1–2	85.3	7.0	4
	2672	1–2	28.0	25.0	5
	2673	1–2	58.8	21.5	5
	2674	1–2	84.8	8.0	5
	2675	1–2	74.3	8.7	5
	2695	1–2	54.0	24.1	4
	2696	1–2	33.0	18.7	5
	2697	1–2	55.5	8.7	4
	2698	1–2	53.0	6.0	4
	2699	1–2	51.3	20.5	5
	2700	1–2	53.0	17.5	5
	2701	1–2	68.8	9 5	4
	2706	1–2	72.3	6.5	4
	2711	1–2	56.0	28.5	4
	2712	1–2	43.3	30.8	4
	2713	1–2	44.3	23.5	5
	2716	1–2	57.0	19.9	4
	2927	1–2	87.3	2.5	4
Crop of 1899	2647	2–3	40.3	11.5	5
White Globe, Crop of 1901	2635	0–1	69.8	3.5	4
	2637	0–1	67.0	1.5	3
	2667	0–1	68.5	3 0	3
	2668	0–1	59.5	1.7	4
	2693	0–1	86.8	2.3	3
	2705	0–1	73.5	1.1	3
	2709	0–1	68.5	0.5	3
	2728	0–1	64.0	5.0	3
	2733	0–1	63.5	1.1	3
	2756	0–1	92.5	4.1	4
	2807	0–1	75.0	2.5	3
	2873	0–1	69.3	0.7	3
	2876	0–1	70.3	14.0	3
	2880	0–1	64.3	7.5	3
	2926	0–1	84.2	2.7	3
Crop of 1900	2636	1–2	73.8	5.0	4
	2645	1–2	66 0	8.0	4
	2646	1–2	66.8	8.0	4

TABLE V.—*Continued.* GERMINATION TESTS MADE IN 1901 OF ONION SEED RAISED IN CONNECTICUT.

Variety.	Station No.	Age of Seed in years at time of testing.	Percentage of Seeds by number. Sprouted in 14 days	Remained hard.	Number of days within which one-half of the sprouting Seed germinated.
White Globe, Crop of 1900	2648	1–2	52.3	11.7	4
	2657	1–2	71.5	5.0	4
	2658	1–2	65 5	3.5	4
	2664	1–2	60.5	10.2	4
	2665	1–2	64.5	8.0	4
	2666	1–2	69.8	5.5	4
	2669	1–2	47.3	15.5	5
	2730	1–2	52.8	17.8	3
	2734	1–2	60.5	6.7	4
	2744	1–2	62.3	3.7	3
	2811	1–2	87.3	4.5	4
	2877	1–2	92.0	3.0	3
	2881	1–2	71.8	5.7	4
	2931	1–2	79.0	0.0	4
Crop of 1899	2662	2–3	43.8	20.0	5
Wethersfield Red, Crop of 1901	2735	0–1	84.5	1.5	3
Crop of 1900	2644	1–2	92.8	2.0	4
	2660	1–2	26.8	25.2	4
	2684	1–2	46.3	17.7	5
	2715	1–2	67.0	13.2	4
Crop of 1899	2649	2–3	40.3	13.7	5
	2652	2–3	40.5	14.0	5
White Portugal, Crop of 1901	2681	0–1	54.3	1.1	4
	2682	0–1	39.8	1.5	4

CAN WRAPPER LEAF TOBACCO OF THE SUMATRA TYPE BE RAISED AT A PROFIT IN CONNECTICUT?

By E. H. JENKINS.

For the past nine years this Station has carried out experiments on the fertilization, curing and fermentation of wrapper-leaf tobacco. These experiments have been made at Poquonock, in the town of Windsor, with the coöperation of the Connecticut Tobacco Experiment Co., an association of tobacco growers, and on land belonging to this company, but placed entirely at the disposal of the Station for a term of years. During the whole time, with the exception noted below, the experiments have been planned and directed by the writer and the field work has been entirely under the direction of Mr. John A. DuBon, of Poquonock, a tobacco grower of many years' successful experience, to whose special knowledge and skill the success of the experiments has been in large measure due. The results of this work, year by year, have been published in the reports of this Station, and, we believe, have largely influenced the methods and practice of successful tobacco growers.

Sumatra tobacco has, from time to time, been raised experimentally in this State in very small amount, in the same way that the "Connecticut Havana" and "Broadleaf" varieties are raised, but the cured leaf had none of the valuable qualities of that raised on the island of Sumatra.

In the year 1900, this Station undertook to determine whether wrapper-leaf tobacco of the Sumatra type, and which would compare favorably with the imported article, could be raised in Connecticut, by other methods than those commonly employed. Prof. Milton Whitney, of the Division of Soils, coöperated with the Station in the experiment, by paying a portion of the expense, furnishing the seed, and giving the services of Mr. M. L. Floyd, who superintended the harvesting of the leaf and later the process of fermentation. The Station furnished the land, fertilizers and labor, paying the larger part of the expense, and put in charge of the field work Mr. DuBon, who devised, built and covered the frame; cultivated, harvested and cured the crop.

The method followed was to raise the Sumatra crop in a field completely covered and closed in on all sides with thin cheese-cloth, supported by a frame nine feet high. This method had already been successfully practiced in Florida for some years. Full descriptions of the construction of this shade and of the conduct of the experiment are given, on pages 322 to 329 of the Twenty-fourth Report of this Station for the year 1900.

The conclusions reached were as follows:

"No further evidence is required to demonstrate that tobacco of the Sumatra type can be raised in Connecticut which is equal in all respects to the average imported Sumatra.

To determine whether this could, or could not, be done was the object, and the *only* object of this experiment.

It remains to be seen whether such tobacco can be *economically* raised in Connecticut; raised on a considerable scale *at a profit.* To determine these points will probably require some years of experiment.

We would strongly urge farmers not to undertake to raise Sumatra tobacco under shade at present, in anything more than a very small way, and purely as an experiment, which will not seriously cripple them, even if it is a complete failure.

The Station proposes to continue these experiments on a somewhat larger scale, so as to get some data to show the cost of making the shade and of harvesting, and also to show the yield of shaded Sumatra per acre."

This was the first experiment made on the subject in the northern states, as far as we can learn. Certainly it was the first experiment of which both the methods followed and the results obtained were accessible to the public.

Encouraged by the success of this experiment, which was promptly described in detail in the Station Report, and in accordance with advice given in that report, at least twenty-one tobacco growers of this State planted more or less Sumatra tobacco under shade, in 1901. More than fifty acres in all were thus planted. Messrs. Ariel and Joseph Mitchellson of Tariffville raised the largest amount, about eighteen acres, while some others raised only one-twentieth of an acre.

Though little of this tobacco has been sold up to the date of writing, the apparent success of the work has been such that several companies have been organized to raise Sumatra tobacco on a considerable scale, and it is not unlikely that approximately one thousand acres of shaded tobacco will be raised in the Connecticut Valley in 1902.

In most cases, growers have availed themselves of the assistance of Mr. M. L. Floyd and other experts in the employ of the U. S. Department of Agriculture, who have watched or superintended the putting up of the shade and all the work of planting, cultivating, harvesting, curing and fermenting during the season of 1901.

The Station Experiments of 1901.

These were managed wholly by Mr. John A. DuBon of Poquonock and the writer. The objects were to raise a larger crop of Sumatra than was raised in the previous year, to learn more definitely both the extra cost of raising a crop under shade and also the yield of tobacco, and to test both the convenience and the effect on quality, of cutting and hanging the plants in the usual way instead of picking the leaves ("priming"), and curing them apart from the stalk. It was also sought to avoid the mistakes of the previous year—mistakes incident to a first experiment—when the leaves were harvested before they were sufficiently ripened, and were not thoroughly fermented. We believed also that the leaf could be made more serviceable and the cigar-wrappers made from it would be less likely to break in the box or in the hands of the smoker if the crop were so grown as to give the leaf more body.

It should also be said that this experiment was made for the information of the tobacco growers of this State. It is our aim, therefore, to state exactly the facts regarding it, whether favorable or unfavorable to the prospects of the new industry. It is not likely that the growing of the Sumatra type of leaf in this State can be made a complete success without some years of experience and intelligent experiment.

A fictitious "booming" of the business at the outset will certainly be followed by a correspondingly irrational depression later.

The Shade.

The frame-work already standing, built in 1900, was extended so as to cover an acre of land.

In this extension, the 4" × 4" uprights supporting the frame were set 11 feet 10 inches apart in the row, the rows of posts themselves being 13 feet 4 inches apart. The posts in each row were fastened together by 2″ × 4″ scantling, nailed flat on top of the posts, and each post was fastened to the posts opposite to it in adjoining rows by 2″ × 4″ scantling nailed on the sides of the posts, with the edge of the scantling flush with their tops. Scantling 2″ × 5″ and 20 feet long were also nailed to the outer rows of posts, close to the ground, on the outside.

At one end of the shaded field was an eight-foot doorway, closed with cheesecloth, through which teams could enter.

Wire was tightly drawn over this frame lengthwise and also crosswise of the structure, midway between each row of uprights. This served as a further support to the cheesecloth cover.

The cheesecloth was 142 inches wide, four one-yard breadths being sewed together, and covering the space between the transverse rows of posts, which had been set 11 feet 10 inches apart. The cheesecloth was fastened to the frame by lath wherever the cloth came in contact with the frame.

We do not recommend this method of construction as superior to others. It certainly is not the most economical, but it answered the purpose perfectly.

Fertilizers.

The land was manured in the fall of 1900 with New York stable manure, 10 tons to the acre, and fertilized after plowing in the Spring of 1901 with 500 pounds of dry fish scrap, 400 pounds of "vegetable ashes," described on page 32 of the Report for 1901, and 1800 pounds of cotton seed meal.

Seed and Planting.

Four different strains of Sumatra tobacco seed were tested in 1901, the main body of the crop, however, being from seed which was grown on the same land in 1900. The seed for the 1900 crop was produced in Florida from seed which came from the island of Sumatra.

In this connection, it should be remarked that Sumatra seed requires for its germination and normal growth in seed-beds much more heat than our New England Havana and Broadleaf varieties. It should also be remembered that Sumatra seed-beds

must not be made where seed of the other varieties has been sown formerly. If they are, there will appear later in the field "mongrel plants" which did not come from the Sumatra seed. They are simply Connecticut Havana plants from seeds which have lain dormant for a year or more in the ground of the seed-bed. The Havana and Sumatra seedlings are not so unlike in appearance as to be distinguished by those who pull the plants for setting in the field.

Through the summer of 1901, and especially at and after harvest time, the land under shade, where the crop of the year before had ripened and shed much of its seed, was thickly covered with young Sumatra plants. These came from seed which fell from the 1900 crop, lay over winter undamaged by the cold, and did not germinate until late in the summer of 1901.

The plants were set under the shade, in rows 3 feet and 3 inches apart, the plants 14 inches apart in the row, or about 11,290 plants to the acre.

This distance in the row is two inches greater than in 1900. Our object was to give the leaf rather more light and thus secure more substance or "body" than we found in the first crop.

Notes During Growth.

The cultivation and care of the crop while growing was the same usually given to crops of our domestic leaf tobacco.

In July a large portion of Connecticut was swept by a wind storm more violent than had been known for thirty years, accompanied with lightning and a heavy downpour of rain.

It lasted about fifteen or twenty minutes, but in that time uprooted a good many trees, unroofed some houses and threw down tobacco barns in the region of Poquonock.

It was a severe test for the cheesecloth shade. The sides were not injured, but in a good many places on the top the cover was badly torn. The tobacco was not at all harmed and four men in two days' time repaired the damage.

The season in general was a wet one, but the quality of the crop through the State was very good at harvest time; the leaf, however, being somewhat lighter in body than usual because of the wet season.

Regarding the effect of the shade, little need be added to what was said in our last report. It secured protection from insect bites, from drought, from high winds and from hail, and a slightly higher temperature and moister air for the growing plants. These are commonly regarded as quite incidental to the thinning of the leaf caused by the slight shade of the cheesecloth. The several items do, however, we believe, largely explain the higher value of the shade-grown crop. The climate under this cloth is wholly different from that outside, and even if no sunlight were intercepted by the cloth, the plants grown under it would yet be of different quality from those grown outside.

The suckers were removed but once, about a week before harvesting. If taken off earlier, a number of new suckers start immediately, higher on the stalk, and we believe in the aggregate draw more heavily on the plant than the main sucker, which starts nearer the base, where it has less light.

Topping and Suckering.

About three and a half weeks before harvesting, the whole crop was topped by cutting off the flower stems close to the upper leaf of the main stalks. This was done wholly at Mr. DuBon's suggestion. His experience in growing tobacco convinced him that on account of the shade and the dark rainy weather that had prevailed, the leaf would be too thin and papery unless the shade of the flower stalks was removed and the substance was left in the leaves, which otherwise would go into flower and seed. The result fully justified this belief.

By taking off the flower head much more light was let in, and had a marked effect in ripening the lower leaves. We found that, under this treatment, all the leaves on the stalk ripened much more uniformly than is usual with our domestic tobacco.

Harvest and Curing.

It is not at all easy for one of limited experience to determine when the leaf is ready to pick. The signs of ripeness can be in general described, but not detected certainly, without long experience. The ripe leaf is likely to be lighter green than the unripe, it shows a yellowish cast on the tip and the edges near the tip, and small spots of darker green appear on its surface. The whole plant at this time takes on a yellowish green shade.

Remembering the misjudgment of the last year when the crop was picked before it was ripe, we endeavored to err, if at all, in the other direction in 1901.

A part of the tobacco—from 7,800 square feet or a little less than one-fifth of an acre—was picked or "primed" from the stalks in the field, and hung on strings in the way which is commonly known and which has been fully described in our last report. Three primings were made, about seven leaves at each priming, and all were made within three or four days, beginning August 28th.

Four-fifths of the crop was harvested on the stalk three or four days later. To do this, each stalk was cut in two and hung on hook lath, the tops with ten hooks, the bottoms with eight hooks to the lath. These were hung in the barn and cured in the usual way.

Both the primed tobacco and that on the stalk were of necessity cured in one barn; a pernicious, because very dangerous method. It is hardly possible, with all care, to keep the conditions of moisture suited to both kinds. Mr. DuBon, however, managed to cure both sorts without accident and with no damage whatever from pole burn.

Cost of Production—Frame.

As we built it, there was required the following spruce timber, which was bought at the nearest lumber yard:

304 pieces	4″×4″×12′	....	4,864 feet.
288 "	2″×4″×13′	....	2,496 "
285 "	2″×4″×14′	....	2,660 "
42 "	2″×5″×20′	....	700 "
			10,720 "

In all, 10,720 board feet, which cost, delivered, $22 per thousand, or $235.84. This will cover less than a square acre of ground, 42,600 square feet. We actually planted under this shade only $^{93}/_{100}$ of an acre in tobacco, as was determined by accurate measurement at harvest time. While the estimate for lumber per acre would be probably sufficient for a piece containing several acres, it is perhaps safer to increase it by $^{7}/_{100}$, making the initial cost of frame $252.35. There were also used

8,118 feet of No. 12 galvanized wire, weighing three pounds per 100 feet and costing 4½ cents a pound, or $10.96 in all.

We estimate that the cost of putting up the frame, labor, nails, etc., was $36.00, making the cost of the permanent structure, lumber, wire and labor, $299.31.

Cover.

To cover this frame, top and sides, were used 6,207 yards of cheesecloth, "Crown Tobacco Muslin, Tape Selvage," costing $162.94 (2⅝ cents per square yard). 2,395 lath for fastening down the cover, at $5.50 per thousand, cost $13.17. To put on the cheesecloth cover required 83 hours work at 15 cents per hour, $12.45.

To the above must be added the expense of setting 3,000 extra plants per acre and the extra cost of setting by hand, for machine planting under the shade and at 14 inches was not practicable. The cost of shaping the land would also be a little greater. These extra items are small, but cannot be closely estimated.

Repairs.

During the growing season, in consequence of a wind storm of very exceptional violence, $12.00 were spent in repairing the cloth cover.

Priming.

The cost of picking the leaves, bringing them to the barn and hanging them after stringing, is probably hardly greater than that of cutting, spearing, teaming and hanging the plants harvested in the usual way. The plants on an acre of land weigh at harvest time about 18,500 pounds, of which 9,500 pounds, or 4¾ tons, are stalks. The work of cutting, spearing, hauling and lifting carefully into place 4¾ tons of stalks is not any less than that of picking the leaves separately, hauling them to the barn and lifting them into place.

The twine used proved perfectly adapted to its use. It was rough enough so that the curing leaves did not slide on it and so strong that there was no breakage during the cure. It is called "16-ply White Peerless Cotton Twine," and cost in 100 pounds lots 19½ cents per pound. A pound of this twine measures 1,200 feet. Twenty-nine pounds are needed for an acre of tobacco, costing $5.66.

With 22 leaves to the plant, and 40 leaves on each lath, there are required 6,200 lath per acre. At the price paid by the Messrs. Mitchellson of Tariffville, for efficient labor, viz., 20 cents for stringing 25 lath, the approximate expense of stringing would be $49.60 per acre and this rate is said to pay the labor $1.35 to $2.00 per day.

To hang the tobacco from an acre in the usual way on the stalk, requires about 1,200 lath. The method of priming therefore requires 5,000 extra lath per acre, costing, at $5.50 per thousand, $27.50.

Allowing 8 inches between lath when tobacco is hung on the stalk and 5 inches when the leaves only are hung, 900 running feet of hanging poles are needed in the former case and 3,100 in the latter; but since two tiers of leaves can be hung where only one of stalks can hang, the disproportion is much less; that is, an acre of primed tobacco takes up as much room in the barn as 1.7 or 1.8 acres of tobacco hung on the stalk.

The disproportion may be made even less, for when the primed leaves are fully wilted and have begun to cure there is often advantage in pushing the lath closer together than they were hung at first. Primed tobacco is much more likely to "hay down," dry out too quickly, than that cured on the stalk.

Where there is a considerable acreage of tobacco, as there was at Tariffville, and the harvesting lasts over a period of five or six weeks, two lots of tobacco can be cured in the same barn, the first harvesting being cured and taken down by the time the last harvesting is ready to go in.

When it is time to take down and strip, the advantage is very greatly with the primed leaf. Certainly, if we count the saving of labor at this point the cost of harvesting by priming is no greater than the cost of harvesting in the usual way, except for the items of stringing and extra lath required. When the primed leaves are cured the string can be cut at each end, wound around the butts, thus making a hand of it, and put in bundles, or the leaves can be drawn from the string and bundled loose. Stripping and bundling can be done much more quickly, easily and neatly when the leaves are primed. The danger of getting the leaf out of condition or bruised is also much less.

To summarize the *extra* cost of growing, harvesting and curing Sumatra wrapper leaf under shade:

Cost per acre of lumber	$252.35	
Cost per acre of wire	10.96	
Cost per acre of construction	36.00	
	$299.31	
Assuming that the frame will last for five years, there should be charged to each crop one-fifth of this sum, or		$ 59.86
Lath for fastening the cloth		13.17
Cost of cheesecloth		162.94
Labor of putting on cloth		12.45
Repairs		12.00
Twine for stringing leaves		5.66
Stringing the picked leaves		49.60
Extra lath for stringing	$27.50	
Charging 40 per cent. of this to the crop		11.00
Total		$326.68

But the actual *extra outlay of the first year* for shading and harvesting was $582.63 per acre.

To this there must be added a suitable amount for refitting the curing barn to hold the primed leaves, and unless the area planted is quite large, there will be needed extra barn room.

These figures show very closely the actual extra cost to us of raising and curing an acre of shaded Sumatra tobacco in this year.

Other experimenters have spent very considerably less. The chief economies are in getting out the needed posts from the owner's wood lot, in setting them further apart, and in using farm labor for putting up the frame, when other work is not pressing.

The cost of stringing the leaf would be somewhat reduced if the farm labor was used for it as far as possible.

A main economy is in construction.

It has been shown by the experience of others to be perfectly feasible to set the 4″ × 4″ uprights a rod apart each way, and to buy them, of chestnut, for not more than 25 cents apiece, delivered.

The lumber for an acre would then be:

205 posts, 4″×4″×12′, @ 25¢	$51.25
200 pieces, 2″×4″×17′, 2,267 board feet @ $22	49.87
1,452 running feet 2″×5″, 1,210 board feet @ $22	26.62
Total	$127.74

This is one hundred and twenty-four dollars less per acre than we paid.

The 2″ × 4″ scantling are nailed on the tops of the posts, running lengthwise of the field, but the posts, crosswise of the field, are only bound by wire. The cheesecloth cover is woven 200 inches wide.

Yield of Pole-cured Tobacco.

The cured leaf was taken down in rather high case on September 29th. *The primed leaf* weighed, in the bundle, at the rate of 1,258 pounds net per acre, less by 250 pounds than the crop of last year, when the plants stood 2 inches closer in the row, but which was calculated from only one-sixth of an acre.

The leaves were taken from the strings and sized without other sorting than to throw out badly torn or otherwise damaged leaves. The hands were then tied with bast fiber.

Unfortunately it was not possible to put the tobacco into fermentation at once, as was desired, and it therefore lay in a cold place till December 4th.

On this date each lot was carefully weighed before putting it into the bulk, deduction being made for the papers and twine which were about the bundles.

The tobacco had dried out somewhat and the net weights were as follows:

Primed shaded Sumatra, 206½ pounds from 7,820 square feet of land, which is at the rate of 1,150 pounds per acre.

Shaded Sumatra cured on the stalk, 883 pounds from 32,300 square feet of land, which is at the rate of 1,190 pounds per acre. Sumatra raised in the open field, set at the same distance as that under shade, cured on the stalk, 184 pounds from 6,552 square feet of land, which is at the rate of 1,223 pounds per acre.

Fermentation of the Crop in Bulk.

In November, 1898, the writer made a test of fermenting Connecticut Havana leaf in a pile or bulk; a method practiced in other countries and in Florida, but which had not been practiced in this State, nor previously tested with tobacco of the type grown in New England to his knowledge. At all events, general attention had not been called to the method or its results. The wrappers fermented in this way were pronounced by leaf dealers to be well sweated and to have the odor of "aged" tobacco, without the sweet smell of "forced-sweat" leaf. The account of this was published in the Station Report for 1898.

In 1899, with the coöperation of the Division of Soils of the U. S. Department of Agriculture and under Mr. M. L. Floyd's superintendence, the experiment was repeated on a larger scale with our tobacco crop of that year, weighing about 3,000 pounds. This work was done at the Station in New Haven.

A full description of the whole operation is given in the Station Report for 1899, pages 291 to 297. The results were most gratifying and successful.

Having demonstrated in this test the value of the method, the experiment crops of 1900, including the shaded Sumatra, were fermented in bulk, at Mr. DuBon's, under Mr. Floyd's superintendence.

With these experiences as a guide, Mr. DuBon and the writer undertook to ferment the experimental crops of 1901, together with two or three small lots of tobacco which had been sent to us by other growers. The whole amount of tobacco was quite small, amounting to a little over 2,000 pounds.

The detail of the operation need not be described, as it was in general the same as described in our Report for 1899, pages 291 to 297.

Electrical thermometers were placed in the bulk, but the telephone instrument soon ceased to work, so that no temperature record could be kept.

The bulk was made December 4th, 1901, five feet wide and ten feet long. Fermentation began promptly and went on satisfactorily. The bulk was a very small one and, as it was evident on examination that the heat was not excessive within it, no change was made till December 19th. We believe that unless there are signs of damage, or the heat rises too high, there is no advantage in turning the bulk and exposing it to the air during the early stages of the fermentation.

On December 19th the bulk was built over in the usual way, the leaf which was outside in the first bulk being put inside the second.

Nothing more was done till January 15th, 1902, when the bulk was taken down, and the leaf, now well fermented, was cased for shipment and sale.

Casing and Selling the Crop.

The leaf which was cured on the stalk was, of course, marked in the bulk and separated by strings from that which had been "primed" and cured on strings.

Large samples were taken to submit to experts and for exhibition and what remained was cased and shipped to Messrs. L. B. Haas & Co. of Hartford, for sale. The amount shipped for sale was as follows:

Of the stalk-cured leaf there were:

133½	pounds of 20 inch leaf.
219	" " 18 " "
59½	" " 17 " "
50½	" " 16 " "
116	" " 15 " "
202½	" " 14 " "
44½	" " 12 " "
825½	

Of the primed leaf there were:

31½	pounds of 18 inch leaf.
44	" " 17 " "
50	" " 16 " "
29	" " 15 " "
16	" " 14 " "
11	" " 12 " "
181½	

This leaf was packed in boxes, holding from 90 to 120 pounds each. It was not baled or "fanned out" in imitation of the imported leaf, but was handled precisely as the domestic leaf is.

Mr. Haas was instructed to sell it in single boxes, the object being to secure its distribution to as many manufacturers as possible and to get from them, if possible, after they had manufactured it, an expression of their judgment of it.

The sale was embarrassed by the fact that there was absolutely no precedent or standard of prices to serve as a guide. This is the first crop of Connecticut Sumatra ever offered in the market, if we except the two hundred pounds sold by the Station last year. The prices asked were, however, accepted by buyers without objection, and indicate, therefore, that those who bought a portion of the crop believed that it was worth, to them, at least as much as they paid.

The actual sales made will appear at the end of this article.

Conclusions.

In conclusion, our success with two crops, the first raised during a season so dry as to affect the growth of tobacco in the open, the second raised when the latter part of the season was unusually cloudy and wet, indicates that Sumatra tobacco can be successfully produced in Connecticut under shade in any season which is not very abnormal as to rainfall and sunshine.

It is, however, a new industry which must be slowly learned by our growers. While much may be acquired from the prevailing ideas and practices in Sumatra and in Florida, there yet remains much more which is absolutely necessary to success but which our growers must learn for and by themselves.

The adaptation of methods of raising, harvesting and curing the leaf to the special local conditions of labor and particularly to the peculiarities of our climate during growth, harvest and curing are essentials, to be worked out by our growers and in which no one but themselves can be experts.

We are not raising Sumatra tobacco, nor Florida tobacco; we are not in a Sumatra climate or a Florida climate. To succeed, our farm practice must be that which we find best for this leaf under Connecticut conditions.

The Seed.

The seed requires for its prompt germination a higher heat than our domestic leaf seed, and also a somewhat higher temperature in the seed-beds. If the beds are made where Havana seed has been sown the year before, many Havana plants will

be found later in the field coming from seed which has lain dormant a year and has come up with the Sumatra seeding.

This was a very common experience in 1901 in most of the fields we visited.

The Extra Cost of Raising Shaded Sumatra.

By this is meant the charges incident to putting up the shade and harvesting the leaf by picking.

As has been shown on previous pages, the actual *initial* cost of the first year for these items *in our experiment* was $582.63 per acre.

Charging the first crop, however, with only twenty per cent. of the cost of frame, and forty per cent. of the cost of lath for hanging tobacco, the extra cost per acre, per year, incident to raising shaded Sumatra was $326.68.

It is however possible, in the way we have indicated on page 304, to reduce the *initial* cost in the first year to about $450 per acre and the average yearly expense to about $300 per acre.

Yield of Tobacco.

The weight of the whole crop as it was taken down from the curing barn was not ascertained. Nearly two months later when the leaf was put into the fermentation it weighed at the rate of 1,171 pounds net from an acre most accurately measured.

Last year from a measured one-sixth of an acre there were raised at the rate of about 1,500 pounds per acre. Most growers this year report crops of from 1,500 to nearly 1,700 pounds. No doubt our own crop weighed somewhat more at stripping time than it did two months later when it was assorted. We purposely set our tobacco plants farther apart this year than last and are satisfied that we got a better quality by so doing.

Fermentation.

The process of fermenting requires a room which can be kept at a uniform temperature in all kinds of weather and in which the air can be kept as moist as is desired. Such facilities are not generally obtainable on the farm. But with them the process of fermentation is nothing which an intelligent grower or dealer cannot learn for himself with some experience.

Our crop of 1901, fermented by ourselves as already described, was examined by a considerable number of dealers of experience, all of whom pronounced it well fermented and in excellent order.

Havana Seed Leaf and Broadleaf under Shade.

About forty plants of each of these varieties were raised under shade and the fermented leaf given to a manufacturer of first-class cigars who in his own trade used exclusively imported Havana filler and Connecticut Broadleaf wrapper. The colors were excellent and the leaf very fine.

From exactly one-half pound of shade-grown Havana were wrapped 172 cigars of ordinary size, equivalent to 2.9 pounds of leaf to 1,000 cigars. Of the Broadleaf were required three pounds and a very small fraction, to wrap the same number of cigars. Of Broadleaf grown without shade from nine pounds upwards are needed per one thousand cigars.

The manufacturer stated, however, that the shaded Broadleaf did not have the same elasticity as that grown in the open. When the cigars dried the wrapper did not contract along with the filler but became loose, the filler shrinking away from it.

Sumatra Leaf Raised Without Shade.

This was set at the same distance as the shaded crop. It was harvested considerably later than the other and was sacrificed in the cure, as the main crop needed drying out and airing just when this leaf needed to be kept damp. The product was comparatively worthless.

Sumatra tobacco properly grown without shade and well cured might make a serviceable wrapper, but the chance is not sufficiently encouraging to make further trials worth while at present.

Topping the Plants.

As has already been noted, we are perfectly satisfied that in this season, at least, topping decidedly improved the crop and made it ripen more evenly from top to base of the stalk. The topping, unlike topping a crop of domestic Havana, is done when the plants are in full flower and a few weeks before harvest. The leaf this year is certainly more elastic and less papery than last year.

Quality of Crop.

In the opinion of competent judges of Sumatra tobacco the leaf raised by us under shade in 1901 is much better than that raised on the same land in 1900. The green colors, so prominent in 1900, are almost entirely wanting in our crop of 1901. The 1901 leaf has much more "body," elasticity, or "life" than that of 1900 and will, therefore, be more acceptable to manufacturers.

It is equally important to note the defects. Our leaf lacks finish, would be better if it had still more "body," and the colors are rather dull. Careful tests showed that one and a quarter pounds of leaf would wrap 1,000 cigars.

A leaf with more body, of which two pounds wrapped 1,000 cigars, would, other things being equal, be preferable. The burn of the leaf is satisfactory and would improve by aging.

Stalk-cured compared with "Primed" Leaf.

Samples of hands of the various lengths, from both sorts, marked for identification, about a dozen hands in each lot, were submitted to Messrs. Darius Ferry, Jr., Seymour & Son, and Sutter Bros. of New York, with the request to decide which lot was the better. They were not told of the difference in the curing of the two lots.

After full examination they unanimously agreed that Lot A, primed, was decidedly better than Lot B, cured on the stalk.

Both lots were of excellent quality. The stalk-cured had lighter colors, but was more papery and had less elasticity and "body" than the primed leaf. Weight for weight, Lot A would cover more cigars than Lot B.

Unquestionably more leaf is damaged when the plants are cut than there is when the leaves are picked or "primed."

Our experience shows that if the plants are cut they should be wilted on hurdles before carting to the barn, as in the unwilted condition they are extremely brittle.

We intend to repeat the experiment, believing that by getting more body into the leaf, by suitable arrangements for carting the plants without breakage, and by curing the plants in a barn where there is no primed tobacco to interfere with the other, it will be possible to make stalk-cured Sumatra leaf of more desirable quality than this year.

Finally, the real value and the standard price for Connecticut Sumatra has not yet been established, nor (in the opinion of the writer) can it be until the leaf has passed from the dealer to the manufacturer, and has been worked into cigars and tested by the consumer. The verdict of all three is needed to fully determine the value of this new grade of wrapper leaf.

At present, however, there is every reason to believe that the leaf can be sold at paying prices and that the new industry, first introduced by the experiments made by us in 1900, may be so managed as to be of great value to the tobacco growers of this State.

Sales.

At the time of going to press there have been sold:

Case No.	Kind of Leaf.	Price per pound.	Total.
11—90	pounds primed leaf......	@1.75	$157.50
12—90½	" " "......	@1.75	158.37
3—90	" stalk-cured leaf..	@2.50	225.00
5—89	" " " ..	@2.25	200.25
8—101	" " "	@1.40	141.40
4—89	" " "	@2.50	222.50

Average price per pound, $2.01.

THE COMPOSITION OF THE COMMERCIAL FEEDING STUFFS SOLD IN CONNECTICUT.*

During the autumn of 1901, agents of this Station collected in forty-one towns and villages of this State two hundred and sixty-four samples of commercial feeding stuffs.

The analyses of these feeds appear in Table IV, pages 330-49. This table shows:

(1) The chemical composition of each of the samples as determined by the methods of analysis adopted by the Association of Official Agricultural Chemists.

(2) The average composition as determined by these analyses.

(3) The digestible nutrients of these feeds. These are calculated by the use of the digestion coefficients compiled by Jordan in Bulletin 77 of the office of Experiment Stations, and which, so far as they apply to the feeds discussed in this report, are given in Table I on page 324.

Cotton Seed Meal.

The six samples analyzed were of excellent quality, the percentage of protein ranging from 43.1 to 45.7, and averaging 44.4; in every case being fully up to the manufacturer's guarantee.

The minimum percentage of protein is equivalent to 6.89 per cent. of nitrogen. A considerable number of samples of cotton seed meal analyzed in March, 1902, contained less nitrogen than this. The cotton-seed oil producers, in convention at New Orleans, prescribed that either "choice" or 'prime" cotton seed meal should contain not less than 6.58 per cent. of nitrogen (8 per cent. of ammonia).

The average percentages of protein and fat, and the average prices, for the last three years have been:

	1899	1900	1901
No. Samples	10	4	6
Percentage of Protein	46.4	43.9	44.4
" " Fat	10.4	8.6	9.8
Average price	$24.00	27.00	28.80

* The microscopic work in connection with the analyses of these feeds was done by Mr. A. L. Winton; the chemical analyses were made by Messrs. Winton, Ogden and Silverman. The results were prepared for publication by the Director.

Linseed Meal.

Confusion still exists in the use of the terms, "old process" and "new process."

By the "old process" the oil is removed by hydraulic pressure, while the "new process" extracts the oil by a solvent, usually benzine. New process meal commonly has less than 2½ per cent. of oil remaining in it, while old process meal has three or more times that amount. The analyses show that samples 4283, 4302, 4413 and 4545 are old process meals, while 4320, 4317, 4309 and 2439 are new process, although 4309 was sold as "old process" meal.

The samples analysed this year were of good quality, one of them containing 44 per cent. of protein, an abnormally high percentage. The average percentages of protein and fat found in linseed meal, with the prices for the last three years, are as follows:

	1899		1900		1901	
Process.	New.	Old.	New.	Old.	New.	Old.
No. of Samples	4	8	2	3	3	4
Percentage of Protein	37.7	33.8	38.4	31.3	39.0	34.4
" " Fat	2.4	7.7	2.4	6.7	1.8	7.7
Average price	$28.10	29.00	32.50	31.00	30.00	30.50

New process meal has from four to seven per cent. more of protein, and from four to five per cent. less of fat, than the old process meal.

Guarantees.

Samples 4320, 4309, 2439 were guaranteed to contain 38 per cent. of protein and 1 per cent. of fat, and fully met this guarantee.

The composition of samples 4413, guaranteed 32 per cent. of protein and 5 of fat, and 4545, guaranteed 34 per cent. of protein and 6 of fat, fully met the guarantees.

Samples 4317 and 4283 had no guarantees.

Wheat Feeds.

These are by-products in the manufacture of wheat flour. Several different processes of milling are in common use, yielding by-products which are not entirely alike in composition.

There are also differences in composition between the products from winter wheat and those from spring wheat.

Wheat Bran consists of the outer layers of the wheat berry, which are dark in color and do not easily pulverize.

Wheat Middlings, as found in the feed market, consist of inner layers of the covering of the berry, which are lighter in color and more easily pulverized than bran, and of other parts from which fine white flour cannot be made.

Red Dog Flour is the poorest grade of flour; off color and often sold as a cattle food. It is also used for paste and in making "pancake leather"—composed of leather scraps and flour paste compacted by hydraulic pressure, stated to be made up into soles for children's shoes.

Many mills do not sell bran and middlings separately, but run them together, often with other waste wheat products, and sell the mixture as "Mixed Feed."

With a single exception the samples of wheat feed were not accompanied with any statements of guaranteed composition.

In the table which follows, the wheat products from the mills named below are classed as winter wheat.

Acme Milling Co., Indianapolis, Ind.
American Cereal Co., Chicago.
Blish Milling Co., Seymour, Ind.
Cole, H. C. Milling Co., Chester, Ill.
Eldred Mill Co., Jackson, Mich.
Evans, Geo. F., Hoosier Mills, Indianapolis, Ind.
Hannibal Milling Co., Hannibal, Mo.
Harter, Isaac, & Co., Galena, O.
Hecker-Jones-Jewell Milling Co., N. Y.
Holly Milling Co.
Hunter Bros., St. Louis.
Jenks, J., & Co., Sand Beach, Mich.
Kane Mill Co., Atchison, Kansas.
Kehlor Bros., St. Louis, Mo.
Lawrenceburg Roller Mills Co., "Snowflake," Lawrenceburg, Ind.
Lexington Roller Mill Co., Lexington, Ky.
Maumee Valley Milling Co., Defiance, Ohio.
McDaniel & Pitman Co., Franklin, Ind.
Meyer, J. T., & Co., Clinton, Mo.
Miles & Son, Frankfort, Ky.
Model Roller Mills, Nashville, Tenn.
Moore, R. P., Milling Co., Princeton, Ind.
Rex Milling Co., Kansas City, Mo.
Saginaw Milling Co., Saginaw, Mich.
Stock, F. W., Hillsdale, Mich.
Scott's Flour Mills, Detroit, Mich.
Taylor Bros. Milling Co., Quincy, Ill.
Valley City Milling Co., Grand Rapids, Mich.
Voigt Milling Co., Grand Rapids, Mich.
Walsh De Roo Milling Co., Holland, Mich.

The wheat products from the following mills are classed as from spring wheat.

Anchor Milling Co., Superior, Wis.
Andrews & Co., Minneapolis.
Banner Milling Co., Buffalo, N. Y.
Bay State Milling Co., Winona, Wis.
Berger, Anderson Co., Milwaukee.
Daisy Roller Mill Co., Milwaukee, Wis.
Davis Co., J. G.
Duluth Imperial Mill Co., Duluth.
Freemen Milling Co., Superior, Wis.
Grafton Roller Mills, Grafton, N. D.
Imperial Mill Co., Duluth, Minn.
Lake Superior Mills, Superior, Wis.
Listman, Wm., Milling Co., Superior, Wis.
Miner-Hillard Milling Co., Wilkes Barre, Penn.
Minkota Milling Co., Superior, Wis.
Moseley & Motley Milling Co., Rochester, N. Y.
New Prague Milling Co., New Prague, Minn.
North Dakota Milling Association, No. Dakota.
North Western Consolidated Milling Co., Minneapolis.
Pillsbury-Washburn Co., Minneapolis.
Russell & Miller Milling Co., Superior, Wis.
Sheffield Milling Co., Faribault, Minn.
Star & Crescent Milling Co., Chicago.
Urban Roller Milling Co., Buffalo, N. Y.
Washburn-Crosby Co., Minneapolis.
Whitney & Wilson, Rochester, N. Y.
Woodworth & Co., E. S., Minneapolis.

Bran from Winter Wheat.

The six samples examined show considerable range in the percentage of protein, from 14.75, in Canadian bran, to 18.06. All appear to be free from adulteration.

Bran from Spring Wheat.

The eighteen samples examined were all of excellent quality as judged by chemical composition.

Middlings.

All the samples, both of winter and of spring wheat middlings, were of good quality, the spring middlings containing considerably more protein.

Mixed Feed.

In the table are included 26 analyses of winter wheat mixed feed, and nine of spring wheat feed. In every case the feed is, judged by chemical analyses alone, of excellent quality.

Average Composition of the Various Wheat Products.

The average composition of the various wheat feeds as sold in Connecticut in the last three years, with their prices, are given in the following table:

AVERAGE COMPOSITION AND PRICE OF WHEAT FEEDS IN CONNECTICUT IN 1899, 1900 AND 1901.

	Bran.		Middlings.		Mixed Feed.	
	Winter.	Spring.	Winter.	Spring.	Winter.	Spring.
1899						
Protein	15.9	15.6	15.8	15.6	16.8	16.8
Fat	4.3	4.7	4.4	4.7	4.5	5.1
Ton price	$19.80	19.14	19.00	19.25	19.44	19.25
1900.						
Protein	16.1	16.5	17.7	19.1	18.1	17.6
Fat	4.6	5.0	4.7	5.5	4.7	5.3
Ton price	$21.09	20.00	21.00	21.50	21.00	20.80
1901.						
Protein	16.3	17.3	18.0	19.7	17.5	18.5
Fat	4.5	4.7	5.0	5.5	4.7	5.1
Ton price	$21.80	21.06	22.75	22.10	22.20	22.20

This table indicates that

1. The spring wheat products, as a rule, have somewhat higher percentages, both of protein and fat, than the winter wheat products.
2. This difference is rather more striking in the case of middlings than in that of either bran or mixed feed.
3. The percentages of protein and of fat in bran are rather lower than in either middlings or mixed feed.
4. On the average the winter wheat products sell at a slightly higher price than the spring wheat products.

Guarantees.

Of all the samples of wheat feeds examined, only one had a guarantee of composition. This was a middlings from N. L. Berry & Co., Providence, R. I., in which 16.85 per cent. of protein and 5.2 per cent. of fat were guaranteed. The sample contained 18.5 per cent. of protein and 4.66 per cent. of fat.

ADULTERATED MIXED FEED.

Three samples of mixed feed have been found to be grossly adulterated with ground corn-cobs. Two of these samples, Nos. 4295 and 4406, bore the brand, "Choice Eclipse Mixed Feed." Both were traced to the W. R. Mumford Co., feed dealers of Chicago, but could be traced no further; no reply, regarding these adulterated feeds, being received to letters of inquiry which were correctly addressed to this firm and were delivered.

The third sample, 4470, was stated to be sold by D. C. Comstock, Providence, R. I., under the name "C" mixed feed. Letters sent to that address were returned, as no such person could be found. We have since heard that he has left Providence and has gone out of business.

The fragments of corn-cob were easily and certainly identified by Mr. Winton with the microscope. The chemical composition also establishes the fact of adulteration. There follows the average composition of winter and spring mixed feed and for comparison the analyses of the adulterated samples.

	Pure.		Adulterated with Cobs.		
	Winter Wheat Feed.	Spring Wheat Feed.	Choice Eclipse Mixed Feed 4295	Choice Eclipse Mixed Feed 4406	C. Mixed Feed 4470
Water	9.11	9.22	8.62	8.23	8.07
Ash	5.64	5.26	4.53	4.74	4.73
Protein	17.51	18.54	12.50	12.44	13.75
Fiber	7.70	8.31	14.59	17.07	13.54
Non-nitrogenous Extract	55.36	53.56	56.27	54.17	56.34
Fat	4.68	5.11	3.49	3.35	3.57
	100.00	100.00	100.00	100.00	100.00

Calculation shows that a mixture of 75 pounds of wheat feed and 25 pounds of ground corn-cobs would have the same composition as these "Choice Eclipse" and "C" frauds.

They are frauds because sold under a name applied, by the produce exchanges and dealers and purchasers alike, only to feeds consisting wholly of wheat products, being a mixture of bran and middlings or of all the waste portion of the wheat used for the flour manufacture. They are also sold for the same price as genuine mixed feed.

Maize and Maize Products.

Corn Meal.

The two samples, of which analyses are given in the table, have the average composition. They were not sold with a guarantee.

Gluten Meal.

The Atlantic Gluten Meal, made at Westport, Conn., is a wheat gluten containing 42.75 per cent. of protein, much more than the corn glutens contain, and its composition is fully up to what is guaranteed.

Only two other brands of gluten meal were found by our sampling agents: Cream Gluten Meal, made by the Chas. Pope Glucose Co., and Chicago Gluten Meal, made by the Glucose Sugar Refining Co., both of Chicago.

The average percentages of protein in the two samples of Cream Gluten agreed with the guarantee, but the amount of fat was nearly two per cent. below the guarantee. The guarantee of 39 per cent. of protein and 2 per cent of fat in Chicago Gluten Meal is understood to refer to a dry basis. The three samples analyzed contained, on the average, 8.73 per cent. of moisture, 35.98 of protein and 3.42 of fat, which calculated to a dry basis is 39.4 per cent. of protein and 3.7 per cent. of fat.

Gluten Feed.

The table contains analyses of a considerable number of brands of gluten feed. The average composition of each brand is given below with the guarantee.

	Protein.		Fat.	
	Found.	Guaranteed.	Found.	Guaranteed.
Buffalo Gluten Feed	26.60	28.0	3.51	3.0
Pekin " "	26.15	27.5	3.50	3.3
Davenport " "	25.68	27.0	4.23	3.0
Marshalltown Gluten Feed	27.66	27.0	3.61	3.0
Waukegan " "	26.62	27.3	4.22	3.4
Geneva " "	26.19	27.0	3.76	3.0
Nat'l. Starch Co.'s Gluten Feed	25.37	31.7	3.06	4.3

The Buffalo, Davenport and Marshalltown Gluten Feeds are made by the Glucose Sugar Refining Co. of Chicago. If their guarantees refer to water-free basis, then the goods sampled were above the manufacturer's guarantee in composition, but if not, both the Buffalo and Davenport feeds are below it.

Germ Oil Meal.

Made from corn germs by the Glucose Sugar Refining Co. of Chicago, contains, *in the dry substance,* the guaranteed percentage of protein, 25.5, and of fat, 10.5.

Corn Bran Sugar Feed.

This material, apparently sold without guarantee, contains only about one per cent. more of protein than corn meal and is not, therefore, by any means a concentrated feed which can be profitably used for supplying protein to balance a ration.

Hominy Feed and Hominy Chop.

Twenty-one samples of this feed are given in the table. The percentage composition is quite uniform. This feed, which has sold for about the same price as wheat bran, contains about five per cent. less of protein and three or four per cent. more of fat than the wheat feeds. It is, therefore, a more costly feed to use. Generally it is sold without a guarantee.

The Niagara Hominy Meal has, however, a guarantee of 11 per cent. of protein and 8 of fat, which is fully met in the three samples analyzed.

Hunter Bros. Hominy Feed is guaranteed to contain 11 per cent. of protein and 7.70 per cent. of fat, and the single analysis shows somewhat more than these percentages.

Cerealine Feed.

This is a corn product, not greatly differing from hominy chop in composition, containing three fourths of a per cent. more of protein, about one and a half per cent. less of fat and two and a half less of fiber.

RYE FEED.

Analyses of six samples are given in the table. One of them, 4391, is very different from the others in composition and quite inferior to them, having four per cent. less of protein. The other five samples have the usual composition of rye feed. No guarantees of composition were given with these feeds.

BUCKWHEAT PRODUCTS.

Buckwheat Middlings.

This feed, which has been made and sold for years by the Quinnebaug Store of Danielson, is richer in protein than the gluten feeds, is moderate in price and is said to give excellent results as a feed for milch cows.

Buckwheat Shucks

As the analysis shows, have very little, if any, feeding value.

FACTORY MIXED FEEDS.

Provender.

Of the twenty-seven samples, of which the analyses are given in the table on pages 344-345, one, 4335, is stated to contain wheat middlings which explains its higher percentage of protein.

A single sample, 4537, stated to be ground by M. L. Crittenden, at Buffalo, N. Y., is inferior, containing only 8.75 per cent. of protein; the others, most of them ground at local mills in this State, have the average composition and are of good quality.

Provender ground at the small mills in this State is generally of better quality than that which is brought in from the West.

The Sterling Provender, 4537, above referred to, has a guarantee of 7.9 per cent. protein and 6.3 per cent. fat. It is far below guarantee in both particulars.

Sample 4490, made by E. C. Dennis, has a guarantee of 12 per cent. protein and 2.5 per cent. of fat. The protein found is nearly 2 per cent. less than the guarantee.

The provenders with guaranteed composition are:

		Protein.		Fat.	
		Guaranteed.	Found.	Guaranteed.	Found.
4537	M. L. Crittenden, Buffalo....	9.9	8.75	6.3	2.40
4490	E. C. Dennis................	12.0	10.19	2.5	4.27
4426	Narragansett Milling Co.	10.5	10.81	4.3	4.25
4390	Miner, Hillard..............	10.5	10.12	4.3	4.28

OAT FEEDS, AND CORN AND OAT FEEDS.

These appear under various names, Monarch Chop Feed, Boss Corn and Oat Feed, Vim Oat Feed, Royal Oat Feed, De-Fi Corn and Oat Feed, etc. The Vim Oat Feed and Royal Oat Feed consist largely of oat hulls, as is shown both by chemical and microscopic examination. Victor Corn and Oat Feed also contains some wheat. None of these things need any special discussion.

The "corn and oat feeds" as a rule consist of manufacturing rubbish and cannot be used economically for feeding purposes.

Corn, Oats and Barley.

This mixture, put up by the American Cereal Co. of Chicago, judged from the five analyses in the table, has a fairly uniform composition, and is sold under a guarantee of 10.8 per cent. of protein and 3.5 per cent. of fat. All of the samples contained considerably more than the guaranteed amounts.

Proprietary Feeds.

These are mixtures sold under trade names which are supposed to be copyrighted.

The Quaker Dairy Feed and American Poultry Food, made by the American Cereal Co. of Chicago; the Dairy Feed, Horse Feed and Poultry Food, made by the H. O. Co. of Buffalo, N. Y., have a fairly uniform composition.

The average composition of these brands, with their guarantees, are as follows:

	Protein. Found.	Protein. Guaranteed.	Fat. Found.	Fat. Guaranteed.
American Cereal Co.'s Quaker Dairy Feed	13.60	12.0	3.33	2.50
American Poultry Food	14.37	14.0	6.85	5.50
H. O. Co.'s H. O. Dairy Feed	19.69	18.0	4.10	4.50
H. O. Horse Feed	13.03	12.0	4.33	4.50
H. O. Poultry Food	17.93	17.0	5.23	5.50

The Quaker Dairy Feed is a mixture of corn and wheat products; H. O. Dairy Feed contains oats, wheat, corn and cotton seed; H. O. Horse Feed is made of oats, corn, wheat and linseed; the H. O. Poultry Food is a mixture of corn, oats and wheat, and the American Poultry Food contains corn and wheat.

Blatchford's Calf Meal has practically the same composition as was found last year. It was found to be a mixture of ground carob beans, linseed, a wheat product, cotton seed and fenugreek, containing about the same percentages of protein, fat and nitrogen-free extracts as the gluten feeds.

The analyses of six animal meals, and other poultry feeds, are also given in the table, and at the end are analyses of four condimental foods or medicines.

Condimental and Medicinal Cattle Foods.

Poultriotone is a mixture of wheat offal, corn, bone, salt and charcoal.

Pasture Stock Food contains corn, linseed, a wheat product, ginger, charcoal and salt.

Imperial Egg Food contains a wheat product, bone, carbonate of lime, red pepper, with 6 per cent. of sand.

Wilbur's Seed Meal Horse and Cattle Food contains gluten meal, wheat, linseed, charcoal and salt.

Regarding these condimental foods we can only repeat what was said last year.

The claims that by the use of condiments and spices the digestibility of food can be increased and in this way a saving of feed can be effected, have no basis in fact. No experiments have demonstrated or made even probable such an effect. Stock feeders will be very slow to believe that cotton-seed meal, linseed meal, wheat feeds, or corn products can be made more easily digestible or even more acceptable to healthy cattle by mixing with them Epsom salts, charcoal, ginger or fenugreek.

The Prices of Condimental Feeds. The cheapest of those collected in this state in 1901 cost about 20 cents per pound, the most expensive 25 cents.

As foods, pure and simple, such prices are ridiculous and prohibitive. If in large lots they can be bought at half or a quarter of the rates for small packages; even such a discount would make them twice as costly as our most expensive standard feeds, and no one of them is as concentrated a feed as either cotton-seed meal, linseed meal or gluten meal.

In buying medicines mixed at a drug store one pays very much more in proportion than he would for the ingredients singly, in bulk, and in much larger quantity. He pays for the convenience of having all of them accessible in one place in as small amount as he desires, mixed accurately according to his written directions and put up to be conveniently carried.

There is, however, absolutely no sense in buying at a very high price a lot of drugs of rather mild medicinal properties, of unknown kinds and in unknown proportions, which claim to take the place of a part of the food and to cure almost every ill and defect that cattle and fowls are heir to.

Salt, charcoal, Epsom salts, sulphur, fenugreek, gentian, cayenne and ginger:—they can all be bought probably in any village in Connecticut, they are already in the stables of many dairy farmers and are used by them, their value is well known, and also their uselessness for the treatment of serious illnesses.

TABLE I.—DIGESTION COEFFICIENTS, OR PERCENTAGES OF THE FOOD INGREDIENTS, FOUND BY ANALYSIS, WHICH ARE DIGESTIBLE BY NEAT CATTLE.

(Jordan's Compilation, Office of Experiment Stations, Bulletin 77.)

	Protein.	Fiber.	Nitrogen-free Extract.	Fat.
Cotton Seed Meal	88	56	61	93
Linseed Meal, new process	85	80	86	97
Linseed Meal, old process	89	57	78	89
Corn Meal	68	--	95	92
Gluten Meal	88	--	90	94
Gluten Feed	86	78	89	84
Wheat Bran	78	29	69	68
Wheat Middlings	80	33	81	86
Wheat Mixed Feed	80	25	78	78
Rye Meal	84	--	92	64
Malt Sprouts	80	33	68	100
H. O. Dairy Feed	78	41	70	86
H. O. Horse Feed	74	35	79	84
Quaker Oat Feed	81	43	67	89
Victor Corn and Oat Feed	71	48	83	87

The use of the above table is quite simple. Suppose analysis shows a certain sample of cotton-seed meal to contain 43.5 per cent. of protein; that is, 43.5 pounds of protein in 100 pounds of the meal. It is desired to know how much *digestible* protein are contained in 100 pounds of meal. The table of "digestion coefficients" shows that of every 100 pounds of crude protein

in cotton-seed meal 88 pounds are digestible. It follows by the rule of three (100 is to 88 as 43.5 is to 38.28), that of the 43.5 pounds of protein, 38.28 pounds are digestible. To apply the table, multiply the percentage found on analysis by the proper coefficient taken from the table and divide the product by 100. The result will be the percentage amount of *digestible* protein, fiber, etc., as the case may be.

REGARDING THE PURCHASE OF COMMERCIAL FEEDING-STUFFS.

It needs to be constantly borne in mind that feeding-stuffs are bought to supply a deficiency of protein in those which are usually raised on the farm.

Hay, corn fodder, ensilage and stover form the basis and make up the bulk of the cattle food and should supply all the coarse feed, as well as most of the starch, sugar and fat which are needed.

They are, however, deficient in protein. The feeder's aim then is, or should be, to buy *digestible protein* at as low a price as he can, in forms relished by his stock. He is not in the market to buy mixtures of cattle medicine and food, nor starchy foods, nor woody fiber, nor the many wastes of factories, where so-called "breakfast goods" for human use are made.

It will very rarely pay him to buy anything which contains as little protein as corn meal. Corn meal he can raise much cheaper than he can usually buy it—and corn meal fed with hay or ensilage needs the addition of some feed richer in protein, in order to avoid waste of starchy matter in feeding.

Table II is a list of the commercial feeding-stuffs mentioned in this Bulletin with the percentages of protein and fat in them, and their average prices, arranged according to the per cent. of protein, the ingredient which the buyer is chiefly concerned with.

Study of the table shows that we have five or six distinct groups of feeding-stuffs:

1. Cotton-seed meal and Atlantic gluten with over 40 per cent. of protein and costing respectively $28.80 and $30.00 per ton.
2. The linseed and gluten meals and buckwheat middlings, containing between 30 and 40 per cent. of protein, the prices ranging from $20.00 to $33.30 per ton.

3. The gluten feeds containing from 20 to 30 per cent. of protein, prices ranging from $23.00 to $25.00 per ton.
4. The wheat feeds, H. O. dairy feed and rye feed, having between 15 and 20 per cent. of protein and costing from $21.00 to $25.00 per ton.
5. Lower grade feeds which the feeder of dairy stock need not consider at all in buying protein to balance a ration made up of home-grown fodder.

It will also be noticed that the percentages of fat in these feeds are not very unlike, ranging between 1.4 and 5.5 per cent., with the exception of cotton-seed meal, old process linseed meal, hominy chops and buckwheat middlings, so that a rough comparison of the feeds can be made, *taking account of protein alone,* as that is the ingredient which the feeder is chiefly concerned in getting.

Such a comparison would show the following:

If 20 pounds of Protein in Cotton Seed Meal cost	$0.65
Then 20 pounds of Protein in Atlantic Gluten Meal costs about	.70
" " Linseed Meals " "	.82
" " other Gluten Meals "	.88
" " Gluten Feeds " "	.93
" " Wheat and Rye Feeds and H. O. Dairy Feed cost about	1.23
" " Corn and Oat Feeds costs about	2.54–2.91

The above is not intended to do more than make a rough but practically just statement of the *comparative* cost of protein in the several classes of feeding-stuffs. Of course all feeds contain other valuable food ingredients besides protein and fat, but they are not ingredients which the feeder needs to buy.

As a general rule, he cannot afford to buy anything belonging in class 5. Home-grown corn meal makes anything in this group superfluous.

It is the part of economy to raise all the corn meal which is needed at home, not to buy anything to balance the cattle ration containing less protein than wheat feeds, and to let all condimental and medicinal cattle foods alone.

"Cheap" and low grade oat feeds do not contain what the feeder needs to buy for his stock, and they are therefore worthless to him.

TABLE II.—COMMERCIAL FEEDS ARRANGED ACCORDING TO THE PERCENTAGES OF PROTEIN IN THEM.

	Protein. Per cent.	Fat. Per cent.	Cost. Per ton.
Cotton Seed Meal	44.4	9.8	$28.80
Atlantic Gluten Meal	42.8	1.4	30.00
New Process Linseed Meal	39.0	1.8	30.00
Chicago Gluten Meal	36.0	3.4	33.30
Cream Gluten Meal	34.5	1.3	28.50
Old Process Linseed Meal	34.4	7.7	30.50
Buckwheat Middlings	30.7	8.2	20.00
Marshalltown Gluten Feed	27.7	3.6	25.00
Buffalo Gluten Feed	26.6	3.5	24.70
Waukegan Gluten Feed	26.6	4.2	25.00
Pekin Gluten Feed	26.2	3.5	24.00
Geneva Gluten Feed	26.2	3.8	24.00
Davenport Gluten Feed	25.7	4.2	23.00
Nat'l. Starch Co.'s Gluten Feed	25.4	3.1	25.00
Spring Wheat Middlings	19.7	5.5	22.10
H. O. Dairy Feed	19.7	4.1	25.30
Spring Wheat Mixed Feed	18.5	5.1	22.20
Winter Wheat Middlings	18.0	5.0	22.75
Winter Wheat Mixed Feed	17.5	4.7	22.20
Spring Wheat Bran	17.3	4.7	21.06
Winter Wheat Bran	16.3	4.5	21.80
Rye Feed	15.8	3.0	24.10
Quaker Dairy Feed	13.6	3.3	22.00
H. O. Horse Feed	13.0	4.3	25.00
Corn, Oats and Barley	12.6	4.9	25.20
Hominy Feed	11.4	8.5	24.45
Corn Bran Sugar Feed	11.0	4.1	19.75
Provender	10.6	4.3	24.00
Victor Corn and Oat Feed	10.3	4.1	23.25
Corn Meal	9.7	4.1	26.70
De-Fi Oat Feed	9.3	3.1	23.66
Boss Corn and Oat Feed	8.9	3.5	26.00
Vim Oat Feed	7.9	2.9	18.00
Royal Oat Feed	6.3	2.2	17.00

THE WEIGHT OF ONE QUART OF VARIOUS FEEDING-STUFFS.

The following table gives the weight of one quart of the feeds named, and is useful to calculate the weight of grain ration fed, from the measure which is almost universally used on farms.

This table was prepared by Mr. H. G. Manchester of West Winsted.

TABLE III.—THE AVERAGE WEIGHT OF ONE QUART OF EACH OF THE FEEDS NAMED.

BY H. G. MANCHESTER, WEST WINSTED.

	Pounds.
Cotton Seed Meal	1.5
Linseed Meal, old process	1.1
Gluten Meal	1.7
Gluten Feed	1.2
Wheat Bran, coarse	0.5
Wheat Middlings, coarse	0.8
Wheat Middlings, fine	1.1
Mixed Wheat Feed	0.6
Corn Meal	1.5
Oats	1.2
Rye Bran	0.6
H. O. Dairy Feed	0.7
Victor Corn and Oat Feed	0.7

SUMMARY.

It appears from the foregoing discussion and tables of analyses,

1. Cotton-seed meal, linseed meal, the gluten meals and feeds, and the factory mixed feeds of the American Cereal Co. and the H. O. Company are, as a rule, sold with a guaranteed percentage of protein and fat as is required by the state law. On the other hand, the wheat feeds, and the corn feeds—other than those named above—as well as most other feeds, are, as a rule, sold without guarantees, which is contrary to law.

2. The only evidence of deliberate fraud in the feed market which is shown by the analyses, is the mixing of finely ground corn cobs with wheat feed. The brand of one of these mixtures of cobs and wheat is "Choice Eclipse Mixed Feed," sold by the W. R. Mumford Co., 528 Rialto Bldg., Chicago, Ill. The other, "C Mixed Feed," was sold by D. C. Comstock, Providence, R. I.

3. There are in the feed market a considerable number of very inferior oat feeds, and mixed corn and oat feeds, which contain a large proportion of hulls and chaff, and which cannot profitably be used by the stock feeder at any price.

4. The dairyman's chief concern in buying feeds to supplement his farm supply of corn, stover, hay, etc., should be to buy, on the most reasonable terms, protein in digestible and palatable forms. Seldom will it pay him to buy any feed containing less than 12 to 15 per cent. of crude protein.

TABLE IV.—ANALYSES OF COMMERCIAL FEEDS. SAMPLED IN 1901.

Station No.	Name of Feed.	Manufacturer or Jobber.	Retail Dealer.	Analyses. Water.	Ash.	Protein.	Fiber.	Nitrogen-free Extract. (Starch, gum, etc.)	Ether Extract.	Price per ton.
	Cotton Seed Meal.									
4319	Cotton Seed Meal	Hunter Bros., St. Louis, Mo.	Bridgeport, Wm. Terry & Co.	8.46	7.31	45.75	9.90	19.08	9.50	$28.00
4524	" "	J. E. Soper & Co., Boston, Mass.	Middletown, Meech & Stoddard	7.74	6.40	45.37	5.39	25.94	9.16	29.00
2438	"	G. B. Robinson, Jr., New York	New Haven, R. G. Davis	8.51	6.41	43.12	6.69	26.42	8.85	28.00
4303	"	Independent Cotton Oil Co., Memphis	Abner Hendee	8.56	7.27	43.56	5.46	23.79	11.36	32.00
4362	" "Dixie Brand	Humphreys, Goodwin & Co., Memphis	New Milford, T. Soule & Co.	8.07	7.16	45.31	6.45	22.72	10.29	28.00
4515	" "	American Cotton Oil Co., Brinkley, Ark.	Willimantic, H. A. Bugbee	6.74	7.26	43.25	9.07	23.64	10.04	28.00
			Average of the above 6 analyses	**8.01**	**6.97**	**44.39**	**7.16**	**23.60**	**9.87**	
			Average digestible			39.07	4.01	14.40	9.17	
	New Process Linseed Meal.									
4320	Linseed (Oil) Meal	Not known	Bridgeport, W. M. Terry & Co.	10.19	5.35	44.00	5.24	33.69	1.53	30.00
4317	" "	Not known	Wheeler & Howe	10.15	5.30	37.31	9.74	36.03	1.47	35.00
4309	Linseed Meal	Not known	Hamden, Ira W. Beers	9.87	5.40	39.87	8.46	34.02	2.38	26.00
2439	" (Oil) Meal	Not known	New Haven, R. G. Davis	10.41	5.58	39.81	8.35	34.42	1.43	29.00
	Linseed Meal, Old Process.									
4283	Lins'd Meal, Square Brand	Not known	New Haven, J. T. Benham	9.84	5.42	30.81	9.56	36.82	7.55	29.00
4302	" "	L. G. F. Co.	Abner Hendee	10.16	5.40	30.75	9.71	35.93	8.05	32.00
4413	"	American Linseed Co., Chicago	New London, Arnold Rudd	9.47	4.80	37.81	8.14	32.19	7.59	31.00
4545	"	Mann Bros. & Co., Buffalo, N. Y.	Rockville, Edward White	9.22	4.69	38.25	7.64	32.79	7.41	36.00
			Average of the above 4 analyses of New Process linseed meal	**10.15**	**5.41**	**40.25**	**7.95**	**34.54**	**1.70**	
			Average digestible			34.21	6.36	29.70	1.55	
			Average of the above 4 analyses of Old Process linseed meal	**9.67**	**5.08**	**34.41**	**8.76**	**34.43**	**7.65**	
			Average digestible			30.62	4.99	26.86	6.81	
	WHEAT PRODUCTS. *Bran from Winter Wheat.*									
4307	Bran, Canadian	C. M. Cox & Co., Boston	Hamden, Ira W. Beers	8.94	6.04	14.75	10.24	55.59	4.44	22.00
4290	" White	" " "	New Haven, J. T. Benham	9.40	6.01	15.25	9.04	55.66	4.64	21.00
4451	" Winter Wheat	Stott's Flour Mills, Detroit, Mich.	Yantic, A. R. Manning & Co.	9.15	5.73	15.87	9.66	55.32	4.27	22.00
4350	" Michigan	Valley City Milling Co., Grand Rapids, Mich.	New Milford, Ackley, Hatch & Marsh	9.36	6.38	18.06	8.51	53.07	4.62	21.00
4397	" Choice	Voigt Milling Co., Grand Rapids, Mich.	Waterbury, Platt's Mill Co.	8.76	5.87	17.37	8.39	55.04	4.57	23.00
			Average of the above 5 analyses	**9.12**	**6.01**	**16.26**	**9.17**	**54.93**	**4.51**	
			Average digestible			12.68	2.66	37.89	3.07	
	Bran from Spring Wheat.									
4447	Bran		Greenville, B. H. Palmer	8.37	6.15	16.87	11.29	52.36	4.96	22.00
4487	" Banner	Banner Milling Co., Buffalo, N. Y.	Willimantic, W. D. Grant	8.45	5.57	17.50	9.81	53.74	4.93	19.00
4440	"	Bay State Milling Co., Winona, Minn.	Norwich, A. A. Beckwith	8.27	6.59	18.44	11.79	49.59	5.32	22.00
4287	" Badger	Bergen Anderson Co., Milwaukee	New Haven, J. T. Benham	9.36	6.12	17.56	10.54	51.50	4.92	19.50

TABLE IV.—*Continued.* ANALYSES OF COMMERCIAL FEEDS. SAMPLED IN 1901.

Station No.	Name of Feed.	Manufacturer or Jobber.	Retail Dealer.	Analyses. Water.	Ash.	Protein.	Fiber.	Nitrogen-free Extract. (Starch, gum, etc.)	Ether Extract.	Price per ton.
4478	Bran	L. Christian & Co., Minneapolis	Putnam, Bosworth Bros.	8.55	6.77	18.62	10.31	50.61	5.14	$22.00
4436	"	New Prague Milling Co., Minnesota	Norwich, Norwich Grain Co.	8.22	6.85	17.50	11.96	50.27	5.20	23.00
4474	" Broad Flake	New Prague Milling Co., Minnesota	Danielson, Quinnebaug Store	8.21	6.58	18.12	10.99	50.95	5.15	21.00
4471	"	Parker-Leland Mill Co., Winnebago, Minn.	Waldo Bros.	8.09	5.91	17.31	10.76	54.04	3.89	21.00
4359	"	Pillsbury, Minneapolis	New Milford, F. R. Green	9.44	6.03	17.19	11.11	51.35	4.88	21.00
4333	"	" "	Stamford, Ingersoll & Bro.	8.96	7.50	16.56	11.49	50.81	4.68	21.00
4372	" Coarse	Sheffield Milling Co., Faribault, Minn.	Bethel, Judd & Judd	8.87	6.26	16.62	12.56	51.85	3.84	22.00
4308	"	Simpson, Hendee & Co., N. Y.	Hamden, Ira W. Beers	9.28	6.65	16.31	9.51	53.79	4.46	20.50
4384	" Coarse	Washburn-Crosby Co., Minneapolis	Litchfield, Marsh & Newcomb	8.96	6.20	17.06	10.79	52.26	4.73	23.00
4288	"	Washburn-Crosby Co., Minneapolis	New Haven, J. T. Benham	9.21	6.28	17.62	10.25	51.44	5.20	20.00
4412	"	Washburn-Crosby Co., Minneapolis	New London, Arnold Rudd	8.65	6.25	16.87	11.54	52.14	4.55	20.00
4363	"	Washburn-Crosby Co., Minneapolis	New Milford, T. Soule & Co.	8.72	6.92	17.44	11.89	51.12	3.91	21.00
4466	" Snow's Flaky	E. S. Woodworth & Co., Minneapolis	Danielson, C. A. Young	8.53	6.51	16.62	11.45	52.27	4.62	20.00
			Average of the above 17 analyses	**8.71**	**6.42**	**17.31**	**11.06**	**51.77**	**4.73**	
			Average digestible			13.50	3.21	35.71	3.22	
	Bran, unclassified.									
4314	Bran		Bridgeport, Wheeler & Howe	9.50	6.35	17.81	9.69	51.62	5.03	20.00
4429	" "F"	Narragansett Middling Co., R. I.	Stonington, S. H. Chesebro	8.22	6.23	17.25	11.64	51.74	4.92	22.00
	Middlings, Winter Wheat									
4419		N. L. Berry & Co., Providence, R. I.	New London, E. H. Caulkins	9.75	3.91	18.50	4.99	58.19	4.66	23.00
4386		Dow & King, Pittsfield, Ill.	Litchfield, Marsh & Newcomb	9.18	4.52	17.19	6.39	57.78	4.94	24.00
4407		Isaac Harter Co., Toledo, Ohio	Guilford, G. F. Walter	9.68	3.95	17.06	5.51	59.04	4.76	23.00
4421		Hecker-Jones-Jewell Co., New York	New London, E. Bishop	8.89	5.13	18.81	8.21	53.81	5.15	21.00
4416		Hecker-Jones-Jewell Co., New York	Beebe & Bragan	8.80	4.90	18.62	9.29	53.04	5.35	21.00
4411		Hecker-Jones-Jewell Co., New York	Arnold Rudd	9.15	4.99	17.75	9.46	53.50	5.15	21.00
4334		Hecker-Jones-Jewell Co., New York	Stamford, Ingersoll & Bro.	9.71	4.68	18.87	7.24	54.67	4.83	22.00
4414		Hunter Bros., St. Louis	New London, Arnold Rudd	9.20	4.20	17.19	5.16	58.06	6.19	24.00
4311		Simpson, Hendee & Co., New York	Hamden, Ira W. Beers	10.13	4.05	17.87	5.34	57.91	4.70	23.00
4450	Fine White	Stott's Flour Mills, Detroit, Mich.	Yantic, A. R. Manning & Co.	10.10	3.75	18.69	3.86	58.63	4.97	23.00
4435	Choice	Valley City Mill Co., Grand Rapids	Norwich, Norwich Grain Co.	9.87	4.87	17.50	5.29	57.74	4.73	23.00
4396	"	Voigt Milling Co., Grand Rapids	Waterbury, Platt's Mill Co.	10.27	4.07	17.50	5.16	58.47	4.53	25.00
			Average of above 12 analyses	**9.56**	**4.42**	**17.96**	**6.32**	**56.75**	**4.99**	
			Average digestible			14.37	2.11	45.96	4.29	

TABLE IV.—*Continued.* ANALYSES OF COMMERCIAL FEEDS SAMPLED IN 1901.

Station No.	Name of Feed.	Manufacturer or Jobber.	Retail Dealer.	Analyses. Water.	Ash.	Protein.	Fiber.	Nitrogen-free Extract. (Starch, gum, etc.)	Ether Extract.	Price per ton.
	Middlings, Spring Wheat.									
4439		Bay State Milling Co., Winona, Minn.	Norwich, A. A. Beckwith	8.69	5.28	21.25	7.24	51.14	6.40	$22.00
4484		L. Christian & Co., Minneapolis	Putnam, Bosworth Bros.	9.16	6.33	20.19	7.94	50.91	5.47	21.00
4457	Daisy	Daisy Roller Mills, Milwaukee	Jewett City, J. E. Leonard & Son	9.74	4.70	19.69	6.39	54.64	4.84	23.00
4477		J. G. Davis Co., Rochester, N. Y.	Danielson, Quinnebaug Store	9.75	3.55	19.50	4.84	57.76	4.60	21.00
4423	Colonial	Miner-Hillard Mill Co., Wilkesbarre	Groton, Groton Grain Co.	8.52	3.63	21.19	6.04	52.87	7.75	24.00
4519		New Prague Milling Co., New Prague, Minn.	Willimantic, H. A. Bugbee	9.52	4.87	19.56	8.36	52.42	5.27	22.00
4433		Northwestern Con. Milling Co., Minn.	Mystic, J. L. Manning & Co.	9.07	5.02	18.19	9.01	53.27	5.44	23.00
4284		Northwestern Con. Milling Co., Minn.	New Haven, J. T. Benham	9.59	4.85	18.69	9.04	52.30	5.53	20.00
4492		Northwestern Con. Milling Co., Minn.	Willimantic, E. A Buck & Co.	8.67	5.27	17.12	11.14	52.37	5.43	21.00
4381	"B"	Pillsbury, Minneapolis	Danbury, O. H. Meeker	9.28	5.07	18.37	9.76	52.62	4.90	21.00
4448	"	" "	Greenville, B. H. Palmer	8.80	5.27	18.44	10.04	52.09	5.36	22.00
4366	"	" "	New Milford, T. Soule & Co.	9.17	4.47	19.75	8.94	52.41	5.26	21.00
4360	"A"	" "	F. R. Green	9.25	4.25	19.87	6.26	54.94	5.43	23.00
4345	"	" "	West Cornwall, Smith & Sons	10.17	4.13	19.69	6.49	54.49	5.03	24.00
4367		Sheffield Milling Co., Faribault, Minn.	Bethel, Johnston & Morrison	10.18	3.78	20.50	4.71	55.34	5.49	24.00
4382		Sheffield Milling Co., Faribault, Minn.	Danbury, O. H. Meeker	9.95	3.90	20.19	4.36	56.02	5.58	22.00
4310		Simpson, Hendee & Co., New York	Hamden, Ira W. Beers	10.22	4.41	19.94	7.74	51.82	5.87	21.00
4459		Urban Roller Mill Co., Buffalo	Jewett City, J. E. Leonard & Son	9.71	4.01	19.31	6.04	55.89	5.04	22.00
4453	Standard	Washburn-Crosby Co., Minneapolis	Yantic, A. R. Manning & Co.	9.29	4.78	19.94	7.76	53.01	5.22	21.00
4370	Snow's Cream Flour	Woodworth & Co., Minneapolis	Bethel, Johnston & Morrison	10.12	3.74	22.19	3.61	54.86	5.48	24.00
			Average of above 20 analyses	**9.44**	**4.57**	**19.68**	**7.29**	**53.55**	**5.47**	
			Average digestible			15.74	2.43	43.38	4.70	
	Middlings, unclassified.									
4321			Bridgeport, W. M. Terry & Co.	9.55	4.39	18.69	9.64	52.83	4.90	22.50
4318			Wheeler & Howe	9.03	4.48	18.06	6.79	56.59	5.05	21.00
4376	Dexter	Chapin & Co.	Danbury, F. C. Benjamin & Co.	8.95	4.82	20.25	7.06	53.25	5.67	22.00
4476	Standard		Danielson, Quinnebaug Store	9.58	4.77	19.75	8.26	52.61	5.03	21.00
4301			New Haven, Abner Hendee	8.71	4.57	19.19	6.71	55.45	5.37	25.00
4462		D. W. Comstock & Co., New York	Plainfield, J. P. Kingsley & Son	9.11	5.04	19.25	7.44	53.99	5.17	20.00
4332		C. M. Cox, Boston	So. Norwalk, M. T. Hatch	9.46	3.32	21.87	3.24	56.92	5.19	25.00
4428		Naragansett Milling Co., R. I.	Stonington, S. H. Cheseboro	9.03	4.90	18.62	7.56	54.92	4.97	23.00
	Mixed Feed from Winter Wheat.									
4544	Acme Feed	Acme Milling Co., Indianapolis	Rockville, Edward White	8.19	5.73	17.50	7.71	56.01	4.86	23.00
4449	"	Acme Milling Co., Indianapolis	Yantic, A. R. Manning & Co.	8.49	5.53	17.25	7.31	56.40	5.02	22.00

TABLE IV.—*Continued.* ANALYSES OF COMMERCIAL FEEDS SAMPLED IN 1901.

Station No.	Name of Feed.	Manufacturer or Jobber.	Retail Dealer.	Analyses. Water.	Ash.	Protein.	Fiber.	Nitrogen-free Extract. (Starch, gum, etc.)	Ether Extract.	Price per ton.
4465	Buckeye Wheat Feed	American Cereal Co.	Danielson, C. A. Young	9.41	4.84	18.31	7.11	55.87	4.46	$22.00
4347	" " "	" "	West Cornwall, Smith & Sons	9.67	5.08	17.75	7.49	55.97	4.04	23.00
4485	" " "	" "	Willimantic, W. D. Grant	8.66	5.30	18.56	7.26	55.48	4.74	21.00
4452	Fancy Mixed Feed	E. W. Bailey & Co., Montpelier, Vt.	Yantic, A. R. Manning & Co.	9.01	5.89	18.50	7.76	53.96	4.88	22.00
4399	Hoosier Mill Feed	Geo. T. Evans, Indianapolis	Ansonia, Ansonia Flour & Feed Co.	8.85	5.71	17.44	7.69	55.85	4.46	22.00
4403	Mixed Feed	Isaac Harter Co., Toledo, Ohio	Ansonia, Ansonia Flour & Feed Co.	8.75	5.52	17.50	7.51	56.19	4.53	22.00
4409	"	Isaac Harter Co., Toledo, Ohio	Guilford, G. F. Walter	9.07	5.90	17.56	7.91	54.75	4.81	23.00
2437	"	Isaac Harter Co., Toledo, Ohio	New Haven, R. G. Davis	9.57	5.92	17.00	7.36	55.17	4.98	22.00
4331	"	Isaac Harter Co., Toledo, Ohio	So. Norwalk, M. T. Hatch	8.95	5.93	17.87	7.74	54.79	4.72	22.00
4286	"	Hecker-Jones-Jewell Co., N. Y.	New Haven, J. T. Benham	9.61	5.38	17.37	8.89	54.18	4.57	21.00
2436	"	Hecker-Jones-Jewell Co., N. Y.	R. G. Davis	9.85	5.79	17.37	8.69	53.42	4.88	22.00
4304	"	Hecker-Jones-Jewell Co., N. Y.	Abner Hendee	9.83	5.41	18.12	8.06	53.76	4.82	21.00
4550	Michigan Mixed Feed	Abner Hendee, New Haven	Avon, J. & H. Woodford	8.71	5.80	17.12	8.29	55.69	4.39	22.00
4479	Sunshine	Hunter Bros., St. Louis	Putnam, Bosworth Bros.	8.69	4.88	17.50	6.86	57.39	4.68	23.00
4547	Mixed Feed	Kehlor Bros.	Hartford, L. C. Daniels Grain Co.	8.63	6.33	17.37	8.31	54.80	4.56	24.00
4463	Snow Flake	Lawrenceburg Roller Mills Co., Ind.	Danielson, C. A. Young	9.08	5.73	18.25	7.16	54.88	4.90	22.00
4354	"	Lawrenceburg Roller Mills Co., Ind.	New Milford, Ackley, Hatch & Marsh	9.29	6.12	18.12	7.51	54.21	4.75	23.00
4518	"	Lawrenceburg Roller Mills Co., Ind.	Willimantic, H. A. Bugbee	9.04	5.84	18.00	7.76	54.55	4.81	22.00
4404	Mixed Feed	Lexington Roller Mills Co., Ky.	Ansonia, Ansonia Flour & Feed Co.	9.37	5.53	15.87	7.31	57.01	4.91	22.00
4539	"	J. E. M. Milling Co., Frankfort, Ky.	New Britain, Hugh Reynolds	8.44	6.18	16.81	6.89	57.00	4.68	22.00
4534	King Feed	R. P. Moore Milling Co., Princeton, Ind.	Wallingford, E. E. Hall	8.55	5.60	17.31	7.14	56.63	4.77	22.00
4348	Mixed Feed	Rex Mill Co.	West Cornwall, Smith & Sons	10.15	5.90	17.19	8.71	53.84	4.21	23.00
4351	Farmers' Favorite	Valley City Milling Co., Grand Rapids, Mich.	New Milford, Ackley, Hatch & Marsh	9.60	5.37	16.75	8.26	55.44	4.58	22.00
4491	"	Valley City Milling Co., Grand Rapids, Mich.	Stafford, E. C. Dennis	9.34	5.33	16.94	7.41	56.35	4.63	22.00
			Average of the above 26 analyses	**9.11**	**5.64**	**17.51**	**7.70**	**55.36**	**4.68**	
			Average digestible			14.01	1.93	43.18	3.65	
	Mixed Feed from Spring Wheat.									
4375	Boston	Imperial Milling Co., Duluth, Minn.	Danbury, F. C. Benjamin & Co.	9.88	4.72	18.75	7.71	54.40	4.54	22.00
4540	Jersey		New Britain, M. D. Stanley	8.91	5.16	18.62	8.46	54.04	4.81	24.00
4475		New Prague Milling Co., Minn.	Danielson, Quinnebaug Store	8.62	5.69	19.44	8.84	51.49	5.92	22.00
4358	Fancy	Pillsbury, Minneapolis	New Milford, F. R. Green	9.80	4.75	18.62	7.09	54.88	4.86	22.00
4343	"	" "	West Cornwall, Smith & Sons	9.50	4.76	18.87	6.94	54.33	5.60	22.00
4380	Superior	Washburn-Crosby Co.	Danbury, O. H. Meeker	8.67	5.88	17.19	8.79	54.14	5.33	22.00

TABLE IV.—*Continued.* ANALYSES OF COMMERCIAL FEEDS. SAMPLED IN 1901.

Station No.	Name of Feed.	Manufacturer or Jobber.	Retail Dealer.	Analyses.						Price per ton.
				Water.	Ash.	Protein.	Fiber.	Nitrogen-free Extract. (Starch, gum, etc.)	Ether Extract.	
4385	Superior	Washburn-Crosby Co.	Litchfield, Marsh & Newcomb	8.80	5.80	17.69	9.29	53.08	5.34	$23.00
4357	"	" "	New Milford, F. R. Green	9.56	5.58	18.44	9.34	52.31	4.77	22.00
4488	"	" "	Stafford, E. C. Dennis	9.28	5.05	19.25	8.29	53.27	4.86	21.00
			Average of the above 9 analyses	**9.22**	**5.26**	**18.54**	**8.31**	**53.56**	**5.11**	
			Average digestible			14.83	2.08	41.78	3.99	
	Mixed Feed, unclassified.									
4542	Monogram		Hartford, E. P. Yates & Co.	9.23	4.68	18.94	6.36	56.35	4.44	25.00
4373	"		Bethel	9.62	4.59	19.44	5.81	55.99	4.55	23.00
2447	J. L. C.	Chapin & Co., Boston	North Haven, Co-op. Feed Co.	9.90	4.77	17.12	6.74	57.10	4.37	22.00
2444	Star and Crescent, Ground Wheat Feed	" "	" "	9.95	4.44	17.87	5.94	57.45	4.35	22.00
4514	Mixed Feed	E. Crosby & Co.	Willimantic, E. A. Buck & Co.	9.29	4.85	18.56	7.89	54.43	4.98	21.00
4306	"	Simpson, Hendee & Co., New York	Hamden, Ira W. Beers	9.34	5.94	18.19	7.71	54.00	4.82	21.00
	Mixed Feed, adulterated.									
4295	Choice Eclipse Mixed Feed	W. R. Mumford, Chicago	Branford, S. V. Osborn	8.62	4.53	12.50	14.59	56.27	3.49	22.00
4406	Choice Eclipse Mixed Feed		Guilford, F. H. Rolf	8.23	4.74	12.44	17.07	54.17	3.35	23.00
4470	"C" Mixed Feed	D. C. Comstock, Providence, R. I.	Danielson, Waldo Bros.	8.07	4.73	13.75	13.54	56.34	3.57	22.00
	CORN PRODUCTS. *Corn Meal.*									
2312	Corn Meal	Ira W. Beers, Hamden	Hamden, Ira W. Beers	11.61	1.32	9.50	1.95	71.57	4.05	25.50
4434	"	J. L. Manning & Co., Mystic	Mystic, J. L. Manning & Co.	10.85	1.34	9.87	1.65	72.19	4.10	28.00
			Average of the above 2 analyses	**11.23**	**1.33**	**9.68**	**1.80**	**71.89**	**4.07**	
			Digestible			6.57		68.29	3.74	
4520	Atlantic Gluten Meal	Atlantic Starch Works, Westport, Conn.	Middletown, Meech & Stoddard	**7.71**	**1.01**	**42.75**	**1.67**	**45.48**	**1.38**	30.00
			Digestible	....	....	37.62		40.93	1.30	
	Gluten Meal.									
4422	Cream Gluten Meal	Chas. Pope Glucose Co., Chicago, Ill.	Groton, Groton Grain Co.	10.11	0.89	36.75	0.84	49.95	1.46	29.00
2448	" "	Chas. Pope Glucose Co., Chicago, Ill.	North Haven, Jos. Pierpont	9.17	0.89	32.31	1.36	55.04	1.23	28.00
			Average of the above 2 analyses	**9.64**	**0.89**	**34.53**	**1.10**	**52.50**	**1.34**	
			Average digestible			30.38		47.25	1.25	
4456	Chicago Gluten Meal	Glucose Sugar Refining Co., Chicago, Ill.	Jewett City, J. E. Leonard & Son	8.61	0.99	35.25	1.49	50.02	3.64	35.00
4352	" "	Glucose Sugar Refining Co., Chicago, Ill.	New Milford, Ackley, Hatch & Marsh	8.71	1.36	35.75	1.99	48.36	3.83	30.00
4395	" "	Glucose Sugar Refining Co., Chicago, Ill.	Waterbury, The Platt Mills Co.	8.87	0.87	36.94	1.79	48.74	2.79	35.00
			Average of the above 3 analyses	**8.73**	**1.07**	**35.98**	**1.76**	**49.04**	**3.42**	
			Average digestible			31.66		44.14	3.21	
	Gluten Feed.									
4315	Buffalo Gluten Feed	Glucose Sugar Refining Co., Chicago, Ill.	Bridgeport, Wheeler & Howe	8.83	1.89	25.87	7.26	52.89	3.26	25.00
4408	" "	Glucose Sugar Refining Co., Chicago, Ill.	Guilford, G. F. Walter	8.72	2.24	26.75	7.29	51.30	3.70	25.00
4305	" "	Glucose Sugar Refining Co., Chicago, Ill.	Hamden, Ira W. Beers	9.34	1.86	26.37	6.96	52.32	3.15	24.00

TABLE IV.—*Continued.* ANALYSES OF COMMERCIAL FEEDS. SAMPLED IN 1901.

Station No.	Name of Feed.	Manufacturer or Jobber.	Retail Dealer.	Analyses. Water.	Ash.	Protein.	Fiber.	Nitrogen-free Extract. (Starch, gum, etc.)	Ether Extract.	Price per ton.
4522	Buffalo Gluten Feed	Glucose Sugar Refining Co., Chicago, Ill.	Middletown, Meech & Stoddard	8.21	2.16	27.81	7.19	51.09	3.54	$27.00
4285	" "	Glucose Sugar Refining Co., Chicago, Ill.	New Haven, J. T. Benham	9.10	1.77	26.62	7.54	51.47	3.50	23.00
4415	" "	Glucose Sugar Refining Co., Chicago, Ill.	New London, Beebe & Bragan	8.47	1.77	26.62	7.46	51.85	3.83	24.00
4516	" "	Glucose Sugar Refining Co., Chicago, Ill.	Willimantic, H. A. Bugbee	8.16	2.64	26.19	7.26	52.16	3.59	25.00
			Average of the above 7 analyses	**8.69**	**2.05**	**26.60**	**7.28**	**51.87**	**3.51**	
			Average digestible			22.87	5.68	46.15	2.93	
4530	Davenport Gluten Feed	Glucose Sugar Refining Co., Chicago, Ill.	East Haven, Hawkins & Forbes	8.90	2.14	26.25	6.14	52.31	4.26	23.00
2445	" "	Glucose Sugar Refining Co., Chicago, Ill.	North Haven, Co-op. Feed Co.	9.62	1.76	25.12	6.94	52.37	4.19	23.00
			Average of the above 2 analyses	**9.26**	**1.95**	**25.68**	**6.54**	**52.34**	**4.23**	
			Average digestible			22.08	5.10	46.58	3.55	
4548	Marshalltown Gluten Feed	Glucose Sugar Refining Co., Chicago, Ill.	Avon, J. & H. Woodford	8.71	1.40	26.87	7.11	52.27	3.64	24.00
4536	Marshalltown Gluten Feed	Glucose Sugar Refining Co., Chicago, Ill.	Meriden, S. A. Billings	7.75	2.80	28.44	7.11	50.31	3.59	26.00
			Average of the above 2 analyses	**8.23**	**2.10**	**27.66**	**7.11**	**51.29**	**3.61**	
			Average digestible			23.78	5.55	45.65	3.03	
4294	Gluten Feed	National Starch Co., Glen Cove, N. Y.	Branford, S. V. Osborn	9.09	0.63	25.37	5.64	56.37	2.90	25.00
2435	"	National Starch Co., Glen Cove, N. Y.	New Haven, R. G. Davis	8.78	0.63	23.62	5.74	58.21	3.02	24.00
4300	"	National Starch Co., Glen Cove, N. Y.	Abner Hendee	8.39	0.67	23.37	5.84	59.19	2.54	25.00
4410	"	National Starch Co., Glen Cove, N. Y.	New London, Arnold Rudd	7.47	0.56	23.69	7.45	57.92	2.91	25.00
4443	"	National Starch Co., Glen Cove, N. Y.	Norwich, A. A. Beckwith	9.94	0.76	30.81	4.69	49.86	3.94	25.00
			Average of the above 5 analyses	**8.74**	**0.65**	**25.37**	**5.87**	**56.31**	**3.06**	
			Average digestible			21.81	4.57	50.11	2.57	
4379	Waukegan Gluten Feed	U. S. Sugar Refining Co., Waukegan, Ill.	Danbury, O. H. Meeker	8.62	1.19	26.69	6.76	52.57	4.17	25.00
4468	" "	U. S. Sugar Refining Co., Waukegan, Ill.	Danielson, Waldo Bros.	8.65	1.32	26.56	7.16	52.03	4.28	25.00
			Average of the above 2 analyses	**8.64**	**1.26**	**26.62**	**6.96**	**52.30**	**4.22**	
			Average digestible			22.89	5.43	46.54	3.54	
4417	Geneva Gluten Feed	Chapin & Co., Boston, Mass.	New London, E. H. Caulkins	**7.91**	**0.96**	**26.19**	**8.31**	**52.87**	**3.76**	24.00
			Average digestible			22.52	6.48	47.05	3.16	
4469	Pekin Gluten Feed	Ill. Sugar Refining Co., Pekin, Ill.	Danielson, Waldo Bros.	7.41	0.88	25.56	7.76	55.44	2.95	25.00
4383	" "	Ill. Sugar Refining Co., Pekin, Ill.	Litchfield, Marsh & Newcomb	6.85	0.92	26.75	7.24	54.19	4.05	23.00
			Average of the above 2 analyses	**7.13**	**0.90**	**26.15**	**7.50**	**54.82**	**3.50**	
			Average digestible			22.43	5.85	48.78	2.94	
2446	Germ Oil Meal	Glucose Sugar Refining Co., Chicago, Ill.	North Haven, Co-op. Feed Co.	10.15	2.35	22.25	9.19	46.53	9.53	25.00
4535	" "	Glocose Sugar Refining Co., Chicago, Ill.	Wallingford, E. E. Hall	9.49	2.37	22.00	9.31	47.43	9.40	24.00
			Average of the above 2 analyses	**9.82**	**2.36**	**22.12**	**9.25**	**46.98**	**9.47**	

TABLE IV.—*Continued.* ANALYSES OF COMMERCIAL FEEDS. SAMPLED IN 1901.

Station No.	Name of Feed.	Manufacturer or Jobber.	Retail Dealer.	Analyses. Water.	Ash.	Protein.	Fiber.	Nitrogen-free Extract. (Starch, gum, etc.)	Ether Extract.	Price per ton.
4400	Corn Bran Sugar Feed	J. E. Soper & Co., Boston, Mass.	Ansonia, Ansonia Flour & Grain Co.	8.85	0.98	11.50	11.90	61.62	5.15	$20.00
4526	" "	J. E. Soper & Co., Boston, Mass.	Middletown, Meech & Stoddard	6.56	0.95	10.62	13.65	65.04	3.18	20.00
2442	" "	J. E. Soper & Co., Boston, Mass.	New Haven, R. G. Davis	9.16	0.82	11.00	11.70	63.51	3.81	19.00
			Average of the above 3 analyses	**8.19**	**0.91**	**11.04**	**12.42**	**63.39**	**4.05**	
	Hominy Feed.									
4461	Hominy Chop	M. F. Barringer, Phila., Pa.	Plainfield, J. P. Kingsley & Son	8.35	2.82	11.50	4.34	63.93	9.06	22.50
4430	Niagara Hominy Meal	Chapin & Co., Boston, Mass.	Mystic, J. L. Manning & Co.	7.67	2.73	11.56	4.04	65.38	8.62	25.00
4418	" "	Chapin & Co., Boston, Mass.	New London, E. H. Caulkins	7.41	2.86	11.81	5.19	63.21	9.52	24.00
2443	" "	Chapin & Co., Boston, Mass.	North Haven, Co-op. Feed Co.	9.41	2.66	11.25	4.33	63.64	8.71	23.00
4533	Diamond Hominy Feed	Chapin & Co., Boston, Mass.	Wallingford, E. E. Hall	8.48	2.43	10.56	4.59	66.41	7.53	24.00
4538	Hominy Feed	C. M. Cox, Boston, Mass.	Berlin, J. C. Lincoln	8.12	2.87	10.94	5.02	65.75	7.30	25.00
4464	Hominy Chop	" "	Danielson, C. A. Young	8.69	2.56	10.94	4.89	65.37	7.55	23.00
4326	Hominy Feed	Hollister, Chase & Co., New York	Bridgeport, Wheeler & Co.	9.05	2.53	10.87	4.21	65.14	8.20	25.00
4521	Hominy Chop	Hollister, Chase & Co., New York	Middletown, Meech & Stoddard	8.42	2.83	11.69	4.64	63.35	9.07	25.00
4546	Hominy Feed	Hunter Bros., St. Louis, Mo.	East Hartford, W. J. Cox	7.03	2.97	11.25	4.54	65.38	8.83	24.00
4353	"	Husted Milling Co., Buffalo, N. Y.	New Milford, Ackley, Hatch & Marsh	7.84	2.61	11.12	5.46	64.97	8.00	26.00
4528	Hominy Chop	T. F. Lane & Co., New York	Middletown, Coles & Co.	8.65	2.82	11.69	4.49	63.47	8.88	24.00
4330	"	T. F. Lane & Co., New York	So. Norwalk, Manuel T. Hatch	9.32	2.53	11.50	4.56	63.79	8.30	25.00
4336	"	T. F. Lane & Co., New York	Stamford, E. E. Scofield	9.86	2.52	11.44	4.41	63.58	8.19	24.00
4388	Hominy Meal	Miner-Hillard Milling Co., Wilkesbarre	Thomaston, L. E. Blackmer	8.90	2.52	11.25	4.19	64.95	8.19	26.00
4393	"	Miner-Hillard Milling Co., Wilkesbarre	Waterbury, D. L. Dickinson	9.23	2.81	11.75	4.69	62.51	9.01	27.00
4455	Hominy Chop	Miner Mills Co., Miner Mills, Pa.	Jewett City, J. E. Leonard & Son	9.27	2.90	12.00	2.84	63.80	9.19	24.00
4427	"	Narragansett Milling Co., R. I.	Stonington, S. H. Chesebro	8.58	2.83	11.56	4.04	63.72	9.27	25.00
2441	"	W. M. Payne, Harlem, N. Y.	New Haven, R. G. Davis	9.48	2.71	11.50	4.55	63.22	8.54	24.00
4424	"	D. S. Shellburger, Decatur, Ill.	Groton, Groton Grain Co.	10.14	2.22	10.62	4.41	64.54	8.07	25.00
4512	"		Willimantic, E. A. Buck & Co.	7.88	2.76	11.56	4.29	64.20	9.31	23.00
			Average of the above 21 analyses	**8.66**	**2.69**	**11.35**	**4.46**	**64.30**	**8.54**	
			Average digestible			8.74	3.66	61.09	6.92	
4460	Cerelene Feed No. 2	M. F. Barringer, Phila., Pa.	Plainfield, J. P. Kingsley & Son	9.44	2.21	12.00	2.11	67.09	7.15	23.00
4401	Rye Feed	H. D. Stone Milling Co., Rochester, N. Y.	Ansonia, Ansonia Flour & Grain Co.	9.98	3.26	15.75	3.54	64.46	3.01	25.00

TABLE IV.—*Continued.* ANALYSES OF COMMERCIAL FEEDS. SAMPLED IN 1901.

Station No.	Name of Feed.	Manufacturer or Jobber.	Retail Dealer.	Analyses. Water.	Ash.	Protein.	Fiber.	Nitrogen-free Extract. (Starch, gum, etc.)	Ether Extract.	Price per ton.
4296	Rye Feed	Abner Hendee, New Haven	Branford, S. V. Osborn	11.03	3.34	15.50	3.81	63.33	2.99	$25.00
4289	"		New Haven, J. T. Benham	10.34	3.39	15.75	3.84	63 52	3.16	22.00
4297	"	H. D. Stone Milling Co., Rochester, N. Y.	Abner Hendee	11.20	3.27	16 52	3.79	62.47	2.75	22.50
2450	"	Smith, Northam & Co., Hartford	North Haven, Jos. Pierpont	10.97	3.59	15.50	3.71	63.17	3.06	24.00
4391	"	F. C. Slade & Son, Oakville	Oakville, F. C. Slade & Son	11.95	1.99	11.87	2.37	70.14	1.68	26.00
			Average of the above 5 analyses*	**10.70**	**3.37**	**15.80**	**3.74**	**63.39**	**3.00**	
			Digestible			13.27		58.33	1.82	
4529	Malt Sprouts			8.33	5.11	27.94	10.36	47.14	1.12	16.75
			Digestible			22.32	3.45	32.06	1.12	
4473	Buckwheat Shucks	Quinnebaug Mills, Danielson	Danielson, Quinnebaug Store	7.26	2.20	3.94	44.24	41.38	0.98	
4472	Buckwheat Middlings	Quinnebaug Mills, Danielson	"	11.85	4.98	30.69	3.09	41.17	8.22	20.00
	Various Mixed Feeds.									
4402	Provender	Ansonia Flour & Grain Co., Ansonia	Ansonia, Ansonia Flour & Grain Co.	10.32	1.87	10.56	4.11	68.74	4.40	29.00
4371	"	Johnston & Morrison, Bethel	Bethel, Johnston & Morrison	9.84	1.69	10.62	3.14	70.46	4.25	30.00
4292	"	S. V. Osborn & Co., Branford	Branford, S. V. Osborn & Co.	10.91	1.86	10.75	3.04	69.15	4.29	30.00
4322	"	W. M. Terry, Bridgeport	Bridgeport, W. M. Terry	11.29	1.79	10.44	6.99	65.62	3.87	27.00
4329	"	Wheeler & Co., Bridgeport	Wheeler & Co.	10.58	1.62	10.25	3.16	70.28	4.11	28.00
4313	"	Wheeler & Howe, Bridgeport	Wheeler & Howe	10.67	1.93	10.50	3.81	68.13	4.96	28 00
4467	"	C. A. Young, Danielson	Danielson, C. A. Young	9.42	2.66	10.94	7.04	66.33	3.61	28.00
4446	"	B. H. Palmer, Greenville	Greenville, B. H. Palmer	10.06	1.86	10.75	3 41	69.52	4.40	28.00
4458	"	J. E. Leonard & Son, Jewett City	Jewett City, J. E. Leonard & Son	9.23	2.69	11.44	5.79	66.32	4.53	25.00
4387	"	Marsh & Newcomb, Litchfield	Litchfield, Marsh & Newcomb	10.85	1.72	10.56	3.11	69.59	4.17	28.00
4537	Sterling Provender	M. L. Crittenden, Buffalo, N. Y.	Meriden, Meriden Grain & Feed Co.	8.33	3.60	8.75	12.89	64.03	2.40	24.00
4527	Provender	Coles & Co., Middletown	Middletown, Coles & Co.	10.08	2.16	10.25	4.61	68.55	4.35	28.00
4525	"	Meech & Stoddard, Middletown	Meech & Stoddard	9.86	1.98	10.81	4.24	68.86	4.25	29.00
4361	"	F. R. Green, New Milford	New Milford, F. R. Green	9.84	2.10	11.50	4.71	67.53	4.32	30.00
4365	"	T. Soule & Co., New Milford	T. Soule & Co.	10.46	1.70	10.56	3.84	69.00	4.44	28.00
2449	"	Smith, Northam & Co., Hartford	North Haven, Jos. Pierpont	10.88	1.91	10.62	4.61	67.68	4.30	28.00
4445	"	A. A. Beckwith, Norwich	Norwich, A. A. Beckwith	10.59	1.75	10.62	3.51	69.28	4.25	28.00
4437	"	Cutler Co., No. Wilbraham, Mass.	Norwich Grain Co.	9.86	2.04	10.87	4.11	68.72	4.40	29.00
4483	"	Bosworth Bros., Putnam	Putnam, Bosworth Bros.	10.18	1.82	10.94	4.04	68.58	4.44	28.00
4490	"	E. C. Dennis, Stafford	Stafford, E. C. Dennis	10.64	1.58	10.19	2.99	70.33	4.27	28.00
4335	"	Ingersoll & Bro., Stamford	Stamford, Ingersoll & Bro.	10.87	2.69	12.50	4.86	64.53	4.55	29.00
4426	"	The Narragansett Milling Co., R. I.	Stonington, S. H. Chesebro	9.77	1.90	10.81	4.26	69.01	4.25	29.00

* Excluding 4391.

TABLE IV.—*Continued.* ANALYSES OF COMMERCIAL FEEDS. SAMPLED IN 1901.

Station No.	Name of Feed.	Manufacturer or Jobber.	Retail Dealer.	Analyses.						Price per ton.
				Water.	Ash.	Protein.	Fiber.	Nitrogen-free Extract. (Starch, gum, etc.)	Ether Extract.	
4390	No. 1 Corn & Oats Provender	Miner-Hillard Milling Co., Wilkesbarre	Thomaston, L. E. Blackmer	10.50	2.04	10.12	3.86	69.20	4.28	$28.00
4344	Provender	Smith & Sons, West Cornwall	West Cornwall, Smith & Sons	10.76	1.98	10.75	4.61	67.44	4.46	29.00
4513	"	E. A. Buck & Co., Willimantic	Willimantic, E. A. Buck & Co.	9.52	2.44	11.37	4.81	67.20	4.66	27.00
4454	"	A. R. Manning & Co., Yantic	Yantic, A. R. Manning & Co.	9.95	1.94	11.00	4.34	68.48	4.29	28.00
4532	Corn and Oats	Hawkins & Forbes, East Haven	East Haven, Hawkins & Forbes	10.10	1.61	10.37	2.67	70.56	4.69	24.00
			Average of the above 26 analyses*	**10.17**	**2.01**	**10.63**	**4.53**	**68.40**	**4.26**	
4327	Corn and Oat Feed	Hollister-Chase & Co., N. Y.	Bridgeport, Wheeler & Co.	8.94	1.72	8.56	11.14	65.67	3.97	22.00
4543	Boss Corn and Oats Feed	The Akron Cereal Co., Akron, Ohio	Rockville, Edward White	7.38	3.63	8.87	12.74	63.89	3.49	26.00
4374	Vim Oat Feed	American Cereal Co., Chicago	Danbury, F. C. Benjamin & Co.	10.49	6.83	7.87	24.31	47.59	2.91	18.00
4299	Royal Oat Feed	Akron Cereal Co., Akron, Ohio	New Haven, Abner Hendee	7.12	6.42	6.31	25.96	51.97	2.22	17.00
4377	Victor Corn & Oat Feed	American Cereal Co., Chicago	Danbury, F. C. Benjamin & Co.	7.43	4.15	10.31	11.56	62.12	4.43	22.00
4405	" " "	American Cereal Co., Chicago	Derby, Peterson, Hendee & Co.	8.00	4.07	12.56	11.47	59.64	4.26	23.00
4364	" " "	American Cereal Co., Chicago	New Milford, T. Soule & Co.	8.30	4.25	9.37	10.99	62.77	4.32	24.00
4346	" " "	American Cereal Co., Chicago	West Cornwall, Smith & Sons	8.89	3.11	9.00	11.20	64.28	3.52	24.00
4349	Monarch Chop Feed	Husted Milling Co., Buffalo, N. Y.	New Milford, Ackley, Hatch & Marsh	8.70	2.78	7.87	12.46	65.11	3.08	24.00
4549	De-Fi Corn & Oat Feed	Ellsworth & Co., Buffalo, N. Y.	Avon, J. & H. Woodford	7.95	4.49	9.25	14.39	60.65	3.27	24.00
4523	" " "	Ellsworth & Co., Buffalo, N. Y.	Middletown, Meech & Stoddard	7.71	4.60	9.25	14.81	59.96	3.67	26.00
4541	" " "	Ellsworth & Co., Buffalo, N. Y.	New Britain, C. W. Lines	7.77	4.31	9.25	14.34	61,90	2.43	21.00
4316	Champion Bell Fodder	Hollister, Chase & Co., New York	Bridgeport, Wheeler & Howe	8.70	3.81	9.06	13.51	62.28	2.64	19.00
4378	Corn, Oats and Barley	American Cereal Co., Chicago, Ill.	Danbury, O. H. Meeker	7.46	4.55	12.62	10.36	60.14	4.87	22.00
4356	" " "	American Cereal Co., Chicago, Ill.	New Milford, F. R. Green	7.50	4.68	12.75	10.94	58.82	5.31	28.00
4389	" " "	American Cereal Co., Chicago, Ill.	Thomaston, L. E. Blackmer	8.47	4.36	12.19	10.76	59.66	4.56	26.00
4392	" " "	American Cereal Co., Chicago, Ill.	Waterbury, D. L. Dickinson	7.85	4.94	13.19	11.34	57.52	5.16	27.00
4486	" " "	American Cereal Co., Chicago, Ill.	Willimantic, W. D. Grant	7.81	4.80	12.06	11.09	59.68	4.56	23.00
			Average of the above 5 analyses	**7.82**	**4.67**	**12.56**	**10.90**	**59.16**	**4.89**	
	Proprietary Feeds.									
4368	Quaker Dairy Feed	American Cereal Co., Chicago, Ill.	Bethel, Johnston & Morrison	6.88	5.15	14.37	17.49	52.58	3.53	22.00
4291	" "	American Cereal Co., Chicago, Ill.	Branford, S. V. Osborn	7.32	5.40	14.12	17.14	52.52	3.50	22.00
4328	" "	American Cereal Co., Chicago, Ill.	Bridgeport, Wheeler & Co.	7.10	5.32	14.06	16.39	53.58	3.55	22.00

* Excluding 4335.

TABLE IV.—*Continued.* ANALYSES OF COMMERCIAL FEEDS. SAMPLED IN 1901.

Station No.	Name of Feed.	Manufacturer or Jobber.	Retail Dealer.	Analyses. Water.	Ash.	Protein.	Fiber.	Nitrogen-free Extract. (Starch, gum, etc.)	Ether Extract.	Price per ton.
4531	Quaker Dairy Feed	American Cereal Co., Chicago, Ill.	East Haven, Hawkins & Forbes	6.63	5.07	14.19	15.89	54.37	3.85	$22.00
2440	" "	American Cereal Co., Chicago, Ill.	New Haven, R. G. Davis	8.13	5.27	13.12	16.19	54.71	2.58	21.00
4420	" "	American Cereal Co., Chicago, Ill.	New London, E. Bishop	7.30	5.17	13.56	17.64	52.73	3.60	23.00
4444	" "	American Cereal Co., Chicago, Ill.	Norwich, A. A. Beckwith	6.86	5.12	14.12	16.21	54.06	3.63	22.00
4489	" "	American Cereal Co., Chicago, Ill.	Stafford, E. C. Dennis	7.65	4.24	11.25	16.96	57.53	2.37	20.00
			Average of the above 8 analyses	**7.23**	**5.09**	**13.60**	**16.74**	**54.01**	**3.33**	
4324	H-O Dairy Feed	H-O Co., Buffalo, N. Y.	Bridgeport, H. H. Bennett	8.25	3.75	20.00	11.69	52.26	4.05	24.00
4438	" "	" " "	Norwich, Norwich Grain Co.	7.49	3.90	19.37	12.27	52.83	4.14	27.00
4337	" "	" " "	Stamford, E. E. Scofield	8.51	4.40	19.69	11.24	52.06	4.10	25.00
			Average of the above 3 analyses	**8.08**	**4.02**	**19.69**	**11.73**	**52.38**	**4.10**	
			Digestible			15.36	4.81	36.67	3.52	
4323	H-O Horse Feed	H-O Co., Buffalo, N. Y.	Bridgeport, H. H. Bennett	8.05	3.57	12.87	8.86	62.13	4.52	25.00
4425	" "	" " "	Groton, Groton Grain Co.	8.80	3.85	13.44	10.09	59.66	4.16	25.00
4342	" "	" " "	Stamford, E. E. Scofield	8.39	3.51	13.12	9.69	60.55	4.74	26.00
4517	" "	" " "	Willimantic, H. A. Bugbee	8.14	3.58	12.69	10.34	61.36	3.89	25 00
			Average of the above 8 analyses	**8.35**	**3.63**	**13.03**	**9.74**	**60.92**	**4.33**	
			Digestible			9.64	3.41	48.13	3.64	
4325	H-O Poultry Food	H-O Co., Buffalo, N. Y.	Bridgeport, H. H. Bennett	9.14	2.77	18.12	4.81	59.97	5.19	35.00
4432	" "	" " "	Mystic, J. L. Manning & Co.	8.92	2.59	16.87	4.61	61.95	5.06	29.00
4338	" "	" " "	Stamford, E. E. Scofield	9.09	2.70	18.81	5.14	58.83	5.43	33.00
			Average of the above 3 analyses	**9.05**	**2.69**	**17.93**	**4.85**	**60.25**	**5.23**	
4369	American Poultry Food	American Cereal Co., Chicago, Ill.	Bethel, Johnston & Morrison	8.98	2.75	14.50	5.26	61.75	6.76	30.00
4293	" "	American Cereal Co., Chicago, Ill.	Branford, S. V. Osborn	9.10	2.75	14.25	4.71	62.26	6.93	28.00
4355	Blatchford's Calf Meal	J. W. Barwell, Waukegan, Ill.	New Milford, Ackley, Hatch & Marsh	9.84	4.40	24.81	4.39	51.53	5.03	70.00
4398	" "	J. W. Barwell, Waukegan, Ill.	Waterbury, Platt's Mill Co.	9.11	4.65	26.19	4.11	50.96	4.98	70.00
4431	Bowker's Animal Meal	The Bowker Co., Boston, Mass.	Mystic, J. L. Manning	5.46	45.23	39.00	1.09	1.12	8.10	40.00
4394	" "	The Bowker Co., Boston, Mass.	Waterbury, D. L. Dickinson	5.76	45.95	38.25	1.55	0.83	7.66	50.00
4298	Poultry Food	Lederer & Co., New Haven, Conn.	New Haven, Abner Hendee	6.17	22.50	53.00		----	13.75	42.00
4480	Poultry Meal	John C. Dow Co., Boston, Mass.	Putnam, Bosworth Bros.	7.18	39.82	31.75	2.91	8.29	10.05	40.00
4482	Dow's Beef Scrap	John C. Dow Co., Boston	" "	8.82	23.05	50.37	2.29	1.20	14.27	43.00
4481	Poultry Feed	D. W. Romaine, Jersey City, N. J.	" "	4.45	24.52	37.56	5.41	6.42	21.64	35.00
4340	Imperial Egg Food	F. C. Sturtevant, Hartford, Conn.	Bridgeport, H. H. Bennett	3.49	57.00	9.69	5.89	22.58	1.35	----
4339	Poultriotone	W. D. Carpenter, Chicago, Ill.	" "	6.36	18.45	16.87	7.51	47.33	3.48	----
4441	Pasture Stock Food	Pasture Stock Food Co., Chicago, Ill.	Shelton, Taylor & Morse	6.57	12.82	17.12	6.56	53.65	3.28	----
4442	Wilbur's Horse & Cattle Food	Wilbur Seed Meal Co., Milwaukee, Wis.	Waterbury, W. H. Richmond	6.18	9.40	22.37	9.24	48.52	4.29	----

THE IMPROVEMENT OF UNCULTIVATED FARM LAND.

By E. H. Jenkins.

In 1900 a somewhat new line of work was undertaken by this Station which may be described as a study of means to improve the waste farm lands of this State.

The amount of cleared farm land in Connecticut is largely in excess of that which is cultivated or pastured at any profit to the owners. Much land which was formerly in productive pasture is now of little or no use, because cattle raising and stock fattening in Connecticut are almost dead industries; and considerable tracts of such land still reckoned as "cleared" are really "bush pastures," choked with hardhack, sumach or laurel, and only an expense to their owners. They are gradually but unprofitably going back to woodland.

There are other lands—for example, in Wallingford, Windsor and Suffield, as well as in other parts of the State—which are sand plains, supporting in places only a scant growth of blackberry vines and poverty grass, in other places sparsely covered with trees, some of which, however, appear vigorous and thrifty. Some of these soils, heavily manured, make excellent truck farms; none of them are naturally productive, all suffer from drought, and many are drifting sandblows, from which the railroad has to protect itself by close fences.

No land in the world is better suited than this for cleansing, by intermittent filtration, the sewage of our cities. Meriden has availed itself of it and has an almost ideal filtration plant. Wallingford is so situated that it can do the same thing, and other cities will no doubt in the future, either from choice or compulsion, acquire and use portions of these sand plains. But the larger part of them is at present an unproductive waste.

Most important of all, a considerable part of what is by courtesy called woodland is relatively unproductive, having been repeatedly cut and burned over, till now it yields only a very scanty amount and inferior grade of wood.

These facts, with others which need not here be added, suggest the questions: Will more intelligent care of the farm wood-

lot pay? If so, what care should be given to it? What can be done with these various kinds of uncultivated lands to make them profitable rather than expensive? Can any of them be planted to some kind of timber in such a way that there will be a profit in it?

It is to answer these, and other like questions which are often asked, that the Station has taken up the work to be described in what follows. This work is not to be confined to forestry and tree planting, but will include, as opportunity offers, the cropping and grazing of waste lands for their improvement as well as for the immediate cash returns.

Our work is of necessity on a very small scale as compared with the forestry work of some of the large states and of the general government. It is undertaken chiefly in the interest of the individual farmer and present owner. Much, however, can also be done which will regulate the flow of the brooks and smaller rivers of the State, and lessen the violence of freshets.

There is another direction in which intelligent planting and care of woodland may be of great value to the whole community. It is becoming more and more desirable and necessary for cities and towns to control absolutely the whole watershed from which their public water supply is derived. Drainage from dwellings into streams or reservoirs used as a public water supply will not long be tolerated by the public. Even the drainage from farm lands heavily fertilized or manured, is undesirable in a public water supply. Other things being equal, surface water from woodland is cleaner and safer than that from cultivated soil. It is, therefore, a great protection to the health of any community, in city or town, which has a common water supply, if the watershed from which the water comes is uninhabited and clothed as far as may be with forest growth. In this way the dangers from disease germs are removed, much other pollution is avoided, and the water of the winter and spring rains is held back longer on the land.

Now to acquire and hold an extensive watershed requires a large investment, but if the whole is planted and managed properly, in time it may be made to yield a fair return in lumber and firewood. Several of our cities are appreciating these facts and the Station is coöperating in arranging for tree planting to cover the watersheds.

But primarily the Station work is in the interest of the individual holders of woodland, of bush pasture and of other waste land which at present is nearly worthless.

While money spent in tree planting is put into a very long investment—if only a return from the wood is considered, rather than an increase in land value, on the other hand, money spent in better care of land now stocked with trees should yield fair returns in a relatively short time.

The outcome of such work seems to many to be very doubtful. The danger of forest fires is very great, their effects are disastrous, and in some places in this State public sentiment seems to be rather in favor of them than opposed to them. The beginning is, however, the hardest part of the work. When some considerable areas bear a thrifty young growth of valuable timber which shelters game, gives promise of large returns within twenty-five years, and in other ways increases the land value, we believe there will be a general movement to redeem many waste places which can produce better wood, and with it a general sentiment regarding the value of woodland which will make forest fires less common and will make the community more zealous to guard against them and to promptly extinguish them.

In the first settlement of a wooded country, forests are a hindrance to progress and must be quickly removed to make way for homes, factories and farms. The forest is the enemy of the settler. Later follows a period when the forests are disregarded altogether. Next they are reckoned as one of the "natural resources" of the community, ready at hand and inexhaustible. But at last it is realized, as we are now just beginning to realize, that even a "natural resource" may fail, that the forest is no longer a "natural resource" but land which bears a crop, the longest lived, the slowest to mature of any, and yet a crop which like any other pays for care spent in its protection, and skill used in its cultivation and harvesting.

For beginning the work the Station bought two pieces of land in the town of Windsor well suited for its experiments, to be described later.

The Station also added to its staff Walter Mulford, B.S.A., F.E., a graduate of the New York State College of Forestry at Cornell University, who entered on his duties April 1, 1901.

FIRST ANNUAL REPORT OF THE FORESTER.

By Walter Mulford.

Probably not far from forty per cent. of the area of Connecticut would be classed as woodland.* If well managed, this should be quite sufficient to meet the home demand for most sorts of wood materials. Yet at present a large proportion of the lumber used in the State comes from beyond its borders.

Besides this relative deficiency of lumber, the flow of our streams is much more fluctuating than it should be in a region favored with the regulating influence which so large a proportion of forest area should exert on water-flow.

These deficiencies are due not to lack of woodland area, but rather to the present faulty condition of that area, from which the original timber has practically disappeared, being replaced chiefly by a coppice ("sprout") growth which has greatly deteriorated from successive careless cuttings and from fire.

The chief defects in our woodlands are in lack of proper protection from fire, in system of cutting, in composition and in density.

There is relatively little woodland in the State on which timber is not prematurely destroyed or at least severely injured, either by fire or by ill-timed and careless cutting.

As to composition, nearly all of our woodland contains a considerable proportion of trees of species which are inferior in value. In places there is little else but these "tree weeds" to be found. Even where the more valuable species form a favorable proportion of the mixture, very many of the individual trees are often unsound or injured, or lack the clean, straight trunks which are essential for a good yield of clear lumber.

Regarding density, on some portions of our wooded area the stand of trees is far too sparse. On the other hand, in much

*As portrayed on the topographical map of Connecticut made by the United States Geological Survey in 1893, and as estimated by the Survey, 38½ per cent. of the total area of the State was then classed as woodland, and the wooded area has probably increased rather than diminished since that time.

of our woodland the trees are left standing so closely crowded as to seriously interfere with their best growth.

Large as is the forest area in Connecticut, it might profitably be increased. There are extensive tracts, at present bare of trees, which are essentially unfitted for anything but forest growth. Much of the sandy "plain" land of the river valleys, and much of the rocky farm land in the hilly districts, abandoned for cropping, fall into this class.

Nature in time covers such land with woody growth of some sort. It is true that, even without aid from man, this process is often rapid and the result a satisfactory forest growth, but more often the trees of the first growth thus established are of poor kinds. In such cases it requires great patience to bide Nature's time of establishing a really valuable forest.

On most of the lands which are unprofitable for agricultural purposes, Nature's method of establishing a forest growth could to good advantage be hastened and improved upon. There is little danger that there will ever be an over-supply of first-class timber in Connecticut. Moreover, the regulation of stream-flow and the improvement of exhausted soil, which forest growth promotes, furnish further and important justification for reclaiming the areas of idle land. The maintenance and improvement of the water-power used in our extensive manufactures, now of growing importance, is of itself a matter of no small moment to the welfare of the State.

To make of our Connecticut woodland and idle land what ought to be made of them, there is needed more intelligent management of such lands; above all, protection from fire. Timber must come to be regarded as a regular crop, and be cared for as such.

This will come with the gradual diffusion of knowledge regarding the fire problem, regarding the general aims and methods of rational forest management, and regarding the details of a practicable system of managing Connecticut woodlands and of establishing forests on idle lands.

It is to promote these objects that the Station has undertaken the work to be described.

Two lines of work have been carried on by the Station during the past year. The first is the Station work proper, planned as outlined in the previous paper.* This work was made possible by the receipt of funds from the Lockwood Trust Estate, to which reference was made in the report of the treasurer for 1900.

A second line of work (that as State Forester) was laid upon the Station by an act of the General Assembly entitled, "An Act Concerning the Reforestization of Barren Lands."†

The Station Work Proper.

The work at present in progress is as follows:

1. A study of the present condition of our woodland and idle land by detailed forest surveys and by more general observation over a wider field.

This is done in order to suggest a practicable plan for managing the Connecticut farm wood-lot and for reclaiming idle land.

2. Actual work in reclaiming waste land.

3. Actual work in the treatment of woodland to improve its present condition.

The two last named kinds of work are being done on experimental lands of our own and also in other places in coöperation with land owners. In this way it is hoped to get facts of value regarding various methods of woodland management and of afforesting idle land; and to present object lessons which may arouse public interest and also direct the efforts of other forest owners.

4. Dissemination of information regarding forestry. The Station hopes to spread an understanding of the aims and methods of forestry by personal contact with woodland owners throughout the State, by giving practical help to such of these owners as wish to do some systematic work on their woodlands, by addressing meetings, by the Station publications and by correspondence. It is hoped that public opinion may be especially aroused against fire, the arch enemy of the forest.

The details of the work in these four directions follow:

1. *Study of existing conditions.*

Aside from the general acquaintance with the forest conditions of the State which has been gained by frequent visits to

* Page 350. † Page 362.

many sections, upon various errands, some work has also been done on a detailed forest survey of Connecticut.

The chief aim of this survey is to study the conditions existing on our woodland and idle lands. Incidentally the lands have been classified and mapped.

The region already finished is in the towns of Windsor, Windsor Locks, East Granby and Bloomfield.

2. *Experimental Work in Reclaiming Idle Land.*

In 1900 the Station bought two tracts of land in the town of Windsor for forest work. The soil of both is what was classed by the Division of Soils of the U. S. Department of Agriculture as "Windsor sand," and is described as "yellowish red or brown sand, resembling a coarse, sharp building sand, and containing less than 5 per cent. of clay. The material contains about 5 per cent. of coarse gravel. . . . In places this formation is 40 feet deep. . . . The soils are coarse and inclined to be leachy or droughty, but, like many soils of this character, are generally somewhat moist beneath the top few inches of dry sand throughout the most severe drought."*

The first tract, which is called the Lockwood Field, consists of fifty-five acres. It is a nearly level sand plain, formerly cultivated, but now abandoned. For the most part it is covered only with a sparse growth of grass (chiefly *Andropogon scoparius* Mich.). In one corner there is a patch of white birch (*Betula populifolia* Marsh.) and in two other places are small groves of pitch pine (*Pinus rigida* Mill.) The field is typical of considerable areas of land in Hartford county.

The second lot, forty-six acres, was cut clean about five years ago. The sprout-growth which followed—mostly chestnut and oak—was entirely destroyed by fire in April, 1901. No work upon this lot was attempted the first year.

Upon Lockwood Field, experimental forest planting has been begun. Planting plans prepared for the Station by the Bureau of Forestry of the U. S. Department of Agriculture were followed in the first year's work. The general plan of the experimental planting may be more fully discussed in a later report, when more shall have been accomplished.

* Field Operations of the Division of Soils, U. S. Dept. of Agric., 1899, p. 132. (Report No. 64.)

But little work upon the final forest site (i. e., Lockwood Field) was done the first year, because we plan to raise in our nurseries most of the material for the planting. With this in view, a nursery was established in the spring of 1901 upon land adjoining our forty-six acre tract.

The first year's work upon Lockwood Field was as follows:

a. Seed of white pine (*Pinus strobus* Linn.) sown broadcast upon two acres of unplowed open ground, April 17, 1901, failed to yield any seedlings, so far as could be discovered. The seed was sown in amounts varying from the rate of two pounds per acre to that of five pounds per acre. Seed from the same source germinated fairly well in the nursery. In a regular germination test, 23 per cent. sprouted. The lateness of sowing is of itself sufficient explanation for the failure of the seed to catch on soil whose surface is so dry and exposed. The experiment was repeated this spring, the seeding being done in March.

b. Two acres were seeded to white birch (*Betula populifolia* Marsh.) and three acres to sweet birch (*Betula lenta* Linn.). This seed was of necessity bought from seedsmen and sowed immediately. Germination tests started at the same time proved the seed worthless: of the white birch only six per cent. sprouted and of the sweet birch none. No seedlings resulted from the field sowing.

It was intended that the birch seedlings resulting from this sowing should be used as nurse trees for white pine. Pine seed was to have been sown broadcast among the white birch one year after sowing the latter. Among the sweet birch two-year old pines were to have been planted two years after sowing the birch seed.

c. Two acres of open ground were to have been seeded with 225 pounds of white oak acorns (*Quercus alba* Linn.), but only seventy-five pounds of acorns could be obtained, as this species did not seed freely in 1901 anywhere in the United States. The seventy-five pounds of acorns were planted in the latter part of September, 1901, in rows four feet apart, the acorns being planted three together, at intervals of three feet in the row. The acorns have wintered finely.

d. About three hundred and twenty-five cuttings of Carolina poplar (*Populus deltoides* Marsh.) were set April 26, 1901.

They were placed two and one-half feet apart in rows four feet apart, and were set by simply pushing into the soil. The cuttings were made from branches cut very late in the season, and received in poor condition with the buds far advanced.

One-year-old wood only was used for the cuttings, varying in diameter from one-fourth to one-half inch. Part were cut about eleven inches long and part about five inches. With each length a further sub-division into two classes was made, one class being terminal cuttings (i. e., those including the terminal bud of the twig), the other non-terminal cuttings. Of the eleven-inch length, one lot was put in of cuttings taken just as they happened to come, terminal and non-terminal, mixed about half and half.

As shown by the following table, cuttings made and set so late were partially successful only when non-terminal eleven-inch cuttings were used; they were entirely unsuccessful when five-inch (either terminal or non-terminal) or when eleven-inch terminal cuttings were employed.

	Number of cuttings set.	Number living at end of season.	Per cent. living at end of season.
11 inch, non-terminal	100	44	44
11 inch, terminal and non-terminal	43	10	23
11 inch, terminal	93	4	4
5 inch, non-terminal	46	3	7
5 inch, terminal	40	0	0

The soil was firmed around half of the cuttings of each class by pressing with the foot after the cuttings had been pushed into the soil. The remainder were left unfirmed. The results showed that the firming had no effect one way or the other in enabling the cuttings to take root.

e. A fire line was established around Lockwood Field in April, 1901, by plowing six furrows. This strip was still almost free from inflammable material the following spring.

The first year's work at the nursery was as follows:

a. Two thousand seedlings (six to nine inches high) each of white pine (*Pinus strobus* Linn.), red pine (*Pinus resinosa* Ait.), and Norway spruce (*Picea excelsa* Link), were brought from a nursery and placed in nursery rows, to be left one year before planting on the final forest site. It had not been intended to use the spruce, and they were received because of a mistake

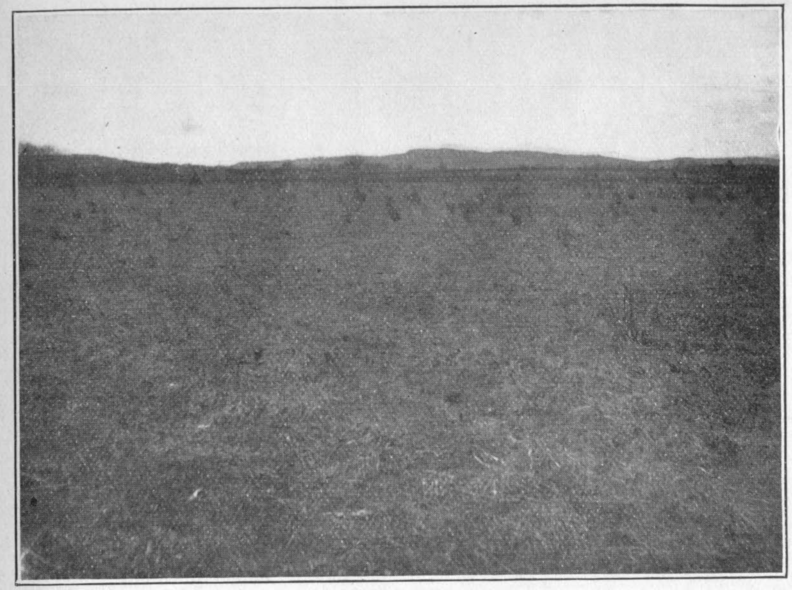


FIG. 1.—"Lockwood Field"—a Connecticut Plain.

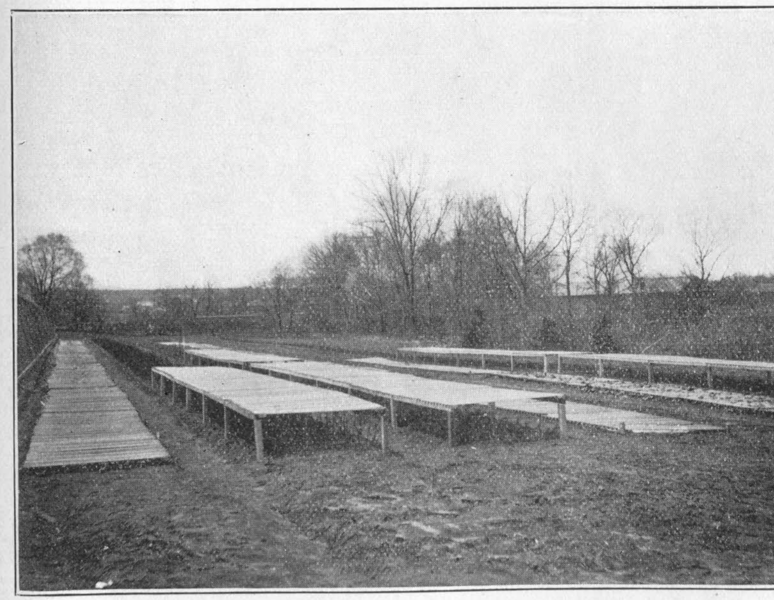
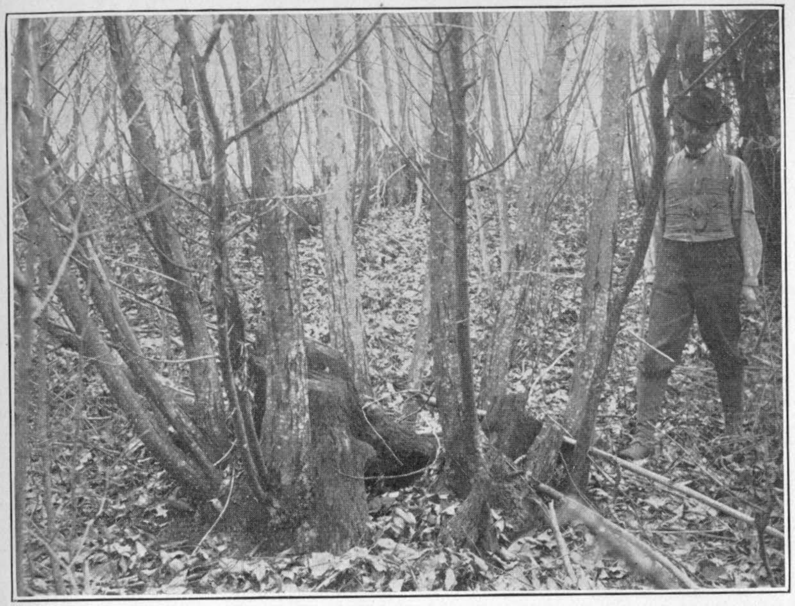


FIG. 2.—Part of the Forest Nursery.
At extreme left White Pine Seed-beds before germination has begun. In center, White Pine and Norway Spruce-nursery stock (6–9 in. high) protected by lath screens.



Treatment of Chestnut Sprout Land. Property of C. S. Wadsworth, Middletown. A clump of Chestnut Sprouts before and after thinning.

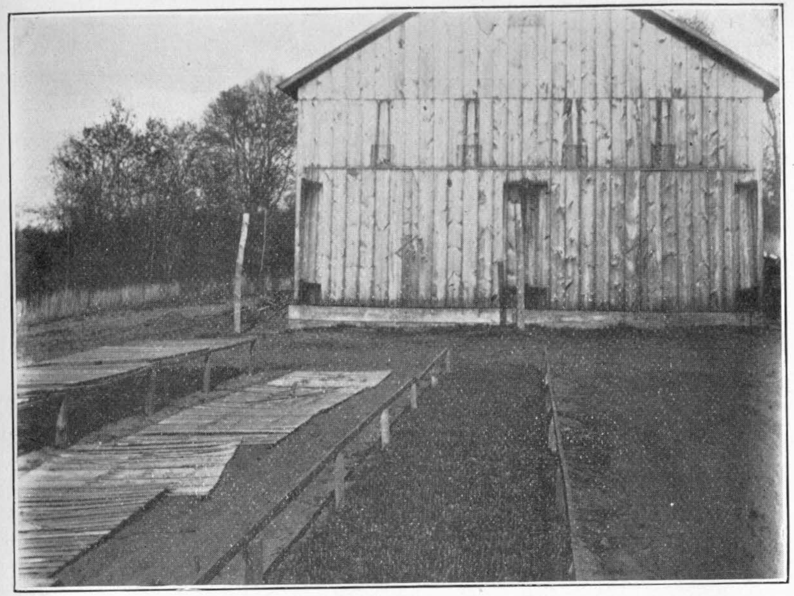


FIG. 1.—Pitch Pine Seed-bed from Drill Sowing.

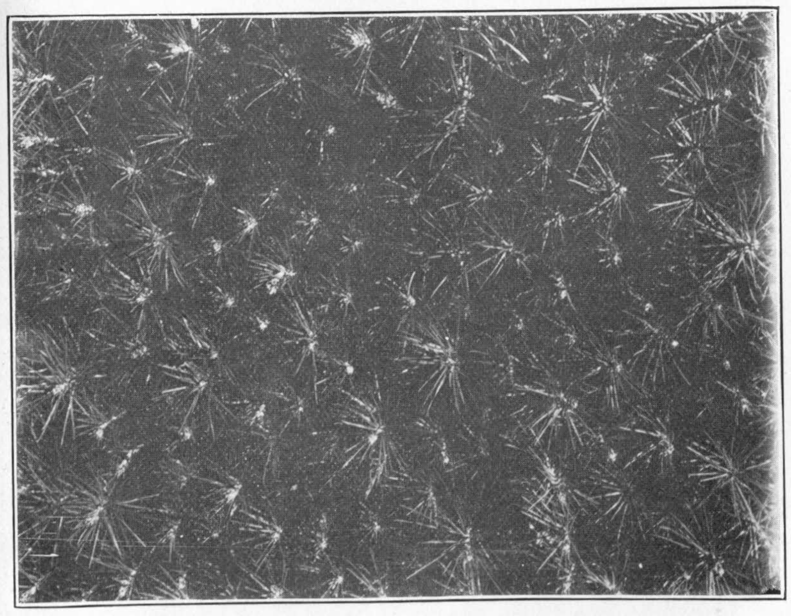


FIG. 2.—Pitch Pine Seed-bed from Broadcast Sowing, seen from above.

in shipment. A portion of the trees of each species were left unshaded through the summer, the remainder being protected with lath screens.

Three weeks after planting, one tree of the six thousand was dead. At the end of the season, the numbers living were:

	Shaded			Unshaded		
	Number planted.	Number living.	Per cent. living.	Number planted.	Number living.	Per cent. living.
Norway Spruce....	360	317	88	1640	382	23
Red Pine.........	1080	976	90	920	633	69
White Pine.......	1080	1038	96	920	842	92

Looked at simply from the standpoint of numbers of trees alive, shade was essential to Norway spruce, advantageous to red pine and immaterial to white pine under our conditions; but with all three species the greater vigor of the shade-grown trees was pronounced—in root development, in color, and to a less degree in height-growth. The root systems of the shade-grown trees were much better developed and their foliage was rich and dark as compared with that of the unshaded trees. The average height of all species at the close of the growing season was for the unshaded trees about ten inches, for the shaded about twelve inches. The relative power of the unshaded and the shade-grown trees to endure drought on the final forest site will be tested this year.

b. Seed of white pine was sown on 1352 square feet of seed bed, and of pitch pine (*Pinus rigida* Mill.) on 576 square feet. The germination of the former was only fair; of the latter, excellent.

Part of the white pine seed was soaked in water for ten days to hasten germination. The proportion which sprouted was about the same for the soaked as for the unsoaked seed. The seedlings from the soaked seed did not seem as vigorous as the others. It was, however, by no means certain that the treatment of the seed before planting was responsible for this difference in vigor, which may have been due to accidental slight differences in the treatment of the seed beds.

Seed of each species was sown both broadcast and in drills nine inches apart. The broadcast seeds were strewn upon the surface and the beds then raked lightly and rolled with a light lawn roller. All the beds were mulched with leaves soon after sowing, because the surface soil could not be kept moist in any other way. The mulch was removed as soon as the seed began to sprout.

At the end of the season sample counts were made. These were found to run very uniformly and from them were made the following estimates of numbers of seedlings then living:

	Area of seed beds, square feet.	No. of seedlings, per sq. ft.	Total number of seedlings.
White Pine, rills	1232	20	24600
White Pine, broadcast	120	70	8400
Pitch Pine, rills	432	95	41000
Pitch Pine, broadcast	144	215	31000
Totals	1928		105000

Only a small part of the pitch pine seedlings will be required for planting the very limited area on Lockwood Field which is to be devoted to that species.

The nursery soil is a deep, extremely sandy loam, very subject to drought. On this soil the drill beds seemed to possess an advantage over the broadcast in that on the former cultivation could be practiced, thereby saving considerable watering. Occasional hand watering of all the seed beds and of the nursery rows was, however, found necessary. A shallow layer of the surface soil was kept lightly cultivated everywhere except in the broadcast seed beds.

All the seed beds were protected with screens, mostly of lath, with a few of coarse cheesecloth. The first cost of both kinds of screens was about the same and their shade seemed equally favorable to the seedlings. The cheesecloth would, however, have to be renewed for use a second season, while the lath screens are still in good condition. We shall discard the cheesecloth screens.

Winter protection was afforded the seedlings by simply covering, in December, with about three inches of leaves, without having previously banked the earth against the rows of seedlings. The leaves were held down by brush. A thinner layer of leaves was spread in the nursery rows. Neither seedlings nor nursery stock were injured by the winter, except one small bed of broadcast white pine seedlings which had been left uncovered. Almost every seedling in this bed was heaved out by the frost and killed.

c. Fifteen bushels of chestnuts (*Castanea dentata* [Marsh.] Borkh) were obtained in September, for spring planting. They

kept admirably through the winter, buried in the well-drained, sandy nursery soil, and came out in the spring with practically no loss.

3. *Work in the Treatment of Woodland.*

Some thinning and improvement cutting was done in February upon property near Middletown belonging to Mr. C. S. Wadsworth. This was chiefly in a vigorous young growth of chestnut coppice.

4. *Dissemination of Information.*

a. Personal contact. Much effort has been made to excite interest and spread information relating to forestry by personal contact with woodland owners throughout the State. Realizing that forestry for Connecticut means chiefly forestry for the farmer, it is the aim to reach the individual owner in every way possible.

b. Practical assistance. The Station forester, so far as his other duties allow, will, on request, visit and inspect any forest land in the State, without expense to the owner other than for travelling expenses to and from New Haven, and board while actually engaged in work on the ground.

The forester will draw up planting plans or working plans for any property the owner of which gives satisfactory evidence of his intention to carry out more or less work in forestry, the expense to the owner being as outlined above.

A planting plan for eight experimental forest plats of a half-acre each, was made for Mr. E. K. Hubbard of Middletown. This plan is being executed this spring (1902).

An agreement with the Board of Water Commissioners of the city of Middletown has been signed, by which the forester is to draw up for them a planting plan for something over one hundred acres of land which they own on the watershed of one of the city reservoirs; and, if so requested within eighteen months of the date of the agreement, to draw up a working plan for some eight hundred acres of woodland owned by them and situated upon the same watershed; also, to give practical assistance in superintending the execution of the planting plan. The Water Board agrees to pay the forester's board and traveling expenses while engaged in the work, and to expend an amount averaging not less than two hundred dollars annually for a term of five years in the execution of the plans, when they shall have been accepted by both parties.

c. Addresses. Talks on forestry have been given at two Grange meetings, at one institute held by the State Pomological Society, at a public meeting held by the Connecticut Forestry Association, at the annual meeting of the State Board of Agriculture, at a public meeting held under the auspices of a chapter of the Daughters of the American Revolution, and at a meeting called by private citizens interested in furthering forest work.

d. Correspondence. A correspondence of about 800 letters was carried on during the year.

THE WORK AS STATE FORESTER.

The following act was passed by the General Assembly at the January session, 1901:

AN ACT

CONCERNING THE REFORESTIZATION OF BARREN LANDS.

Be it enacted by the Senate and House of Representatives in General Assembly convened:

SECTION 1. The board of control of the Connecticut Agricultural Experiment Station at New Haven shall designate and appoint a man qualified by scientific training and practical experience to be state forester during the pleasure of the board, and to be responsible to said board for the performance of his duties as prescribed in this act. The state forester shall have an office at the experiment station in New Haven, but shall receive no compensation other than his regular salary as a member of the station staff of deputies or aids, as may be necessary.

SEC. 2. The state forester is authorized to buy land in the state suitable for the growth of oak, pine, or chestnut lumber at a price not exceeding four dollars per acre to the amount of the appropriation hereinafter named, which land shall be deeded to the State of Connecticut and shall be called a state park.

SEC. 3. The state forester is authorized to plant the lands so bought with seed or seedlings of oak, pine, or chestnut, and such other trees as he may deem necessary or expedient, at a cost not exceeding two and one-half dollars an acre; to exchange the lands so bought with adjoining proprietors, if desirable in order to make the state park more compact for fencing, and for and in behalf of the state to execute deeds for such purpose; to fence such lands with substantial wire fencing, not barbed; and to use proper precautions to protect said lands from forest fires, from trespassers, and the destruction of game, fish, and timber thereon, and in so doing may employ such local wardens or assistants as may be necessary.

SEC. 4. The state forester shall be the lawful custodian of such lands, with the power to enter complaint against trespassers thereon, and shall pay, from the sum hereinafter appropriated, the town taxes upon said land when assessed at the same rate as similar adjoining lands, and with the approval of the governor and the attorney general, may sell portions of the same when they shall command a greater price than the cost and interest thereon, and may execute a deed for the sale, for and in behalf of the state.

SEC. 5. The sum of two thousand dollars for the two fiscal years ending September 30, 1903, is hereby appropriated for carrying out the provisions of this act.

SEC. 6. The accounts of the forester for all disbursements under the provisions of this act shall be paid by the comptroller upon the audit of the state board of control.

Approved June 17, 1901.

Pursuant to the provisions of this act, the Board of Control of the Experiment Station, in July, 1901, appointed the Station forester to be state forester.

It will be noticed that the act just quoted makes no provision either for the salary or for the expenses of the state forester incurred in correspondence, in travel to examine tracts of land which are offered for sale, or for other expenses incidental to the work. The whole expense of the work, therefore, which has been required of the Station under this act of the General Assembly, as well as the outlay made under the plan which had been previously adopted by the Station, has necessarily been met from station funds.

The appropriation made by the General Assembly in this act became available October 1, 1901. Immediately thereafter a circular was distributed throughout the State entitled:

NOTICE TO OWNERS OF WASTE LANDS AND CUTOVER WOODLANDS SUITABLE FOR GROWTH OF TIMBER.

After citing the act concerning the reforestization of barren lands quoted above, the circular proceeded: In substance, provision is made in the above act for purchase by the undersigned of land suitable for the growth of oak, pine, or chestnut lumber, such land to be used as a state park in the following way:

The land will be deeded to the State of Connecticut, but is to be assessed and taxed by the town in which it lies, at the same rate and in the same way as similar land held by private owners. It is to be managed in such manner as to secure as rapid and profitable a growth of timber as possible, artificial planting of valuable timber trees being resorted to wherever necessary. It may, if desirable, be fenced, but not with barbed wire. The whole will be under the charge of the State Forester.

It is hoped that this undertaking may be practically useful in restoring to forest production some land at present nearly worthless, and that such land may be so tended as to serve as an object lesson in tree planting and in the proper management of woodland, thus leading to a more rational and consequently more profitable handling, by their owners, of the cord-wood lands and timber lands of Connecticut.

The amount appropriated by the State for this object is $2,000 for two years, and no land can be bought, under the provisions of the act, for more than $4.00 per acre.

Up to and including November 10, 1901, the undersigned will receive offers of land, for the purposes above named. Owners should give the size of the tract offered and the price per acre. Full particulars are desired as to condition of the tract at present, including the kinds of trees, average size and age, amount of wood and timber per acre. Information is also desired regarding the commonest kinds of trees in the region about the offered land, and whether or not there is a possibility of the purchase of adjoining lands subsequently.

Offers of land at present without tree growth of any kind, and of land covered with young timber or scrubby growth, are desired. The right is reserved to reject any or all offers or bids. Bids and correspondence on the subject should be addressed to

WALTER MULFORD, *State Forester*,

AGRICULTURAL STATION,

NEW HAVEN, CONN.

New Haven, Conn., Oct., 1901.

In response to this call, offers of land were received from twenty-three parties. The lands offered aggregate some 5,500 acres, mostly in small parcels, scattered through twenty-one towns of the State. Prices range from $1.00 to $4.00 per acre, about one-half being the latter figure. Most of these tracts were carefully examined during the late fall and winter, five being left until spring. It is expected that a purchase will be made during the present summer (1902).

The amount of the appropriation is so small and the restrictions imposed so limit its use, that it seems impossible to make with it a suitable beginning of forest work for the people of the State. Yet it is hoped that a little of real value to the State may be accomplished—a beginning which, if it is ever to attain real success, must be put on a far more liberal basis.

THE NUCLEIC ACID OF THE WHEAT EMBRYO.

BY THOMAS B. OSBORNE AND ISAAC F. HARRIS.

I. INTRODUCTION.

All organisms, whether animal or vegetable, begin life as single cells which develop by division, the single cell becoming two, or in some cases four, which grow and again divide, so that their number multiplies in rapidly increasing progression. This division is preceded by division of the nucleus, a small body within the mass of the cell, which has a different chemical constitution from the protoplasm contained in the other parts of the cell. The nucleus is evidently the center of the physiological processes of the cell and is present in all those which are capable of growth and development. It is, therefore, of the greatest importance for an intelligent study of life phenomena to have the most complete knowledge possible of the substances contained in the cell and especially of those forming the nucleus.

Investigations made during the past twenty-five years show that a large part of the nuclei of all the cells so far examined consists of one or more of a group of acids, with peculiar and characteristic properties, which have been named the nucleic acids. Although these acids have been the subject of much study, our knowledge of them is as yet very imperfect. The ultimate composition of no one of them has been established beyond a reasonable doubt, although that from salmon-milt appears to be fixed within narrow limits. Of the basicity of these acids and the details of their relations to other substances we have little definite information. The constitution of none has been established, although a number of their decomposition products have been obtained. It is true that Bang has recently described the constitution of a somewhat similar acid found in the pancreas, but this evidently belongs to a different group of substances.

Nucleic acid is usually found in nature combined with protein matter, and it is necessary, therefore, in continuing the studies of vegetable proteins, which have been carried on in this laboratory for years, to obtain a thorough knowledge of nucleic acid and its protein compounds, the nucleins and nucleo-proteids. These latter are bodies of great physiological importance, about which much confusion and uncertainty still exists. They are described as compounds of nucleic acid with protein bodies, but whether they are salts or esters or some more intimate form of combination, is not set forth by any one. Whether the nucleo-proteids, obtained by the methods now employed, are to be considered as constituents of the tissues from which they are derived, or as products of the investigator's manipulation, is a question which is not yet established.

Sometime ago one of us[1] briefly described a nucleic acid found in relatively large amount in the embryo of wheat, and similar in properties and composition to the nucleic acids of animal and vegetable origin previously described.

So far as we are aware, this is the only nucleic acid which has yet been isolated from the higher orders of plants, the only other one heretofore obtained from a vegetable organism in a state of approximate purity having been found in yeast.

As the nucleic acid of wheat is distinctly different from the nucleic acids already described, we propose to call it tritico-nucleic acid.

We have recently made an extensive study of tritico-nucleic acid, have determined its decomposition products and have also obtained information which has enabled us to describe the probable constitution of its molecule. Although this investigation is not yet completed, we have thought best to publish the results obtained and hope that we may soon be able to supply the data now lacking.

Nucleic acid was first found in combination with protein matter and it was for a long time thought that these compounds formed a special class of phosphorized proteids which were called nucleins. Even after Miescher found the protamine compounds of nucleic acid which were free from protein, and had isolated the free acid from these, he still called the latter nuclein, although he fully recognized its acid properties. It was not until about ten years later that Altmann designated this substance nucleic acid, and distinguished sharply between this acid and its protein compounds—the nucleins.

[1] Osborne and Campbell, Report of this Station for 1899, p. 305, also Jour. Am. Chem. Soc. 22, 379.

After the discovery of the nucleins most preparations of protein which contained a notable quantity of phosphorus were considered to belong to this group of bodies, but it was soon found that many yielded on hydrolysis one or more bases of the xanthin series, while others did not yield any of these. A distinction was, therefore, made between the two, the former being called the true nucleins, since they were characteristic products of tissues rich in nucleated cells, and the latter para- or pseudo-nucleins, being largely contained in substances free from nucleated cells, such as milk or the yolk of eggs.

The present state of our knowledge of nucleic acid and the confusion which still exists in regard to it are set forth in the following review of the literature:

II. Review of Literature of Nucleic Acid.

Miescher's[2] investigations of the constituents of cell nuclei led, in 1869, to the discovery in the nuclei of pus cells of a substance rich in phosphorus which showed reactions characteristic of proteins. This substance he called nuclein and regarded it as a special form of protein in which the phosphorus was firmly bound. Efforts to obtain preparations still richer than the original in phosphorus and, if possible, free from protein, led Miescher to examine nucleated cells of other kinds, and among them the sperm cells of salmon-milt. From these he got a compound of a new base, which he named protamine with what he then called a very "insoluble nuclein." This latter contained 9.8 per cent. of phosphorus but no sulphur, did not give the xanthoprotein or Millon's reactions and appeared to be a polybasic acid, free from protein, whose salt-like compound with protamine formed 96 per cent. of the dry matter of the spermatozoa heads of the salmon-milt. This phosphorus-containing body he recognized as different from one similarly obtained from hens' eggs. From it he separated a "guanin like complex" which gave the xanthin reaction with nitric acid and soda. Later he prepared its barium salt, from which he inferred that it is either a penta- or hexa-basic acid.

Somewhat later he gave its formula as $C_{22}H_{32}N_6P_2O_{16}$ and then described it as a tribasic acid.

[2] Die histochem. u. physiol. Arbeiten von H. Miescher. Leipzig, 1897. Briefe I-XV, 1869-1870.

Soon after Miescher's discovery, Hoppe-Seyler[3] found in yeast a body very similar to Miescher's nuclein, and at about the same time Plosz[4] found another in the nucleated red corpuscles of goose blood.

Kossel[5] obtained from yeast nuclein several preparations with a nearly constant content of phosphorus, 3.28 per cent. to 3.94 per cent., which he concluded were definite chemical compounds. One preparation, however, contained 6.2 per cent. of phosphorus and was manifestly a different body. On decomposition, this yeast nuclein yielded protein matter in two modifications according as the nuclein was boiled with water, when freshly precipitated, or was washed with alcohol. Hypoxanthin and sarkin resulted on decomposition, but were not obtained in definite proportions.

Having found that hypoxanthin was a product of decomposition of yeast nuclein, Kossel[6] undertook a study of the origin of this base in the organism.

From nuclein, prepared from cells by Miescher's method, he got 1.03 per cent. of hypoxanthin, and from nuclein from goose blood corpuscles 2.64 and 1.97 per cent.

The hypoxanthin was obtained from the nuclein by treatment with a weak acid and did not, therefore, result from a profound decomposition of the protein part of the nuclein.

Kossel[7] next showed that hypoxanthin was more widely distributed and present in greater amount in the various organs of animals and plants than had up to that time been supposed. From yeast, lycopodium spores, wheat-bran and many animal tissues, he got hypoxanthin by the same process that he used to get it from the nucleins.

In his work, "Die Nucleine und ihre Spaltungsprodukte," Strassburg, 1881, Kossel gave the substance of the preceding papers together with some additional observations. His conclusions were that the chemical relations of the nucleins to one another could not then be established; that some of them were complicated bodies, standing near the proteins, but that others were simpler; that some nucleins yield hypoxanthin on decomposition while others do not, and that in respect to the physiological role of these bodies we have scarcely any information.

[3] Med. chem. Untersuch. 500, 1871.
[4] Ibid., 461.
[5] Zeit. f. physiol. Chem. 3, 284, 1879; and 4, 290, 1880.
[6] Zeit. f. physiol. Chem. 5, 152, 1881.
[7] Zeit. f. physiol. Chem. 5, 267, 1881.

He directs attention to the fact that nucleins are abundant in seeds and that destruction or solution of nuclein seems to occur in degenerating tissues.

Kossel[8] again investigated the nuclein from goose blood and stated that the nuclei of the red corpuscles when treated with hydrochloric acid shrunk in a striking manner, and that this was doubtless the same phenomenon which microscopists had observed when treating cell nuclei with acids. From this nuclein he isolated a peptone-like body which he named histon.

The wide distribution of nucleic acids in plants was soon after made probable by Schulze and Bosshard,[9] who found both hypoxanthin and guanin in extracts of many parts of numerous kinds of plants.

Kossel[10] next confirmed Miescher's earlier statement that the nuclein obtained from the yolk of hens' eggs yields none of the nitrogenous bases characteristic of the nucleins from cell nuclei, and also added that the entire yolks do not contain any of them. Consequently these complexes are formed during the development of the embryo, since in the latter they are easily detected. Two classes, therefore, of nucleins are to be recognized, those of the cell nuclei which contain these bases, and those of egg yolks and milk which do not.

From the extract of a large quantity of pancreas glands Kossel obtained a new base which he named adenin. He also found this base in yeast nuclein and in a large number of animal and vegetable tissues, and in especially large amount in tea leaves.*

In a later paper Kossel[11] stated that adenin was present in tissues rich in nucleated cells but was not found in those which, like muscle, were poor in such cells, and that in these it occurred loosely combined with protein and phosphoric acid. In this

[8] Zeit. f. physiol. Chem. 8, 511, 1884.
[9] Zeit. f. physiol. Chem. 9, 420, 1885.
[10] Zeit. f. physiol. Chem. 10, 248, 1886.
[11] Zeit. f. physiol. Chem. 12, 241, 1888.

* It is to be noted that, since Kossel's discovery of adenin, hypoxanthin has rarely if ever been found among the decomposition products of nucleic acids or tissues containing them. It is probable that the "hypoxanthin" previously found was, in many cases, either adenin or resulted from it by oxidation.

paper he also gave an extended account of the properties of adenin and its compounds.

During the same year Liebermann[12] obtained reactions in solutions containing yeast nuclein which he considered to be characteristic of metaphosphoric acid. Since artificial compounds, made by precipitating egg albumen with metaphosphoric acid, behaved like the natural nucleins, Liebermann concluded that these latter were compounds of protein with metaphosphoric acid.

Liebermann[13] also obtained reactions of metaphosphoric acid in hydrochloric acid extracts of egg yolks. By precipitating a solution containing xanthin and egg albumin with metaphosphoric acid he obtained a product from which xanthin could be extracted with boiling water or with ammonia. Guanin is precipitated by metaphosphoric acid, and he therefore concluded that these bases, xanthin and guanin, were admixed with the nucleins and that hypoxanthin, which is not precipitated by metaphosphoric acid, when found in nuclein results from other substances, perhaps adenin or carnin.

Liebermann[14] obtained a barium salt from yeast nuclein, which he thought to be barium metaphosphate, as it contained approximately the required quantity of phosphorus, was precipitated from an acetic acid solution, and reacted for orthophosphoric acid only after boiling with acids.

Altmann,[15] who was the first to emphasize the distinction between the nucleins and nucleic acids, stated that *nucleic acids* were organic phosphorus compounds which can be split from the different *nucleins* and are characterized by a higher phosphorus content than that of the original *nuclein*. Like the nucleins, the nucleic acids are easily soluble in alkalies and ammonia but in contrast to the former are not precipitated by acetic acid from such solutions, but readily by hydrochloric or other mineral acid, by an excess of which, however, the nucleic acid is decomposed, the amount of change depending on the time of action and strength of the acid. Solutions containing the free nucleic acids precipitate proteins and proteoses, the resulting compounds having the properties of nucleins.

[12] Ber. **21**, 598, 1888.
[13] Centralbl. f. d. med. Wissensch. 210 u. 225, 1889.
[14] Plüger's Archiv. **47**, 155.
[15] Archiv. f. Anat. u Physiol. physiol. Abth. 1889, p. 524.

Altmann then described his method for preparing nucleic acid by removing all of the protein that can be dissolved by pepsin, dissolving the residue in alkali, precipitating the protein by acetic acid and then separating it from the filtered solution by adding hydrochloric acid.

Altmann considered that the nucleic acids are easily decomposed by alkalies and that the free acids are less resistant to the action of pepsin than their protein compounds. The nucleic acids from yeast, thymus, egg yolk, and salmon-milt were prepared by his method and the supposedly pure acids found to contain respectively 9.44, 9.2, 7.9 and 9.6 per cent. of phosphorus. Since these preparations of nucleic acid manifested many and important differences from those products which had, up to that time, been called nuclein, Altmann considered it to be important to designate these last described products as nucleic acid.

In his opinion these nucleic acids are not identical but similar in their characters and do not contain metaphosphoric acid, as Liebermann suggested, but are organic phosphoric acids, which, however, are not identical with any of the known organic acids which form precipitates with protein substances.

Having found that solutions of fatty acids or of lecithin, under suitable conditions, precipitate egg albumin, Altmann concluded that it is not impossible that a component related to or derived from the fatty acids may be the cause of the protein precipitation caused by nucleic acids.

Malfatti[16] obtained artificial compounds of protein with metaphosphoric acid which he regarded as identical with Kossel's paranucleins. He also stated that guanin could be made to combine with this artificial nuclein so that it was afterwards separated with difficulty. The resulting product he considered to be a true nuclein and that it differed from the paranucleins only in containing the nuclein base. A similar attempt to introduce hypoxanthin failed.*

Kossel[17] next showed that the nucleic acids from yeast and thymus gland differ in composition, properties and decomposi-

[16] Zeit. f. physiol. Chem. **16**, 68, 1892.
[17] Verhandlungen der physiol. Gesellsch. zu Berlin, 14 Oct., 1892.
* Guanin metaphosphate is insoluble in water, hypoxanthin metaphosphate is not, hence the apparent combination of guanin and the failure of the experiment with hypoxanthin.

tion products. Analysis of the thymus nucleic acid led to the formula $C_{30}H_{52}N_9P_3O_{17}$, which he thought should probably be doubled. This formula agreed closely with that obtained by Miescher for the nucleic acid of the salmon-milt, namely $C_{29}H_{49}N_9P_3O_{22}$.

Kossel further found that yeast nucleic acid on decomposition gave evidence of a reducing carbohydrate, yielded two phenylhydrazine compounds, one melting at 204-205° the other at 150°, and also much furfurol when distilled with acids.

By treating yeast nucleic acid with alkali, at the room temperature, the organic parts were gradually split from the phosphorus-containing part, and products resulted which were very rich in phosphorus. The first of these, *plasminic acid,* differed from nucleic acid in its ready solubility in water or aqueous hydrochloric acid. Its solution precipitated protein bodies, yielded the nuclein bases by hydrolysis, but contained no carbohydrate group, this latter being easily separated by the action of alkalies. It contained another nitrogenous group, which, on boiling with acids, yielded its nitrogen in the form of ammonia.

Its analysis corresponded to the formula $C_{15}H_{28}N_6P_6O_{30}$, which contains twice as much phosphorus as the formula which Kossel then assigned to nucleic acid. From this he concluded that nucleic acid must contain at least six atoms of phosphorus. Together with this plasminic acid and, as he thought, from it, there resulted another acid, which contained less oxygen than phosphoric acid, probably an anhydride form of phosphoric acid, since its properties corresponded to those of metaphosphoric acid. With this latter, however, it was not identical, since essential differences existed between them. Kossel, therefore, concluded that in the nucleic acids a nucleus must be present which results from the union of several atoms of phosphoric acid with the separation of water. The formation of plasminic acid can thus be easily explained by the successive splitting off of the carbon and nitrogen-containing groups from the phosphorus groups.

The next year A. Kossel,[18] in conjunction with A. Neumann, gave the results of their investigations of the thymus nucleic acid, which they called adenylic acid, as adenin was the only

[18] Verhandlungen der physiol. Gesellsch, zu Berlin, 8 Dec., 1893.

purin body found among its decomposition products. Together with adenylic acid they found in the thymus gland another acid which was more easily soluble in water and formed salts that gelatinized on cooling. Both were precipitated by hydrochloric acid and when boiled for a short time with water yielded a third acid and also adenin or an adenin-containing complex.

To this third acid they gave a provisional formula, $C_{15}H_{23}N_3P_2O_{12}$, the true formula being undoubtedly several times greater than this. They called this acid paranucleic acid, since it precipitated protein.

They further showed that the nuclein bases were organically combined in the nucleic acid and that in neutral and weakly alkaline solutions the nucleic acid was more stable than in acid solutions.

Their paranucleic acid when boiled for a longer time with water was converted into thyminic acid which did not precipitate protein. On decomposing thyminic acid with strong sulphuric acid (30 per cent.) thymin and orthophosphoric acid were produced.

Thymin separated from its purified solutions in large, white double-refracting crystals, slightly soluble in cold, much more soluble in hot water, and by boiling alcohol was gradually dissolved.

Above 250° it melted, and sublimed in crystals on cooling. It had neither pronounced acid or basic properties, was precipitated by mercuric nitrate but not by phosphotungstic acid, was precipitated by silver nitrate and a little ammonia, and also by mercuric chloride when neutralized by sodium hydroxide.

They stated that the nucleic acids of yeast and spleen also contained thymin.

H. Kossel[19] described experiments tried in conjunction with A. Kossel on the bactericidal properties of nucleic acid. He called attention to the fact that several investigators had observed that aqueous extracts of tissues rich in nucleated cells had bactericidal properties, but that it had not been shown to what constituent of the extract this property belonged.

He found that thymus nucleic acid had a pronounced bactericidal action decidedly greater than could be attributed simply

[19] Verhandlungen der physiol. Ges. zu Berlin, 8 Dec., 1893.

to the *acidity* of its solutions. Since different bacteria behaved very differently towards nucleic acid, they concluded that the bactericidal action of the nucleic acid was connected with its power to combine with protein.

Although the details of the preceding experiments on these nucleic acids were promised in a future paper, many of them, especially those relating to the nucleic acid of yeast, have not as yet appeared. The two papers next noticed contained such of these details as have been thus far published. In the first of these Kossel and Neumann[20] state that nucleic acids are to be regarded as constituents of young cells of vegetable or animal origin which are capable of growth, and that these acids occur in the cell nuclei either free or combined with protein.

On boiling the free nucleic acids with water, the relative proportion of the nuclein bases split off was not the same, Inoko getting from the nucleic acid from bull's semen 6 per cent. of xanthin, 2 per cent. hypoxanthin and 0.7 per cent. adenin, while they found only adenin in this acid from calves' thymus. From these facts they concluded that there are different nucleic acids and suggest that each may contain but a single one of these bases.

On boiling adenylic acid with water, another acid results which contains no adenin, is not precipitated by hydrochloric acid, but forms insoluble compounds with protein bodies. This they think may be paranucleic acid, though this was not proved. A second acid is also formed, thyminic acid, which is free from adenin, soluble in water and does *not* precipitate protein solutions. On heating this acid with 30 per cent. sulphuric acid for one hour, it is decomposed and a substance which they named thymin results, as already stated in a previous paper.

In the nuclei of the leucocytes of calves' thymus, Lilienfeldt[21] found a body which he named nucleohiston, and which was a compound of a peculiar protein substance, histon, with pronounced basic proporties and leuconuclein, which latter yielded, like other nucleins, both protein and nucleic acid when decomposed by acids. The nucleic acid yielded by decomposition the nuclein bases adenin and hypoxanthin.

[20] Ber. 26, 2753, 1893.
[21] Zeit. f. physiol. Chem. 18, 473, 1894.

Kossel and Neumann,[22] in a paper appearing a year later than their preceding, gave the method by which the thymus nucleic acid was prepared in quantity as a white amorphous powder, entirely free from protein.

They decomposed this acid by:

1. Boiling with 30 per cent. sulphuric acid for one hour.
2. Heating with 5 per cent. sulphuric acid at 115°.
3. Heating with 20 per cent. sulphuric acid at 150°.
4. Heating with water at 170-180° for two hours.

By process 3, adenin was completely destroyed and the following products resulted: thymin, cytosin, laevulinic acid, ammonia, phosphoric acid and formic acid. They concluded from their experiments that adenin cannot be the source of the thymin. They also obtained thymin from the nucleic acid of bull's semen, having the same composition as that from thymus nucleic acid. They state in this paper that the composition of thymin given in the preceding paper was incorrect and that its true composition is $C_5H_6N_2O_2$, with which formula their determinations of its molecular weight by the boiling point method agreed.

About 8 per cent. of thymin was obtained from the thymus nucleic acid. By treating this nucleic acid with 20 per cent. sulphuric acid at 150° or with water at 170°, they obtained about 2 per cent. of another base in well formed crystals for which they gave the provisional formula $C_{21}H_{30}N_{16}O_4$ and proposed to call it cytosin. Laevulinic acid was extracted from the products of hydrolysis by ether, from which the presence of a carbohydrate group yielding a hexose was inferred. The distillate first passing over from the products of hydrolysis also contained formic acid.

At about this time Hammarsten[23] obtained a nucleo-proteid from mammary glands, pancreas and liver, which on boiling with acids yielded a reducing substance and guanin. Three different preparations of this substance from the pancreas had the same composition. He regarded this as a body standing near to the nucleins, since it yielded nuclein on digestion, but differing from them in yielding a reducing body.

This reducing substance, obtained as a syrup, reacted like the

[22] Ber. 27, 2215, 1894.
[23] Zeit. f. physiol. Chem. 19, 19, 1895.

pentoses and yielded an osazone with a melting point similar to that of a pentose, but not that of any of the pentoses then known.

In concluding this paper, Hammarsten proposed the following designations for the various phosphorus-containing proteid substances:

Nucleins are those substances which are compounds of protein and nucleic acid, insoluble on pepsin digestion and which yield xanthin bases when decomposed.

Psuedo-nucleins are those nuclein-like substances which form when various proteid bodies are digested with pepsin, but yield no xanthin bases on decomposition.

Nucleo-albumins are those phosphorus-containing protein bodies which, like milk casein, are not compound proteins, and on digestion yield pseudo-nuclein.

Nucleo-proteids are those substances which yield true nuclein on pepsin digestion and xanthin bases when further decomposed.

He objects to Kossel's term paranucleins, because it probably includes many unrelated substances.

M. Tichomiroff[24] next made the observation that the tox-albumin, ricin, and the poisons excreted by the tetanus and diphtheria bacteria were precipitated from their solutions unchanged by nucleic acid, while from the culture fluids of streptococcus and the cholera bacteria precipitates resulted, which had no poisonous properties.

Kossel and Neumann,[25] continuing their investigations, found that thymo-nucleic acid does not yield two acids which are free from nuclein bases as before stated, but only thyminic acid, which results when the nuclein bases are split off from nucleic acid by heating with water, no other decomposition products being then formed. They also found that thymus nucleic acid, which they formerly supposed to contain only adenin and therefore called adenylic acid, in fact contains guanin also. By cautiously heating nucleic acid with water, until the filtered solution gives no precipitate with hydrochloric acid nor a precipitate of barium phosphate with baryta, the nuclein bases are split off and thyminic acid is formed. By neutralizing with baryta and adding alcohol to the filtrate from the precipitate that formed barium thyminate is precipitated, which has the following composition: $C_{16}H_{23}N_3P_2O_{12}Ba$.

[24] Zeit. f. physiol. Chem. **21**, 90, 1895.
[25] Zeit. f. physiol. Chem. **22**, 74, 1896.

Thyminic acid is easily soluble in water, is not precipitated by mineral acids, and gives a precipitate in acetic acid solutions of albumin, which dissolves readily on adding hydrochloric acid.

They confirm their previous statement that the nuclein bases are not in salt-like combination, as might be supposed, but are organically bound.

Schmiedeberg[26] next worked up the notes and material which Miescher had collected through many years and left unfinished at his death. Miescher had found that in acid solutions the nuclein bases are easily detached from the nucleic acid of salmon-milt, and that in working with such solutions the temperature must be kept as near 0° as possible.

The method of preparing nucleic acid from salmon-milt is given in detail and the formula $C_{40}H_{54}N_{14}O_{17},2P_2O_5$ as the result of several analyses.

A sample of the nucleic acid prepared by Altmann from yeast was likewise analyzed and its formula given as $C_{40}H_{59}N_{16}O_{22}, 2P_2O_5$. Schmiedeberg considered that this preparation was an acid ammonium salt containing two molecules of ammonia, so that the formula for the free acid would be $C_{40}H_{53}N_{14}O_{22},2P_2O_5$. Nuclein bases were recognized among the decomposition products of the salmo-nucleic acid, but were not identified. By heating with hydrochloric acid, a substance having the same properties as Kossel's thymin was obtained, which Schmiedeberg named nucleosin. The nucleic acid formed about 60 per cent. of the dried heads of the spermatozoa, in which it existed in combination with protamine as a salt.

Since Schmiedeberg's nucleosin had the same properties and composition as thymin, Kossel[27] prepared thymin from sturgeon's spermatozoa, and found it to be identical with that from calves' thymus and with Schmiedeberg's nucleosin.

Milroy[28] next compared the behavior of natural with artificial nucleins, obtained by precipitating thymo-nucleic acid with syntonin, deuteroalbumose and "Witte's peptone." The artificial contained approximately the same proportion of phosphorus as the natural.

[26] Miescher and Schmiedeberg, Archiv. f. expt. Path. u. Pharm. **37**, 100, 1896.
[27] Zeit. f. physiol. Chem. **22**, 188, 1896.
[28] Zeit. f. physiol. Chem. **22**, 307, 1896.

As Kossel and Neumann's method for obtaining nucleic acid from the thymus yielded no nucleic acid when applied to the artificial nucleins, Milroy concluded that the union between the protein and nucleic acid in these was a firm one, similar to that which exists in the pancreas nuclein.

The acidity of the original nucleic acid appeared to be partly neutralized in the artificial nucleins, but experiments with indicators did not give uniform results.

After digestion with pepsin the natural, as well as the artificial, nucleins, except that from "Witte's peptone," left residues containing the same proportion of phosphorus as the original substance, hence the components of the nuclein must have been dissolved in the same proportion as they existed in the nuclein.

Less than one-tenth of the phosphorus dissolved by pepsin digestion could be precipitated by magnesia mixture, except in the case of nuclein from duck and goose blood, of which 42.8 and 15.7 per cent. respectively was precipitated thereby. These solutions, with the exception of that from the pancreas proteid, contained an acid, which precipitated proteids from acetic acid solution. The residue left, after digestion with trypsin, contained a much smaller percentage of phosphorus than did the nuclein before digestion, and a larger proportion of orthophosphoric acid was found in the solution than after pepsin digestion.

Digestion with dilute sodium carbonate solutions, *without trypsin,* gave essentially the same results as the latter, but the action was slower.

The proteid-precipitating acid in the trypsin solution was not metaphosphoric acid since its acid solution could be boiled for a long time without increasing the amount of orthophosphoric acid.

A comparison of the syntonin compound of thyminic acid with the paranuclein of egg yolk showed a similarity between the two, but these cannot be identical, because the proteid-precipitating acids split from them are different.

The year following, Mathews[29] found that the spermatozoa heads of the invertebrate sea urchin contained nucleic acid which had the same proportion of phosphorus and nitrogen as that of the salmo-nucleic acid. It was, however, not united with protamine, but with arbacin, a substance which resembled

[29] Zeit. f. physiol. Chem. 23, 399, 1897.

histon, and from which it differed only in not being precipitated by ammonia. Mathews also found that the heads of herring spermatozoa consisted almost entirely of a compound of protamine and nucleic acid, having the same composition as that found in salmon-milt, $C_{30}H_{57}N_{17}O_6$–$C_{40}H_{54}N_{14}P_4O_{27}$. The semen from the boar and bull he found free from protamine.

Noll[30] found that laevulinic acid was produced in relatively large quantity by the hydrolysis of nucleic acid from sturgeon's sperm. This nucleic acid contained the same amount of phosphorus as that from the salmon-sperm.

Ruppel[31] soon after found in tubercle bacilli a nucleic acid which contained 9.42 per cent. of phosphorus and showed the characteristic properties of acids of this class. This substance he named tuberculinic acid.

Bang[32] next described the acid which in combination with protein formed Hammarsten's pancreas nucleo-proteid. This he named guanylic acid, since when hydrolyzed it yielded guanin as the only purin base. The free acid, as well as its potassium salt, was much more soluble in hot than in cold water, and was purified by repeated precipitation from its solution in hot water. Its composition corresponded to the formula $C_{22}H_{34}N_{10}P_2O_{17}$.

By hydrolysis it yielded about 30 per cent. of pentose, assuming the pentose to have the same copper-reducing power as dextrose; about 35 per cent. of guanin; a very small quantity of ammonia, probably arising from slight decomposition of guanin; phosphoric acid and possibly other unknown products.

This acid contained no thymin nor iron and was nearly ash-free. The ratio of phosphorus to nitrogen was 1:5, whereas in the acids previously investigated this ratio was nearer 1:3—a difference which he attributed to fundamental differences in the structure of these acids.

In a paper which appeared the same year, A. Neumann[33] defined the nucleic acids as phosphoglyco-compounds containing in their molecules the alloxure bodies.

He found that nucleic acid, prepared according to the then current methods, is a mixture of three acids, which he designated

[30] Zeit. f. physiol. Chem. 25, 430, 1898.
[31] Zeit. f. physiol. Chem. 26, 231, 1898.
[32] Zeit. f. physiol. Chem. 26, 133, 1898.
[33] Archiv. f. Anat. u. Physiol. physiol. Abth. p. 374, 1898.

nucleic acid *a* and *b* and nucleothyminic acid. To this fact he ascribes the lack of agreement between analyses of different preparations.

By a method which he described later he obtained these three acids separately, the acid *a* or *b* resulting according to the time of preparation. The chief difference between these acids is that the 5 per cent. salt solution of *a* gelatinizes while that of *b* does not, but in other respects their properties are nearly alike and similar to those of nucleic acid, as earlier described. By hydrolysis of either of these acids, nucleothyminic acid is produced, which still contains the alloxure and carbohydrate groups as well as phosphoric acid, and can be precipitated by hydrochloric acid. Nucleothyminic acid is fairly easily dissolved by water. Of the alloxure bodies it appeared to contain only those of the hypoxanthin group, since the xanthin reaction was obtained only feebly with the purin bodies separated from this acid. Analyses of the acid *b* and the nucleothyminic acid were stated by Neumann to agree well, but were not given.

These three nucleic acids all yielded the same decomposition products that Kossel and Neumann obtained from the thymus nucleic acid, as already described.

When fed to a dog, about four-fifths of these acids were eliminated by the kidneys, the remainder passing off with the faeces.

Nucleic acid given per os, or nucleothyminic acid subcutaneously injected, within a few hours caused a strong hyperleucocytosis, which was not preceded by a hypoleucocytosis.

In a second paper, published the next year, A. Neumann[34] described the method of preparing the three nucleic acids just described.

One kilogram of pure thymus gland was boiled in weak acetic acid, then chopped as fine as possible and brought into two liters of boiling water, made alkaline with 100 cc. of 33 per cent. sodium hydroxide, and 200 grams of sodium acetate were added. After heating on the water bath, for one-half hour, if the acid *a* is to be obtained, or for two hours if acid *b* is desired, the solution is neutralized with 100 cc. of 50 per cent. acetic acid, filtered and concentrated to 500-1000 cc. It is then precipitated, at about 40°, by an equal volume of alcohol and allowed to stand

[34] Archiv. f. Anat. und Physiol. physiol. Abth. suppl., Bd. 552, 1899.

till clear and cold. The liquid is then decanted and the sodium salt collected on a linen filter and redissolved in 500 cc. of water. After heating on the water bath until the insoluble matter separates, leaving the solution clear, it is filtered and the solution precipitated by pouring into alcohol, containing a little sodium acetate. The precipitate is then dissolved in water and reprecipitated by dilute hydrochloric acid. The products thus obtained are very difficultly soluble in water, acid *a* more so than acid *b*. When treated with sodium acetate solution ensues, that of *a* being gelatinous. Neumann considers the sodium salts of these acids to be very stable when heated, while the free acid is much more easily decomposed.

By heating the free acid to 100° with water, it is rapidly decomposed, but if heated to 60° the nucleothyminic acid results, which is separated from its solution by pouring into three times its volume of alcohol containing 15 cc. of concentrated hydrochloric acid per liter.

Neumann thinks that these three acids can be obtained from all tissues containing nucleated cells, capable of development, and states that he has found them in the thymus, spleen, pancreas and bull's testicles.

Schmiedeberg,[35] continuing the investigation set forth in his preceding paper, found that the preparations previously analyzed all contained some protamine which could be replaced by copper. He also found, in agreement with Kossel and Neumann, that nucleic acid is stable in neutral and alkaline solutions, if the latter are not too strong, and that, when freshly precipitated, it is dissolved by potassium acetate. Analysis of a number of copper salts prepared by Schmiedeberg led to the formula, for the free acid: $C_{40}H_{56}N_{14}O_{16}2P_2O_5$. The differences between this and the formula first given, he explains by the fact that the former preparations were acid sodium salts as shown by a determination of sodium in one of them. This alkali had been reckoned as oxygen and therefore the formula previously given for yeast nucleic acid was incorrect.

On decomposition, the salmo-nucleic acid yielded guanin and adenin, not more than one "atom" of each being present. These bases he considers to be certainly in salt-like combination with

[35] Archiv. f. Expt. Pathol. u. Pharm. 43, 57, 1899.

the acid and not organically combined as Kossel had stated them to be in thymo-nucleic acid.

By subtracting the formulas of adenin and guanin from that of the nucleic acid, Schmiedeberg obtained figures which he thought represented the formula of an acid, which he named nucleotinphosphoric acid. The nuclein bases, he states, cannot be completely separated from this acid without profoundly decomposing it, and when this happens the decomposition products are precipitated with the bases and removed from them with such difficulty that accurate determinations can scarcely be made. Nucleotinphosphoric acid is characterized by the tenacity with which it retains bases in combination.

He finds all its phosphorus to be present in a form yielding orthophosphoric acid on treatment with acid, and on heating with strong hydrochloric acid, it yields a black substance, which he called a phosphorized melanin. The following formula is suggested for nucleotinphosphoric acid: $C_{30}H_{38}N_4O_9$; $(OP(OH)_2)_4$. The phosphorus-free substance that remains, after splitting off the phosphoric acid, may be called nucleotin, although, as he says, the different atomic groups may be severally united to the phosphoric acid.

Herlant[36] next obtained nucleic acid by Schmiedeberg's method from unripe salmon-milt and assigned to it the same formula as that given by Schmiedeberg. From calves' thymus he made three preparations of copper salts, the analyses of which led him to assume that the formula of the free acid was $C_{40}H_{58}N_{14}P_4O_{26}$. The purin bases obtained from this acid were guanin and adenin.

From yeast he got preparations of two copper salts for which he gave the following formulas:

$$C_{36}H_{50\frac{8}{10}}Cu_{4\frac{6}{10}}N_{14}O_{28}, 2P_2O_5 \text{ and } C_{36}H_{48}Cu_2N_{14}O_{20}2P_2O_5.$$

These formulas he thinks show no satisfactory agreement, probably because during the preparation of the substance analyzed, some of the carbohydrate group which this nucleic acid was found to contain was split off.

A. Kossel[37] proposed a classification of nucleins and paranucleins as follows:

[36] Archiv. f. Expt. Path. u. Pharm. 44, 148, 1900.
[37] In Liebreich's Encyklopaedie, Bd. III.

A, *nucleins;* Under this name are included the nucleic acids and their compounds with protein. These yield nuclein bases on splitting. The nucleic acids are divided into, *a,* thymonucleic acids, which yield on decomposition thymin and other products; *b,* inosinic and guanylic acids which yield no thymin; *c,* plasminic acids, splitting products not sufficiently known.

B, *paranucleins,* phosphorus-containing protein compounds which yield no nuclein bases.

Ascoli[38] obtained from yeast, preparations of an acid which contained from 16 to 27 per cent. of phosphorus, gave both nuclein bases and phosphoric acid on decomposition with acids, and yielded furfurol on distillation. These preparations he regarded as mixtures, which, however, probably contained plasminic acid. Kossel, as already noted, obtained from yeast-nucleic acid a product rich in phosphorus, which he designated plasminic acid, and Ascoli's preparations were therefore supposedly likewise derived from the nucleic acid of the yeast.

The investigation of the properties of this acid led Ascoli to conclude that it contained phosphorus in the form of a hexametaphosphoric acid. A phenylhydrazine and a strychnine salt were made, having a composition similar to the metaphosphates of these bases, yet the differences found between the analytical figures and the calculated compositions were considerable.

Ascoli[39] then examined the leuconuclein from leucocytes and also milk casein, but was unable to obtain any evidence of metaphosphoric acid by the methods employed in his last cited investigation of the plasminic acid from yeast.

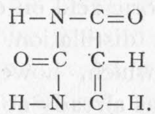
Soon after this Osborne and Campbell[40] found a nucleic acid in the wheat embryo whose analysis corresponded to the formula $C_{21}H_{31}N_8P_2O_{15}$. This yielded, on boiling with acids, both guanin and adenin, together with phosphoric acid and other decomposition products.

Continuing his investigations of yeast, Ascoli,[41] by Jones' method for getting thymin from the thymus gland, obtained from yeast nuclein a body which behaved with silver nitrate

[38] Zeit. f. physiol. Chem. **28**, 426, 1899.
[39] Zeit. f. physiol. Chem. **31**, 156, 1900.
[40] Report of this Station for 1899; also Journal Amer. Chem. Soc. **22**, 379, 1900.
[41] Zeit. f. physiol. Chem. **31**, 161, 1900.

like thymin and was not precipitated by phosphotungstic acid. It crystallized in rosettes of needles, and did not sublime undecomposed as easily as thymin, but yielded copious red vapor and a gummy reddish deposit. Analysis of the recrystallized product led to the formula $C_4H_4N_2O_2$, and a molecular weight estimation by the boiling point method gave 110 instead of 112, calculated.

This is the formula of uracyl, and Steudel[42] considers that there could be little doubt but that this is, in fact, Behrend's hypothetical uracyl, that is 2.6 dioxypyrimidin.



Levene[43] next proposed the following method for preparing nucleic acid. The tissues containing it are digested with 5 per cent. sodium hydroxide or 8 per cent. ammonia solution for about two hours, then the cold solution is nearly neutralized with acetic acid, picric acid added to acid reaction, an excess of acetic acid added, the solution filtered and the nucleic acid precipitated by alcohol.

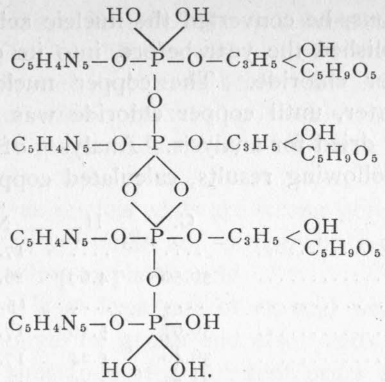
Bang[44] continued his investigation of guanylic acid from the pancreas and prepared a silver salt, from the analysis of which he concluded that this acid is pentabasic and has the formula $C_{44}H_{70}N_{20}P_4O_{34}$.

The amount of ammonia obtained by distilling this acid with magnesia was only 0.11 per cent. and he definitely concludes that this is derived from the guanin, since experiments with this latter substance yielded about the same amount.

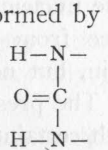
He also concludes from his experiments that this acid contains four molecules of guanin and three of sugar.

The remaining decomposition product, which he had not previously recognized, he found to be glycerin, of which not less than 12 per cent. is probably present. From the results of this investigation he concludes that guanylic acid probably has the following structure:

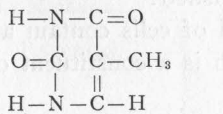
[42] Zeit. f. physiol. Chem. 32, 244, 1901.
[43] Jour. Am. Chem. Soc. 22, 329, 1900.
[44] Zeit. f. physiol. Chem. 31, 412, 1900.



H. Steudel[45] found that thymin by oxydation with barium permanganate yields urea, from which it is evident that one side of the pyrimidin ring is formed by the group



By chlorinating thymin, dichlorthymin is obtained, from which it appears that there must be an oxygen atom near to a hydrogen atom. Since the resulting body would be the same, whether the oxygen atom was in the position 4 or 6 he assigns it to 6. The methyl group cannot have the position 4 since thymin would then be identical with Behrend's methyl uracyl, which it is not. It must, therefore, have the position 5 and thymin is consequently 2.6 dioxy 5 methyl pyrimidin and is related to the ureides, uric acid and the purin bodies. Its formula is:



Continuing his work with nucleic acid, P. A. Levene[46] gave the results of analyses of preparations of nucleic acids of different origin.

In order to remove a little glycogen, which he found in some

[45] Zeit. f. physiol. Chem. 32, 241, 1901.
[46] Zeit. f. physiol. Chem. 32, 541, 1901.

of his preparations, he converted the nucleic acid, obtained by his method, published the year before, into its copper salt, by means of copper chloride. The copper nucleate was then washed with water, until copper chloride was removed, then with alcohol and dried for analysis. Analyses of these preparations gave the following results, calculated copper-free:

	C.	H.	N.	P.
Pancreas I	....	....	17.10	8.66
" II	36.50	4.69	16.70	8.73
" IV	....	....	15.85	9.00
" V	36.67	5.10	17.18	8.65
Spleen	36.40	5.24	17.30	9.03
Cod fish milt	34.76	5.16	16.77	9.15
Yeast	36.65	4.57	17.89	8.93

Levene points out that the nucleic acid from the pancreas is a wholly different substance from Bang's guanylic acid. It contained guanin and adenin, but no xanthin or hypoxanthin could be obtained from it. The presence of thymin was probable, but not established with certainty.

The preparations of nucleic acid obtained from the tubercle bacilli showed no definite composition since they contained from 9.04-13.22 per cent. of phosphorus and 9.42-14.19 per cent. of nitrogen. Guanin and adenin were found among its decomposition products.

E. Fischer and Hagenback[47] have recently prepared both thymin and uracyl synthetically and have confirmed Steudel's view that Ascoli's substance from yeast neuclein is in fact uracyl, identical with that artificially produced.

From the results of all these numerous investigations it appears to be established:

1. That the nuclei of cells contain a relatively large amount of phosphorus which is a constituent of a complicated organic acid.

2. That the nucleins and nucleoproteids obtained from tissues rich in nucleated cells are compounds of this acid with protein, the proportion of these constituents being variable, those containing a large proportion of nucleic acid forming the so called nucleins, those with a smaller proportion, the nucleoproteids.

[47] Ber. 34, 3751, 1901.

3. That there are phosphorus- and protein-containing substances of similar solubilities which, however, do not contain the true nucleic acid, but other acids from which the characteristic decomposition products of nucleic acid cannot be obtained. These latter acids are now known as para- or pseudo-nucleic acids.

4. That the true nucleic acids are strong polybasic acids, containing the purin, pyrimidin and carbohydrate groups and yield on hydrolysis orthophosphoric acid.

5. That there is at least one other acid which contains the purin and carbohydrate group and also yields orthophosphoric acid, but is a substance of a different order since it contains glycerine and lacks the pyrimidin group.

6. That there are at least two true nucleic acids—one containing thymin, the other uracyl.

7. That the ultimate composition of these acids is not yet settled, though the more carefully purified preparations have a similar composition.

The results of the analyses of different nucleic acids have led to the following formulas:

SALMON MILT.

$C_{44}H_{64}N_{12}P_4O_{32}$ Miescher.*
$C_{40}H_{54}N_{14}P_4O_{27}$ Miescher and Schmiedeberg.
$C_{40}H_{56}N_{14}P_4O_{26}$ Schmiedeberg.
$C_{40}H_{56}N_{14}P_4O_{26}$ Herlant.

THYMUS OF CALF.

$C_{40}H_{69}N_{12}P_4O_{25}$ Kossel.*
$C_{40}H_{56}N_{14}P_4O_{26}$ Herlant.

ARBACIA.

$C_{40}H_{54}N_{14}P_4O_{27}$ Mathews.

PANCREAS.

$C_{42}H_{64}N_{16}P_4$
$C_{42}H_{73}N_{17}P_4$

SPLEEN.

$C_{42}H_{74}N_{17}P_4$

CODFISH MILT.

$C_{40}H_{70}N_{17}P_4$

(Pancreas, Spleen, Codfish Milt: Levene.†)

* Calculated to a basis of four P atoms.
† Ratio calculated by the writer from Levene's analyses.

YEAST.

$C_{40}H_{59}N_{16}P_4O_{32}$ Schmiedeberg.
$C_{36}H_{60}N_{14}P_4O_{38}$ Herlant.
$C_{36}H_{52}N_{14}P_4O_{30}$ Herlant.
$C_{42}H_{63}N_{18}P_4$ — Levene.†

WHEAT.

$C_{42}H_{62}N_{16}P_4O_{30}$ Osborne.*

Although these analyses indicate that nucleic acids of different origin have a similar composition, nevertheless the differences between many analyses of preparations obtained from the same source are so considerable that it is impossible to determine what may be the true composition of the acid or the relations of the different preparations to one another. These differences in composition are probably largely due to the fact that doubtless most, if not all, the preparations of the free acid which have been analyzed were acid salts, in which the base has been overlooked. Since the nucleic acids are probably all highly polybasic acids, a number of different salts may be formed, so that on attempting to precipitate the free acids from their alkaline solutions the product obtained consists largely of a mixture of acid salts. If these acid salts are wholly inorganic, only the ratio of the oxygen atoms will be affected, but if organic bases are present the results of analysis are entirely misleading.

III. PREPARATION OF TRITICO-NUCLEIC ACID.

The embryo of wheat, and doubtless of other seeds, is very rich in nucleated cells. Sections stained with iodine green show that the tissues of the embryonic plant consist of a mass of nucleated cells of which the nuclei are so large that in many places the stained tissue looks as if it contained no other material. On extracting the embryo with water a large part of the nucleic acid, which it contains, passes into solution, in combination with protein matter and can be separated from the latter in the way described in the following pages.

The material used for this investigation was a commercial product of the modern milling process, consisting almost entirely

* Calculated to a basis of four P atoms.
† Ratio calculated by the writer from Levene's analyses.

of the embryo of the wheat kernel, flattened into thin scales by passing between smooth steel rolls and being practically free from bran or endosperm was an excellent material from which to obtain constituents of the embryo. This meal when fresh yielded about 1.25 per cent. of tritico-nucleic acid. It was necessary, however, to use very fresh meal, as we found that after a few weeks the meal from which we at first obtained 1.25 per cent. of nucleic acid yielded a very much smaller amount.

The following experiment indicates that only about one-third of the tritico-nucleic acid present in the meal was extracted by water.

Ten grams of the meal were boiled with 4 per cent. hydrochloric acid for four hours, the insoluble matter filtered out and washed, the filtrate made alkaline with ammonia and precipitated with a solution of silver oxide dissolved in ammonia. The silver compound of the purin bases was washed free from the greater part of the ammonia, suspended in water and distilled with magnesia, until the ammonia was completely expelled. The solution was then mixed with 20 cc. of sulphuric acid concentrated by evaporation, and the nitrogen, which was contained in the purin bases, determined by Kjeldahl's method.

We thus found 0.0360 gram of purin nitrogen in the 10 grams of meal, which corresponds to 0.0730 gram of equal parts of guanin and adenin, equivalent to 0.356 gram of tritico-nucleic acid or 3.56 per cent. if all these bases were originally contained in nucleic acid. The quantitative determination of the purin bases contained in tritico-nucleic acid is described in the following pages.

It was not practicable to use an alkaline solution in extracting the meal, whereby a larger yield of acid would, doubtless, have been obtained, because the extracts made with such solutions could not be filtered.

Tritico-nucleic acid was prepared from the wheat embryo meal in the following manner.

a. *First Extraction.*

Nine kilograms of finely ground, oil-free wheat embryo-meal was agitated with about 60 liters of water, the extract strained through bolting cloth and allowed to settle during 24 hours in a cool place, protected by thymol. The somewhat turbid extract was then siphoned from the deposit, saturated with sodium chloride and strongly acidified with acetic acid. The large precipitate, thus produced, was filtered out, washed with water until most of the salt and acid was removed, suspended in water, an equal volume of 0.4 per cent. hydrochloric acid containing 3 grams of active pepsin was added and the mixture digested for 24 hours at 40°. The insoluble matters were filtered from the solution, suspended in 6 liters of 0.2 per cent. hydrochloric acid, 1.5 gram of pepsin added and the digestion continued for 24 hours longer at 40°. The insoluble matter was filtered out and again digested as before. The filtrate from this last digestion contained but little proteose, showing that all the proteid matter soluble by peptic digestion had been removed from the insoluble crude nuclein. This nuclein was washed, suspended in 3 liters of water, strained through fine cloth, to ensure complete subdivision, and an aliquot portion was neutralized to phenolphthalein with a measured quantity of potassium hydroxide solution. The whole of the mixture was then neutralized by the calculated quantity of the alkali and the nearly clear solution which resulted was filtered clear and divided into two equal parts, A and B.

Part A was treated with so much decinormal hydrochloric acid as just sufficed to produce a flocculent precipitate which separated readily from solution and was easily filtered out. The slightly brownish, strongly acid filtrate that was obtained was treated with an excess of hydrochloric acid which produced a characteristic precipitate that settled rapidly, forming a dense deposit that contracted to a solid mass which could be ground to a course powder under water. This latter was washed with water, dissolved in dilute potassium hydrate solution and reprecipitated with hydrochloric acid. The precipitate, thus produced, was dissolved with potassium hydrate and the solution of the potassium salt was poured into ten times its volume of strong alcohol. In order to cause the precipitate to separate, a little ammonium acetate was added and the precipitate washed extensively with absolute alcohol and dried over sulphuric acid. This preparation, **1**, weighed 12.8 grams, was a white amorphous powder, readily soluble in water, its concentrated solution having a yellowish brown color. This and the following preparations were dried at 110° to constant weight and analyzed accordingly to the following methods:

Methods of analysis.

Carbon and hydrogen. The substance was mixed with a large proportion of freshly ignited calcium phosphate and burned with a current of oxygen in a tube filled with copper oxide and a roll of metallic copper gauze. The calcium phosphate absorbed the fusible metaphosphate, resulting from burning the substance, and rendered a complete combustion possible.

Nitrogen was determined by the Kjeldahl method.

Phosphorus. The substance was fused with sodium hydroxide and oxidized with sodium peroxide in a nickel crucible. The fusion was dissolved with nitric acid and the phosphoric acid precipitated with ammonium molybdate and weighed as magnesium pyrophosphate in the usual way.

Potassium and *sodium.* The substance was burned in a porcelain crucible, and the residual, fused metaphosphate, weighed. This was then dissolved by long boiling with hydrochloric acid and the amount of phosphorus determined and calculated as PO_3. This quantity was deducted from the weight of the metaphosphate and the difference taken as representing the quantity of potassium or sodium according as the preparation was obtained from potassium or sodium nucleate. While the results thus obtained are obviously not entirely accurate, they are more satisfactory than those obtained by a direct determination of the bases and are sufficiently near the truth to answer all the purposes for which they have been used.

ACID POTASSIUM NUCLEATE, *Preparation* **1.**

	Per cent.	Atomic Ratio.
C	33.06	42.12
H	4.22	64.52
N	14.96	16.32
P	8.11	4.00
K	8.72	3.40
O	30.93	29.56
	100.00	
Ash	28.60	
PO_3	19.88	
K	8.72	

Free acid $= C_{42}H_{68}N_{16}P_4O_{30}$

The other half, B, of the alkaline solution of the nuclein, referred to on page 390, was treated, according to Levene's method,[48] with a strong solution containing 18 grams of picric acid, the molecular equivalent of the hydrochloric acid added to the other half of the solution. This appeared to be very nearly the necessary quantity because complete separation of the protein did not take place until nearly all of the picric acid solution had been added.

The filtered solution thus freed from protein, when treated with an excess of hydrochloric acid gave a flocculent precipitate, which soon settled to a coherent layer, having the characteristic properties of this nucleic acid. After extensively washing this precipitate with water, it was dissolved with potassium hydroxide, reprecipitated by an excess of hydrochloric acid, washed with water, again converted into the potassium salt and reprecipitated by pouring into 10-12 volumes of strong alcohol to which were added a few drops of ammonium acetate solution in order to promote its separation. The nearly colorless preparation **2** thus obtained, when dehydrated with absolute alcohol and dried over sulphuric acid, weighed 10 grams and, dried at 110°, had the following composition:

ACID POTASSIUM NUCLEATE, *Preparation* **2.**

	Per cent.	Atomic Ratio.
C	33.00	41.52
H	4.07	61.44
N	15.99	17.24
P	8.20	4.00
K	6.11	2.20
O	32.63	30.84
	100.00	
Ash	25.40	
PO_3	19.29	
K	6.11	

Free acid = $C_{42}H_{63}N_{17}P_4O_{31}$.

The formula of this preparation shows one atom more of nitrogen and one atom less of potassium than that of preparation **1.**

Since ammonium acetate was used to cause the potassium salt to separate from the alcoholic solution, it is quite possible that

[48] Jour. Am. Chem. Soc. **22**, 329, 1900.

a little ammonium has combined with the nucleic acid. This supposition was confirmed by the strong reaction for ammonia which this preparation showed when treated with lime, but unfortunately at the time this preparation was analyzed, not enough of it was left for a quantitative determination of the ammonia.

If we assume that one atom of the nitrogen of the above formula belongs to ammonia and deduct this with the corresponding three atoms of hydrogen, the resulting formula of the free acid will be in close agreement with those obtained for the other purer preparations, namely, $C_{41}H_{60}N_{16}P_4O_{31}$.

The potassium salts forming these two preparations were acid salts, since their aqueous solutions reacted strongly acid towards litmus. As both, when dissolved in water, yielded pale yellow solutions, what remained of them was united, dissolved in water, the solution made alkaline to litmus, and, in order to separate any combined basic coloring matter or other basic organic substance, the solution was precipitated by pouring into an excess of alcohol. The voluminous precipitate thereby produced was filtered out, washed with alcohol, redissolved in water, the solution made alkaline to phenolphthalein with potassium hydroxide and again precipitated with alcohol. The precipitate was filtered out, dissolved in water and the free acid precipitated by adding decinormal hydrochloric acid. The flocculent precipitate that separated soon settled to a coherent layer, which was ground to a powder under water and thoroughly washed with water, dilute and absolute alcohol and, dried over sulphuric acid, gave 10.15 grams of preparation **3.** This had the following composition when dried at 110°:

NUCLEIC ACID, *Preparation* **3.**

	Per cent.	Atomic Ratio.
C	35.41	41.84
H	4.37	62.00
N	16.07	16.28
P	8.75	4.00
K	0.32	
O	35.08	31.00
	100.00	
Ash	3.52	
PO_3	3.20	
	0.32	

Free acid = $C_{42}H_{62}N_{16}P_4O_{31}$.

b. *Second Extraction.*

Four portions of oil-free embryo meal, each weighing 12 kilograms, were separately agitated with 60 liters of water, the extract strained through coarse cloth and the suspended matters allowed to deposit during the night. The somewhat turbid liquid was then siphoned off, saturated with sodium chloride and made distinctly acid with hydrochloric acid. The large precipitate that separated was filtered out, removed from the paper, suspended in water and again thrown on a filter. After the water had run out it was suspended in 0.2 per cent. hydrochloric acid, pepsin added and the digestion continued for three days at the room temperature. The undissolved residue was filtered out, washed twice, by suspending in water and draining on filters, and then treated with an excess of potassium hydroxide solution and a large quantity of picric acid. After about an hour, the mixture was acidified with acetic acid, the insoluble protein picrate filtered out and the clear filtrate treated with strong hydrochloric acid, as long as a precipitate was formed. The very large flocculent precipitate soon settled to a coherent deposit that rapidly contracted to a dense cake, which retained the form of the vessel in which it had settled. By transferring the precipitate to a smaller vessel, before it had become too dense, it was obtained in four round cakes about 6.5 centimeters in diameter and 2.5 centimeters thick. These four cakes, which contained but little combined water, weighed about 100 grams each and were so dense that they closely resembled vulcanite.

The crude nucleic acid from the two portions first extracted were separately dissolved in a small excess of potassium hydroxide solution, an operation which required much agitation and time, owing to the density of the substance, and the two solutions which resulted were then poured into a large quantity of strong alcohol containing an excess of hydrochloric acid. This process was then repeated, the alcoholic filtrate from the second precipitation being much less colored than was that from the first. The two flocculent precipitates were dehydrated with absolute alcohol and dried over sulphuric acid, giving preparations **4** and **5**, which weighed, respectively, 36 and 18 grams. The crude nucleic acid of the third and fourth portions was together treated in the same way, giving 28 grams of preparation **6**, which was more colored than **4** or **5** and appeared less pure.

The acid alcohol, from which the preceding preparations **4**, **5** and **6** had been separated, was treated with twice its volume of strong alcohol and 10 grams of preparation **7** were obtained, which was nearly free from color.

It is evident that much loss of nucleic acid was incurred in thus reprecipitating the crude acid, since from the dense precipitates, which contained but little water and weighed nearly 400 grams, only 92 grams were finally obtained in the four preparations above described.

When dried at 110° and analyzed, these four preparations gave the following results:

NUCLEIC ACID.

	Preparation **4.**		*Preparation* **5.**		*Preparation* **6.**		*Preparation* **7.**	
	Per cent.	Atomic Ratio.	Per cent.	Atomic Ratio.	Per cent.	Atomic Ratio.	Per cent.	Atomic Ratio.
C	34.37	40.92	32.92	42.72	32.73	44.68	34.25	44.76
H	4.33	61.84	4.32	66.80	4.32	70.76	4.15	65.12
N	16.12	16.44	15.10	16.68	15.55	18.16	16.33	18.28
P	8.69	4.00	8.02	4.00	7.57	4.00	7.90	4.00
K	1.62	0.59	4.41	1.74	2.86	1.20	3.25	1.30
O	34.87	31.12	35.23	34.04	36.97	37.84	34.12	33.44
	100.00		100.00		100.00		100.00	
Ash	10.73		18.98		12.95		13.35	
PO_3	9.11		14.57		10.09		10.10	
K	1.62		4.41		2.86		3.25	

Free acid=

$$C_{41}H_{62}N_{16}P_4O_{31}-C_{43}H_{69}N_{17}P_4O_{34}-C_{45}H_{72}N_{18}P_4O_{38}-C_{45}H_{66}N_{18}P_4O_{34}.$$

c. *Third Extraction.*

The nuclein, obtained from another lot of 12 kilograms of the embryo meal in the same manner as in the preceding extraction, was dissolved by a slight excess of potassium hydroxide and a solution of potassium bichromate and acetic acid added, as long as a precipitate was produced.

The latter was filtered out and washed once by suspending in water and returning to the filter. The filtrate and washings were then strongly acidified with hydrochloric acid and the very large precipitate, with the peculiar properties characteristic of this acid, was thoroughly washed with water and with alcohol and dried over sulphuric acid. In this way 120 grams of preparation 8 were obtained which, when dried at 110°, had the following composition:

NUCLEIC ACID, *Preparation* 8.

	Per cent.	Atomic Ratio.
C	36.53	44.60
H	4.51	66.08
N	15.87	16.44
P	8.45	4.00
K	0.52	0.20
O	34.12	31.36
	100.00	
Ash	6.40	
PO_3	5.88	
K	0.52	

Free acid $= C_{44}H_{66}N_{16}P_4O_{31}$.

Since this preparation represents the whole of the acid that can be obtained from this meal, and has the same properties and nearly the same composition as the purified preparations of the acid, it seems almost certain that we have but one nucleic acid to deal with in all these preparations.

d. *Fourth Extraction.*

Another preparation of nucleic acid was made as in the preceding experiments and then treated with a strong solution of sodium acetate, whereby a part passed into solution as sodium nucleate. From this solution the nucleic acid was precipitated by hydrochloric acid and found to contain much less coloring matter than did any of the previously obtained crude products. This precipitate was dissolved in a slight excess of sodium hydroxide and the resulting solution poured into alcohol. The sodium nucleate thus precipitated was dissolved in water and its solution poured into alcohol containing an excess of hydrochloric acid. The voluminous precipitate of the free acid was then washed with alcohol and dehydrated with absolute alcohol.

The 200 grams of nucleic acid thus prepared formed a pure white, dusty powder, which had the following composition when dried at 110°:

NUCLEIC ACID, *Preparation* 9.

	Per cent.	Atomic Ratio.
C	35.15	44.88
H	3.93	63.60
N	15.59	18.08
P	7.63	4.00
Na	1.42	1.00
O	36.28	36.84
	100.00	
Ash	17.22	
PO_3	15.80	
	1.42	

Free acid $= C_{45}H_{65}N_{18}P_4O_{37}$.

In order to obtain as pure a preparation as possible, about 120 grams of the crude nucleic acid was dissolved in an excess of potassium hydroxide solution, three grams of picric acid added and the solution acidified with acetic acid. A small precipitate of protein picrate was filtered out and the perfectly clear filtrate precipitated with an excess of hydrochloric acid. The nucleic acid thus precipitated was washed with water, redissolved with potassium hydroxide and the clear solution poured into five volumes of strong alcohol.

The precipitate thus produced was dissolved in water and the solution again poured into five volumes of alcohol, which threw down the potassium nucleate, leaving the alcohol only slightly colored. After filtering out and washing with alcohol, the potassium nucleate was again dissolved in water and reprecipitated as the free acid by pouring its solution into several volumes of strong alcohol containing an excess of hydrochloric acid, whereby a very voluminous, white precipitate resulted, which was washed with alcohol, dehydrated with absolute alcohol and dried in the air, yielding a white powder, which weighed 53 grams. This was then dried at 110° and analyzed with the following results:

NUCLEIC ACID, *Preparation* 10.

	Per cent.	Atomic Ratio.
C	34.65	40.76
H	4.30	60.72
N	15.88	16.00
P	8.70	4.00
K	1.42	
O	35.05	30.92
	100.00	
Ash	13.71	
PO_3	12.29	
Na	1.42	

Free acid $= C_{41}H_{61}N_{16}P_4O_{31}$.

This preparation was free from chlorine, iron and all other mineral bases which with phosphoric acid form compounds insoluble in alkaline solutions.

The analyses of these several preparations of nucleic acid show wide differences, similar to those presented by the analyses of nucleic acids heretofore published by others.

This is chiefly due to the fact that all these preparations contained a variable proportion of mineral base. As this nucleic acid is polybasic, it forms acid salts with potassium or sodium, which are insoluble in water and whenever an attempt is made to precipitate the free acid from a solution of its alkaline salt, a part is thrown down as an acid salt, from which it has been impossible to remove all the base.

If the atomic ratio is calculated from the analyses, the differences caused by this combined base largely disappear and formulas are obtained which are not unlike those previously given for the nucleic acids obtained by other investigators.

In the more carefully purified preparations the ratio of phosphorus to nitrogen is approximately 4 to 16, but in the less pure it is greater, reaching even 4 to 18. It would appear that it is almost as difficult to remove organic bases as inorganic and that consequently an excess of nitrogen is usually present.

Preparations **3** and **10** were more extensively purified than the others, and their analyses doubtless most closely represent the true composition of this nucleic acid. It is to be noted that the ratio of phosphorus to carbon in **3** is 4 to 42, whereas in **10** it is 4 to 41. In the latter the ratio of phosphorus to nitrogen is 4 to 16, but in the former 4 to 16¼. Since in the other preparations the ratio of carbon to phosphorus increases with that of nitrogen, it is probable that preparation **10** is somewhat purer than **3** and that there are 41 and not 42 atoms of carbon for every 4 of phosphorus in the molecule of the pure acid.

We may, therefore, take the formula found for **10** as most closely representing the molecule of the tritico-nucleic acid, namely, $C_{41}H_{61}N_{16}P_4O_{31}$.

IV. Properties of Tritico-nucleic Acid.

a. *Solubility in Water.*

Compared with nucleic acids of animal origin, that from the wheat embryo is very insoluble in water. Definite statements concerning the solubility of the former are not to be found in the literature, but the practice of precipitating these acids by the addition of one or more volumes of alcohol, containing hydrochloric acid, indicates that they are soluble in water to a notable extent.

Owing to the difficulty encountered in preparing tritico-nucleic acid free from base, it is not possible to make precise statements in regard to its solubility in water. None of the preparations just described were soluble in cold water to a noticeable degree. In boiling water, most of them formed a pasty mass, of which very little was soluble.

One preparation, not previously described, which was very finely divided, and contained about 3 per cent. of sodium, when boiled with water for a few minutes dissolved almost completely, its solution being acid to litmus. After boiling for some time, its solution gave only a slight precipitate with hydrochloric acid, which, however, did not have the peculiar character of the unchanged acid. From this it would appear that, by boiling with water, tritico-nucleic acid is altered to such an extent that it is no longer precipitated by hydrochloric acid. It is probable that the free tritico-nucleic acid is very slightly, if at all, soluble in boiling water, except in so far as it is altered thereby with the formation of soluble products.

b. *Inorganic Salts of Tritico-nucleic Acid.*

With potassium, sodium or ammonium, tritico-nucleic acid forms salts that are soluble in water. Potassium, sodium or ammonium form readily soluble acid salts whose aqueous solutions are strongly acid to litmus. Tritico-nucleic acid, like the nucleic acids described by others, is soluble in solutions of alkali acetates. Strong solutions of potassium nucleate are precipitated abundantly by barium or calcium chloride, the precipitate being moderately soluble in water, but are only incompletely precipitated by magnesium sulphate solutions.

With zinc sulphate a voluminous gelatinous, white precipitate forms; with ferric acetate a light reddish, bulky precipitate; with mercuric nitrate a more dense, colorless precipitate, and with silver nitrate a gelatinous, white one. With copper salts a pale greenish precipitate results in which only a part of the copper is present in the usual form of basic combination.

Thus a quantity of the acid was dissolved with just enough potassium hydroxide to give a neutral reaction with phenolphthalein, and was then treated with a dilute solution of copper sulphate until precipitation was complete. The copper nucleate was filtered out, washed, suspended in water and the substance, thus very finely divided, was poured into a large volume of alcohol containing an abundant excess of hydrochloric acid. The free nucleic acid was filtered out, thoroughly washed with dilute alcohol and dried over sulphuric acid. When moist, this substance had a very pale green color; when dry it was white, with a just perceptible greenish tint. Dissolved in an excess of ammonia it gave a clear yellow solution, with no trace of the blue color caused by the copper ammonium ions usually formed under such conditions. On ignition this preparation left an ash of copper phosphate, which formed 17.43 per cent. of the dry substance. The remainder of this preparation was dissolved in ammonia, the solution acidified with acetic acid, ammonium chloride added and hydrogen sulphide passed through the solution. After filtering out the copper sulphide, the nucleic acid was precipitated by hydrochloric acid and recovered with unchanged properties and composition.

Schmiedeberg[49] observed a similar behavior of salmo-nucleic acid, for he says that in no case could the nucleic acid be freed from copper by precipitating with hydrochloric acid or even by dissolving in concentrated hydrochloric acid. If the copper nucleate was dissolved in ammonia and the solution treated with barium chloride, the precipitated barium nucleate still contained copper which could not be removed by washing with ammonia.

c. *Attempts to Crystallize Potassium Tritico-nucleate.*

A quantity of tritico-nucleic acid was dissolved with enough potassium hydroxide to give a slightly alkaline reaction with phenolphthalein, enough alcohol added to give a faint turbidity

[49] Archiv. f. Exper. Path. u. Pharm. 43, 57.

and the mixture allowed to evaporate over calcium oxide. The amorphous deposit that formed was redissolved and treated as before, but no crystals could be obtained, even after the several fractional precipitations had been again treated in this way. No crystals resulted from the addition of more alcohol to the solutions decanted from these deposits and further evaporation over lime.

d. *The Basicity of Tritico-nucleic Acid.*

A silver salt of this acid was prepared by adding silver nitrate to the aqueous solution of the acid potassium salt. Dried to constant weight over sulphuric acid, this was found to contain

	Found.	Calc. for $C_{41}H_{55}N_{16}P_4Ag_6O_{31}$.
Ag	31.62	31.76 per cent.
P	5.97	6.08

In harmony with this result, it was found that 4.4 cc. of decinormal potassium hydroxide solution were made neutral to phenolphthalein by 1.4 grams of preparation **3**, and that on neutralizing the added alkali with decinormal nitric acid the solution became turbid when 3 cc. of the added alkali were still unneutralized by the nitric acid. When the nucleic acid was precipitated by completely neutralizing the whole of the added alkali, the precipitated acid was redissolved and a clear solution obtained with 3.1 cc. of decinormal potassium hydroxide solution. Since the calculated molecular weight of this acid is 1397, the above quantity of nucleic acid corresponds in its capacity for reaction to 1 cc. of decinormal alkali. We see, therefore, that with three atoms of potassium a soluble acid salt is formed, and with a little more than four atoms, one that is dissociated, under the conditions of the experiments, to such an extent as to give an alkaline reaction with phenolphthalein.

The salt with three atoms of potassium reacts acid with litmus, that with four atoms, alkaline.

V. Hydrolytic Decomposition Products of Tritico-nucleic Acid.

a. *Purin Bases.*

Most of the preparations of this acid, as already stated, when heated with boiling water form a plastic mass, of which little is dissolved. One preparation of an acid sodium salt, which was insoluble in cold water, dissolved almost completely in boiling water and, after an hour and a half, its solution gave no trace of a precipitate with silver oxide-ammonia, although a considerable quantity of orthophosphoric acid was found in the solution.

Hot 1 per cent. hydrochloric acid rapidly dissolves tritico-nucleic acid, and if the solution is at once tested with ammoniacal silver solution no precipitate of purin bases is obtained. If, however, the 1 per cent. hydrochloric acid solution is boiled for 30 minutes, these bases are completely separated and the solution yields no more by further treatment with boiling acid. These facts show that in tritico-nucleic acid these bases are in ester combination, as Kossel found them to be in thymo-nucleic acid, and not in salt-like combination, as Schmiedeberg supposed them to be in salmo-nucleic acid. Boiling for a longer time and with stronger acids does not increase the yield of purin bases. Thus one gram of preparation **8**, when boiled for 30 minutes with 1 per cent. hydrochloric acid, gave 11.4 per cent. of guanin, when boiled for 90 minutes with 1.5 per cent. hydrochloric acid, 11.6 per cent., and when boiled with 5 per cent. sulphuric acid for 7 hours, 11.2 per cent.

A considerable quantity of adenin is also obtained by hydrolysis and indeed in nearly equi-molecular proportion with the guanin. The identity of these two bodies was established by their reactions and the crystalline form of their salts, which were throughout those characteristic of these substances.

The nitrogen of the two bases was determined with the following results:

	Guanin. Found.	Guanin. Calc.	Adenin. Found.	Adenin. Calc.
N........	46.04	46.36 per cent.	51.49	51.85 per cent.

A quantity of the adenin was also converted into the picrate, which had the following composition:

	Found.	Calculated for $C_{11}H_8N_8O_7$.
C..................	36.07	36.27
H..................	2.51	2.19
N..................	30.28	30.77

The proportion of these purin bases was found by boiling two one-gram portions of preparation **8**, air dried, with 25 cc. of 2 per cent. sulphuric acid for 30 minutes, making the solution alkaline with ammonia and precipitating the guanin and adenin with a solution of silver oxide in ammonia. After washing out the greater part of the free ammonia and its salts, the precipitate was freed from the last traces of these by continued boiling with an excess of magnesia. The remaining nitrogen was then determined by Kjeldahl's method and 0.0942 and 0.0950 gram of nitrogen was found. The one air-dry gram of substance taken contained 0.1531 gram of nitrogen, one-sixteenth of which is 0.00957 gram, from which it appears that the nitrogen of the purin bases is ten-sixteenths of the whole, a proportion required by the presence of one molecule of guanin and one of adenin.

The amount of each of these bases was then determined in a number of different preparations of the acid by hydrolyzing, as above, and precipitating the guanin by adding an excess of ammonia to the solution, which had a volume of 100 cc. After filtering out the guanin on asbestos in a Gooch crucible, the adenin was precipitated by ammoniacal silver oxide solution. The precipitates were washed until every trace of ammonia was removed and nitrogen determined in them with the following results:

WEIGHT IN GRAMS OF PURIN NITROGEN IN 1 GRAM OF TRITICO-NUCLEIC ACID.

Preparation	**4**	**5**	**7**	**8** I	**8** II	**10** I	**10** II	Calculated for 1 mol. of each.
Guanin N....	0.0579	0.0572	0.0548	0.0474	0.0463	0.0573	0.0532	0.0500
Adenin N....	0.0494	0.0448	0.0433	0.0441	0.0459	0.0488	0.0459	0.0500
	0.1073	0.1020	0.0981	0.0915	0.0922	0.1061	0.0991	0.1000

These figures correspond to the following quantities of guanin and adenin:

WEIGHT OF GUANIN AND ADENIN IN 1 GRAM OF NUCLEIC ACID.

Preparation	**4**	**5**	**7**	**8** I	**8** II	**10** I	**10** II	Calculated
Guanin ...	0.1249	0.1235	0.1182	0.1022	0.0999	0.1235	0.1148	0.1080
Adenin ...	0.0953	0.0865	0.0835	0.0850	0.0885	0.0941	0.0885	0.0964
	0.2202	0.2100	0.2017	0.1872	0.1884	0.2176	0.2033	0.2044

The total purin nitrogen, thus found, in the purest of these preparations, namely, **4**, **5** and **10**, is very nearly equal to the amount calculated for one molecule of each of these bases for every four atoms of phosphorus, whereas that found in **7** and **8**, which are not quite so pure, was a little less.

Although in these determinations the amount of guanin nitrogen was found to be higher than the adenin nitrogen, the amounts are so nearly the same that there can be no doubt that these bases are present in equal molecular proportions and that the differences observed are due to the difficulties presented in completely separating the two bases, a little adenin being doubtless precipitated with the guanin.

It would appear from these results that all of the purin bases are easily precipitated from the solutions containing the other hydrolytic products of decomposition of tritico-nucleic acid and that no such difficulties are met with as those described by Schmiedeberg,[50] who states that he was unable to completely precipitate the silver salt of these bases in the presence of the other decomposition products of salmo-nucleic acid. He confirmed, therefore, Kossel's[51] assertion that thyminic acid, from thymo-nucleic acid, prevents the precipitation of guanin and adenin as silver salts. Schmiedeberg also found that a very considerable amount of some other substance was precipitated with the silver purin compounds, which on evaporation with hydrochloric acid yielded melanin-like decomposition products.

In our determinations of guanin and adenin, we have largely avoided errors due to such products by determining the nitrogen in the precipitates, instead of weighing them, for we found that the results obtained by weighing were always somewhat higher than those calculated from the nitrogen content of the precipitate.

Kossel[52] obtained a compound of guanin with ammonia, which was stable at 110°, and it might therefore be thought that such a compound was formed under the conditions of these experiments. A distillation with sodium hydroxide of the guanin obtained in the determinations made in preparation **10**, as above given, showed no trace of ammonia, so that it is

[50] Archiv. f. Exper. Path. u. Pharm. **43**, 57.
[51] Zeit. f. physiol. Chem. **22**, 74, 1896.
[52] Zeit. f. physiol. Chem. **7**, 17.

probable that in these analyses an ammonium compound of guanin was formed in very small quantity, if at all.

These determinations make it almost certain that an equal number of molecules of the two bases are contained in these preparations of the nucleic acid, and since **8** represents the whole of the nucleic acid obtained from the wheat embryo, while **4**, **5** and **10** are purified fractions of the acid, it is certain that both of these bases are present in each molecule of nucleic acid and that the preparations are *not* mixtures of two acids, one containing guanin, the other adenin, for it is hardly possible that two acids should have so nearly the same solubility as to escape separation, to a recognizable extent, by the fractional precipitations occurring during the process of purification.

By treating tritico-nucleic acid with alkalies, it has been found that the purin bases are removed very slowly and incompletely. The rate at which these bases are split off was determined by boiling one gram portions of the acid with 100 cc. of normal sodium hydroxide solution for various times, neutralizing with hydrochloric acid, adding an excess of ammoniacal silver oxide solution, filtering out the silver purin precipitate, washing it free from ammonia and determining the amount of nitrogen in it. In this way the following percentages of the purin nitrogen were split off during the times indicated.

Percentage of the Purin Nitrogen split off from Tritico-nucleic Acid by boiling with Alkali.

After boiling	1¼ hours	2.1 per cent.
"	4 "	17.9 "
"	6 "	20.0 "

These figures show that the bases are separated much more slowly by alkalies than by acids, a result in harmony with those obtained by Stokes,[53] who found that in amido-phenylphosphoric acids the amido binding, while very unstable in acid solutions, was very stable in alkaline, whereas the reverse was true for the hydroxyl binding. We may, therefore, conclude that the purin bases are joined to the phosphorus by a nitrogen and not by a carbon atom.

[53] Amer. Chem. Jour. **16**, 123, 1894.

b. *Ammonia.*

Kossel and Neumann[54] found ammonia among the decomposition products of thymo-nucleic acid. We, also, have found it among those of tritico-nucleic acid, but only after boiling the nucleic acid with a strong mineral acid for some time.

Thus, when one gram of the acid was boiled for 30 minutes with 2 per cent. sulphuric acid and the resulting solution distilled with an excess of magnesia, no trace of ammonia was found.

When one gram was boiled for 6½ hours with 12 per cent. hydrochloric acid, the solution diluted with twice its volume of water and precipitated with phosphotungstic acid, the precipitate washed, dissolved in sodium hydroxide solution and distilled, 0.0110 gram of nitrogen was evolved as ammonia.

Another gram, hydrolyzed under the same conditions, gave a solution, which, when freed from the greater part of its hydrochloric acid by evaporation and the residue distilled with an excess of magnesia, gave 0.0101 gram. Two portions of nucleic acid weighing one gram each, when boiled with 12 per cent. hydrochloric acid for ten hours and the solution distilled, after standing over night, yielded respectively 0.0170 and 0.0180 gram of nitrogen. This ammonia was unquestionably, for the most part, yielded by guanin, adenin and uracyl, as we found that, when 0.1 gram of guanin, 0.1 gram of adenin and 0.16 gram of uracyl were similarly boiled for ten hours with 12 per cent. hydrochloric acid and the ammonia determined by distilling with magnesia, the following quantities of nitrogen, as ammonia, were produced from each:

Guanin	0.0020 gram.
Adenin	0.0103 "
Uracyl	0.0010 "
Total	0.0134 "

As Kossel[55] has stated that adenin may be boiled for hours with hydrochloric acid without being changed, we repeated this experiment by boiling 0.1 gram of adenin with 20 per cent. hydrochloric acid for seven hours and found 0.0100 gram of nitrogen as ammonia.

[54] Ber. **27**, 2215, 1894.
[55] Zeit. f. physiol. Chem. **12**, 248.

One gram of tritico-nucleic acid was distilled with normal sodium hydroxide solution and the water lost by distillation continuously replaced. The first distillate, 220 cc., contained .0180 gram of nitrogen as ammonia, which is very nearly two-sixteenths of the total nitrogen; the second .0040, the third .0043, and after this the amount fell to .0010 or .0020 gram of nitrogen in each distillate, until after four days only insignificant quantities were found. During this time about eight liters of water had distilled over. The total nitrogen found in the distillates was 0.0742 grams or 46.4 per cent. of the total, equivalent to more than seven of the sixteen atoms of the nitrogen in the nucleic acid molecule.

Since guanin and adenin yielded not more than minute traces of ammonia when we boiled one gram of each under the same conditions, it seems almost certain that uracyl, two molecules of which, as we shall next show, are present in the nucleic acid, also would not. It would seem, then, as if the atoms in the radicals yielding guanin, adenin or uracyl exist under different conditions than in these bodies when isolated, for at least five of the seven atoms thus passing over as ammonia must have belonged to one or another of these complexes.

c. *Pyrimidin Compounds.*

Twenty grams of air-dry tritico-nucleic acid, which contained phosphorus equal to 16.22 grams of the pure acid, was digested in an autoclave for two hours at 150-160°, with 45 cc. of 20 per cent. sulphuric acid. A large black mass of undissolved matter remained, which was treated with hot water and thoroughly washed.

The filtrate and washings were then made to contain 5 per cent. of sulphuric acid, and phosphotungstic acid added as long as a precipitate formed. This was filtered out, washed with water, dissolved with sodium hydroxide solution and reprecipitated with an excess of sulphuric acid, equivalent to 5 per cent. of the solution, and a little more phosphotungstic acid added. The resulting precipitate was filtered out and washed, and the filtrate and washings added to those first obtained. This solution was freed from phosphotungstic acid by barium hydroxide and the filtrate from the precipitate, so produced, was freed from barium by a slight excess of sulphuric acid. An excess of silver nitrate was then added to the solution, filtered from the barium sulphate, and ammonia enough to neutralize the free acid. The voluminous white precipitate that formed was filtered out, washed with water, decomposed with hydrogen sulphide, the silver sulphide filtered out and washed and the solution evaporated to dryness. The residue, which was left, weighed 1.78 grams, equal to 11 per cent. of the original acid. This residue was dissolved in a little hot water and allowed to cool slowly, whereupon a large quantity of colorless crystals separated in microscopic balls and bunches of needles. The mother liquor from these crystals, on concentration, yielded a second crop of similar crystals and the small quantity of substance in the second mother liquor, on further concentration, did the same, showing that practically the whole of the original 1.78 grams of residue consisted of this substance. To these crystalline products was added about one-half as much more substance obtained in the same way in a preceding experiment, and the whole, after decolorizing with animal charcoal, was repeatedly recrystallized. The pure product, thus prepared, melted, with decomposition, on rapid heating at 337° (uncor.), which agrees well with the melting point of uracyl determined by E. Fischer and Hagenbach[56] to be 336°.

This substance when dried at 110° and analyzed was found to have the composition of uracyl:

	Found.		Calculated for $C_4H_4N_2O_2$.
Carbon.........	43.08	43.21	42.83
Hydrogen	....	3.65	3.59
Nitrogen	....	25.09	25.05

From these results there can be no doubt that this substance is uracyl and that the tritico-nucleic acid, in this respect, resembles the yeast nucleic acid, in which Ascoli[57] found this substance. One molecule of uracyl in the molecule of nucleic acid is equal to 8 per cent. of the latter. In the above described experiment 11 per cent. of uracyl was found, from which we must conclude that there are at least two molecules of this

[56] Ber. 34, 3751, 1901.
[57] Zeit. f. physiol. Chem. 31, 161, 1900.

body in the nucleic acid molecule. That the quantity found should fall so far short of the 16 per cent. required for two molecules, is not surprising in view of the long process involved in its separation and the great bulk of the phosphotungstic acid and barium hydroxide precipitates.

That the guanin and adenin, which contain the pyrimidin ring, are not the source of the uracyl is shown by the fact that when the purin bases were removed by a brief hydrolysis and the residual portion of the nucleic acid subjected to further hydrolysis, uracyl was found among the decomposition products. The fact that thymo-nucleic acid, which also contains these bases, yields no uracyl, but thymin in its stead, is further evidence in this direction.

A 1 per cent. aqueous solution of the uracyl thus obtained is not precipitated by phosphotungstic acid nor by barium hydroxide. With lead acetate and ammonia, silver nitrate or mercuric nitrate, it gives voluminous white precipitates; with copper acetate no precipitate, even after adding an excess of alcohol.

If a solution of copper acetate is added to an aqueous solution of uracyl and then dilute sodium hydroxide solution, drop by drop, the precipitate of copper hydroxide first formed redissolves and a very considerable amount passes into solution before any remains undissolved.

Uracyl is much more firmly bound within the molecule of nucleic acid than are the purin bases and has been obtained in sufficient quantity for identification only after the profound decomposition of the acid caused by strong sulphuric acid at high temperature or by very long continued action of strong hydrochloric acid. Thus after boiling 10 grams of the acid with 100 cc. of 10 per cent. sulphuric acid for four hours no uracyl could be found in the solution, but by prolonged treatment with hot concentrated hydrochloric acid it was found in quantity among the decomposition products.

d. *The Carbohydrate Group.*

Like the other nucleic acids previously described, tritico-nucleic acid gives no copper oxide reduction even after boiling for some time with hydrochloric acid.

Kossel and Neumann, *l. c.*, found both formic and laevulinic acids among the decomposition products of thymo-nucleic acid, from which they concluded that this nucleic acid contains a hexose group.

No formic acid was found in the distillate from 10 grams of tritico-nucleic acid when boiled for seven hours with 5 per cent. sulphuric acid, nor was any laevulinic acid found by shaking the residual acid solution with ether. We therefore conclude that there is no hexose group in this nucleic acid.

The distillate produced by boiling with acids contains, however, large quantities of furfurol, in which respect the tritico-nucleic acid resembles the yeast nucleic acid, from which Kossel[58] likewise obtained this substance.

The furfurol is evolved slowly, and is found in the distillate in appreciable quantities even after boiling for many hours. In this fact we have, perhaps, an explanation of the failure to obtain a copper oxide reduction, as it is possible that the sugar is decomposed by the acid as rapidly as it is separated from the nucleic acid.

The following figures show the amount of furfurol-phloroglucide obtained from one air-dry gram of preparation **8** in each successive 500 cc. of distillate:

WEIGHT OF FURFUROL-PHLOROGLUCIN.

	I.	II.
1st distillate	0.2165	0.2325
2d "	0.0205	0.0255
3d "	0.0180	0.0260
4th "	0.0083	0.0100
Total	0.2633	0.2940

The amount of furfurol was calculated from the weight of the phloroglucide by dividing the quantities greater than 0.2 gram by 1.895 and those less than 0.2 gram by 1.82. Subtracting 0.0104 gram from the furfurol found in each of the above determinations and multiplying by 1.91, we find 27.5 and 30.6 per cent. respectively of xylose in the nucleic acid dried at 110°; or, multiplying by 2.35 we find 33.8 and 37.6 per cent. of arabinose. Three molecules of pentose are equal to 32.2 per cent. of the nucleic acid, with which the above determinations

[58] Verhandl. der Physiol. Gesellsch. zu Berlin, 14 Oct., 1892.

agree more closely than with the quantity calculated for four molecules. There can be little doubt, therefore, that the nucleic acid molecule contains three pentose groups.

In this connection it is interesting to note that very recently Neuberg[59] has found that the pentose contained in the pancreas and derived, presumably, from guanylic acid, is xylose.

To confirm the preceding figures, two portions of 1 gram each of preparation **4**, air-dry, were distilled for seven hours with 12 per cent. hydrochloric acid and 0.2520 and 0.2495 gram of furfurol-phloroglucide were obtained. These quantities are equal to 25.4 and 25.1 per cent. of xylose in the nucleic acid dried at 110° or to 31.2 and 30.9 per cent. of arabinose.

e. *Phosphoric Acid.*

Kossel and Neumann[60] found that the aqueous solution of thymo-nucleic acid, when heated on the water bath for about ten minutes, underwent hydrolysis to such an extent that the purin bases were wholly removed and that, when this operation was carefully conducted, none of the phosphorus appeared as orthophosphoric acid.

This process cannot be applied to tritico-nucleic acid, because it is not soluble in water and when heated therewith forms a dense and gummy mass that permits only a superficial action of the water. This acid is, however, much more resistant to hydrolysis than thymo-nucleic, as it must be boiled with 1½ per cent. hydrochloric acid for at least 30 minutes before all the purin bases are set free.

When heated for 30 minutes with 1½ per cent. hydrochloric, or with 2 per cent. sulphuric acid, all the purin bases are removed, but the solution contains also some orthophosphoric acid. When 1 gram of preparation **8** was boiled for 30 minutes with 2 per cent. sulphuric acid, and the orthophosphoric acid at once precipitated with baryta and its amount determined in the usual way, it was found that 20.76 per cent. of the total phosphorus of the nucleic acid had been converted into orthophosphoric acid by the boiling acid. In another experiment the phosphoric acid was precipitated directly with ammonium

[59] Ber. 35, 1467, 1902.
[60] Zeit. f. physiol. Chem. 22, 74, 1896.

molybdate, the precipitate at once filtered out, to avoid further hydrolytic action of the acids and 22.8 per cent. of orthophosphoric acid was found. The remaining phosphorus appears to be mostly contained in a complicated organic acid, which is difficult to separate and purify.

This acid might be thought to correspond to the thyminic acid which Kossel and Neumann (l. c.) obtained from thymo-nucleic acid, and to the nucleotinic acid which Schmiedeberg assumed to be formed when the purin bases were removed from salmo-nucleic acid. The results of analysis of the barium salts of the acid derived from the tritico-nucleic acid, however, indicate that it is formed by a furthergoing decomposition of the nucleic acid by which a part of the carbohydrate and phosphorus are split off as well as the purin bases.

This acid was separated by the same process that Kossel and Neumann used in preparing their thyminic acid.

The nucleic acid was boiled for about 45 minutes with 2 per cent. sulphuric acid and a sufficient excess of baryta water added to give a distinct alkaline reaction with phenolphthalein. After standing over night the precipitate, which contained guanin, together with barium phosphate and sulphate, was filtered out and one and one-half volumes of alcohol were added to the filtrate. A very voluminous precipitate was thus produced, which settled slowly. This was filtered off, after standing over night, dissolved again in water, of which a considerable quantity was required, the solution filtered from a little insoluble matter, chiefly barium carbonate, and again precipitated by mixing with one and a half volumes of alcohol.

When dried to constant weight over sulphuric acid, the substance thus prepared gained in weight when dried in air at 110°. Three different preparations so made were dried and analyzed with the following results:

	11	12	13
Carbon	....	20.80	20.72
Hydrogen	....	3.37	3.19
Nitrogen	6.52	6.52	6.68
Phosphorus	5.60	6.08	6.22
Barium	30.65	31.16	30.99

On distilling with acid, preparation **12** yielded furfurol equal to 22.7 per cent., that from **13** to 21.3 per cent. of pentose, calculated for the mean between xylose and arabinose.

Preparation **13**, when dried in a current of hydrogen at 100°, lost 4.28 per cent. of moisture. Calculating the formula for the free acid, after deducting the moisture and barium, we have $C_{26}H_{48}N_7P_3O_{26}$.

It has already been shown that, by the brief hydrolysis employed in preparing this acid, all the guanin and adenin are split off and, at the same time, very nearly one-fourth of the phosphorus appears as orthophosphoric acid.

The amount of pentose found in these barium salts corresponds very closely with the quantity calculated for two molecules of this sugar for every three atoms of phosphorus, which shows that one of the three pentose groups of the original acid is also split off.

The sum of the atoms contained in the radicals which represent the groups split off from the original nucleic acid, is $C_{15}H_{17}N_{10}PO_6$.

If this is subtracted from the formula of the nucleic acid, we have as a remainder $C_{26}H_{45}N_6P_3O_{25}$, which agrees closely with that of the acid contained in the barium salts, $C_{26}H_{48}N_7P_3O_{26}$.

The excess of one atom of nitrogen is probably due to a little adenin, in the presence of which the barium salt was precipitated, for an examination of preparation **13** showed that it contained a little of this base. The excess of three atoms of hydrogen and one of oxygen may well be due to a molecule of water, which was not driven off at 100°. If these assumptions are correct, it would seem probable that one of the four molecules of phosphoric acid, present in the tritico-nucleic acid, is united to a guanin, an adenin and a pentose group, and that this is easily split off from the rest of the nucleic acid molecule and at the same time decomposed into its constituent groups.

In alkaline solutions the hydrolysis proceeds very differently from that in acid solutions, as already indicated in connection with the purin bases, which are separated with difficulty by alkalies, though easily by acids.

On boiling with alkalies, orthophosphoric acid is the most abundant decomposition product detected, the only other ones found being the two purin bases, though the remaining constituents of the nucleic acid can easily escape detection, owing to the difficulty of isolating them.

Gram portions of the nucleic acid were boiled with 100 cc. of normal sodium hydroxide solution for different definite lengths of time and then treated, while boiling hot, with baryta solution, the precipitates were filtered out, washed with hot water and the amount of phosphorus determined in them. Other gram portions were similarly boiled for the same definite lengths of time, the free purin bases precipitated by silver oxide, dissolved in ammonia, the purin silver compounds washed free from ammonia and the nitrogen determined in them. The following figures show the percentage of the total phosphorus and of the total purin bases which were thus found to have been split off by boiling for the times indicated:

	Phosphorus.	Purin bases.
$1\frac{1}{4}$ hours.	21.5 per cent.	2.1 per cent.
4 "	47.0 "	17.9 "
8 "	58.3 "	20.0 "

From these figures it would seem as if the part of the nucleic acid molecule to which the purin bases are attached is less easily broken up by alkalies than is the other part.

It would appear that nearly 25 per cent. of the phosphorus is readily split off, since 21.5 per cent. was obtained after boiling for only one and one-quarter hours, which suggests that one of the four atoms of phosphorus is present in the nucleic acid molecule under different conditions from the others.

By boiling for two hours, an aqueous solution of an acid sodium nucleate, which dissolved in water with an acid reaction to litmus, 7.35 per cent. of the phosphorus appeared as orthophosphoric acid, while no trace of any free purin bases could be detected with ammoniacal silver solution.

It is, however, to be remembered that, by long boiling with alkali, we found that nearly one-half the nitrogen of the nucleic acid was evolved as ammonia, so that it is possible that a notable proportion of the purin bases, that were liberated by the alkali, may have been destroyed and also that the presence of the other decomposition products of the nucleic acid may have hindered the precipitation of the purin silver compounds, as Kossel stated was the case with thymo-nucleic acid when boiled in acid solution.

f. *An unidentified decomposition product of Tritico-nucleic Acid.*

Kossel and Neumann[61] described, as cytosin, a decomposition product of thymo-nucleic acid, which was precipitated by phosphotungstic acid or by silver nitrate in neutral solution, but its character was not established, owing to the difficulty encountered in isolating a sufficient quantity of it.

We, also, have found a substance which, under the above conditions, is precipitated from solutions containing the hydrolytic decomposition products of tritico-nucleic acid, but, as yet, we have been unable to separate it in sufficient quantity for identification. Although this substance is precipitated from its solution by phosphotungstic acid, it cannot be afterwards separated from the precipitate by decomposing this with baryta, because its barium compound is insoluble and remains undissolved with the barium phosphotungstate.

By suspending the phosphotungstic acid precipitate in acidified water and shaking out with ether, according to Winterstein's method,[62] it has been possible to obtain a little of the body in question in an impure condition. The decomposition of the phosphotungstic acid precipitate could not be made complete in any way that we tried, and, as its bulk was so great, it was almost impossible to wash it free from phosphoric acid, which subsequently went into the aqueous solution and contaminated the basic body that we were attempting to separate. The product thus obtained yielded a gummy precipitate with picric acid, which dissolved on adding more water, and by silver nitrate, in neutral solution, was precipitated, but the product contained so much silver phosphate that it was not suitable for analysis.

g. *Melanin-like decomposition products of Tritico-nucleic Acid.*

Schmiedeberg[63] states that the ground substance of nucleic acid, that is, the part of the acid other than the purin bases, is characterized by a great tendency to form melanin. He collected the black melanin formed by repeatedly evaporating nucleic acid with hydrochloric acid, washed the precipitate

[61] Ber. **27**, 2215, 1894.
[62] Zeit. f. physiol. Chem. **34**, 153, 1901.
[63] Archiv. f. Exper. Path. u. Pharm. **43**, 57, 1899.

with dilute acid, dissolved it in ammonia and treated the resulting solution with magnesia mixture. After filtering out the ammonium magnesium phosphate he precipitated the melanin with hydrochloric acid and found that it contained much phosphorus, from which he concluded that it was a phosphorized melanin.

We have observed the formation of similar black products when tritico-nucleic acid is boiled with sulphuric or hydrochloric acid, it being especially abundant when the solution is repeatedly evaporated with the latter acid.

On decomposing the nucleic acid by heating with 20 per cent. sulphuric acid at 150° for two hours, a large amount of this melanin-like matter was obtained, which was filtered out, washed with water and absolute alcohol, and dried at 110°. In this condition it was a bulky, brownish black powder, which in one case, *a*, formed 24.4 and in another, *b*, 23.3 per cent. of the nucleic acid. Another preparation, *c*, was obtained by boiling the nucleic acid with 12 per cent. hydrochloric acid for ten hours and then evaporating the solution to a syrup on the water bath. The insoluble residue was washed thoroughly with water and alcohol and dried at 110°. This product formed 16.2 per cent. of the original acid and appeared similar in all respects to the substance produced by sulphuric acid. These preparations were dried at 110° and analyzed with the following results:

	a.	*b.*	*c.*
Carbon	62.03	60.57	63.14
Hydrogen	4.09	3.70	4.36
Nitrogen	9.63	10.67	5.07
Oxygen	24.25	25.06	27.43
	100.00	100.00	100.00

All these preparations were phosphorus-free and are evidently not the same as Schmiedeberg's *phosphorized* melanin. The amount of them was so great it is improbable that they can have originated from any *one* of the constituents of the nucleic acid.

Kossel[64] states that adenin, heated with zinc and hydrochloric acid, is decomposed and that from the solution, so obtained, he separated about 40 per cent. of the adenin as a black mass, which

[64] Zeit. f. physiol. Chem. 12, 249, 1888.

contained from 28.8 to 33 per cent. of carbon and 47 per cent. of nitrogen. This product he considered to be a mixture, and suggests that it may have some relation to the so-called alzuminic acids. It may well be that our melanins were mixtures of somewhat similar decomposition products of the purin bases, with the humus-like decomposition products of the carbohydrate.

h. *Glycerin.*

Bang[65] found a considerable quantity of glycerin among the decomposition products of guanylic acid. Although we have several times examined relatively large amounts of tritico-nucleic acid for glycerin, we have not been able to detect it among the decomposition products nor have we obtained any reactions which would indicate its presence. We are, therefore, satisfied that tritico-nucleic acid contains no glycerin.

VI. The Constitution of the Molecule of Tritico-nucleic Acid.

It has been shown that for every four atoms of phosphorus there are sixteen of nitrogen in the molecule of tritico-nucleic acid, and that of the recognized decomposition products containing nitrogen we have found one molecule of guanin, one of adenin and two of uracyl, for every four of phosphorus. These products contain fourteen of the sixteen atoms of nitrogen, leaving two unaccounted for. We have also shown that a basic decomposition product occurs, which it was not possible to isolate in sufficient quantity for identification, and it is probable, though not proved, that this contains the two remaining atoms of nitrogen.

Tritico-nucleic acid also yields furfurol, equivalent to three molecules of pentose for every four atoms of phosphorus, and a silver salt with six atoms of silver for every four of phosphorus, from which we conclude that there are six hydroxyl groups in the molecule.

Assuming that the four atoms of phosphorus are united by three of oxygen, we have the following constituents in the molecule of tritico-nucleic acid:

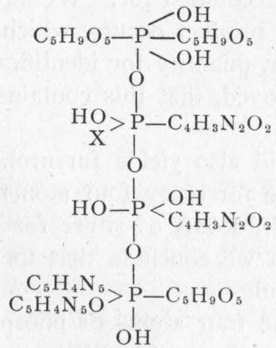
[65] Zeit. f. physiol. Chem. 31, 416.

			Mol. Wt.
Guanin,	1 molecule,	$C_5H_5N_5O$	151
Adenin,	1 "	$C_5H_5N_5$	135
Uracyl,	2 "	$2(C_4H_4N_2O_2)$	224
Pentose,	3 "	$3(C_5H_{10}O_5)$	450
Hydroxyl, 6 groups, $6(HO)$		....	102
Phosphorus, 4 atoms, P_4		....	124
Linking Oxygen, 3 atoms, O_3		....	48
			1234

Deducting seven atoms of hydrogen, eliminated when the four first mentioned substances unite with the phosphoric acid, we have 1227 parts of the 1397, which constitute the molecular weight of the tritico-nucleic acid, or 87.8 per cent. There remains, therefore, 12.2 per cent. unidentified, which probably belongs to the basic substance already mentioned.

The sum of the atoms in the radicals of the substances contained in the above table is $C_{33}H_{47}N_{14}P_4O_{29}$, which is less than the formula of tritico-nucleic acid by $C_8H_{14}N_2O_2$. We consider that it is probable that this difference belongs to the unidentified decomposition product, but of this we have as yet no evidence which has much weight.

Assuming, however, that this unknown substance belongs to a single group, and designating it by X, the possible structure of tritico-nucleic acid may be represented by the following formula, in which four atoms of phosphorus are united in much the same way as Bang assumed them to be in guanylic acid:



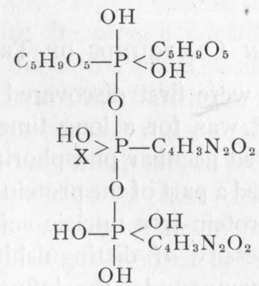
This formula presupposes the union of four $P(OH)_5$ groups, although $P(OH)_5$ is unknown in the free state.

Stokes[66] has shown, however, that the esters of pentahydroxyl phosphoric acid are stable bodies and there can, therefore, be no objection to the above formula on this ground. The position of the various groups in the formula is arbitrarily assigned, with the exception of guanin and adenin and one pentose group which are united with a terminal phosphorus, as there is strong evidence that this phosphorus, with the groups attached to it, is readily split off from the rest of the molecule.

It is assumed that the guanin and adenin are united to the phosphorus by a nitrogen atom, because this union was found to be far more stable in alkaline than in acid solutions.

Uracyl is represented as bound in this way also, though this is not in harmony with the difficulty encountered in separating it from the nucleic acid. If the uracyl were united by a hydroxyl group two atoms of oxygen would be required and there would then be no oxygen remaining for group X, which, however, may in fact contain none.

We have shown that after a brief hydrolysis guanin, adenin, one pentose and one phosphorus atom are split off and that a barium salt of a complicated acid can be obtained from the solution, which has a composition corresponding pretty closely with an acid of the following structure:



VII. The Relation of Tritico-nucleic Acid to the Nucleic Acids previously described.

The nucleic acids of animal and vegetable origin have similar properties and their composition as determined by analysis are much alike. All the later investigators agree in assigning four atoms of phosphorus to their empirical formulas. In salmo-

[66] Amer. Chem. Jour. 16, 123, 1894.

and thymo-nucleic acids there appears to be fourteen atoms of nitrogen for four of phosphorus. In the other animal nucleic acids this ratio is not definitely ascertained.

In yeast nucleic acid the proportion of nitrogen to phosphorus is variously stated by different investigators, but is mostly given higher than in the animal nucleic acids.

The animal nucleic acids as well as the vegetable contain both guanin and adenin. The pyrmidin group is represented in the animal nucleic acids, so far as they have been investigated, by thymin, which is a methyl uracyl; in the yeast and wheat nucleic acids by uracyl. In the thymo-nucleic acid the carbohydrate group appears to be a hexose, in the yeast and wheat nucleic acids to be a pentose. We thus have an apparent distinction between animal and vegetable nucleic acids, but further investigations are required to show in how far this holds good.

Whether all the animal nucleic acids are the same cannot be determined from the information now obtainable, but an examination of the literature indicates that this may prove to be the case. It is also possible that yeast nucleic acid may be identical with tritico-nucleic acid, but this, too, cannot be determined without further investigation.

VIII. The Protein Compounds of Tritico-nucleic Acid.

The nucleic acids were first discovered in combination with protein bodies and it was for a long time supposed that these compounds represented peculiar phosphorized proteids in which the phosphorus formed a part of the protein molecule. Although Miescher obtained protein-free nucleic acid and Altmann later pointed out the necessity of distinguishing the nucleic acids from their protein compounds, the influence of the old view respecting phosphorized proteids persisted and even now seems to have force, as shown by the almost universal practice of writers, who treat the nucleic acids in intimate connection with the proteins as though the two classes of bodies were chemically related.

Since the nucleic acids undoubtedly form a special class of phosphoric acid esters which can readily unite with protein bodies to form artificial compounds, similar to, if not identical with, those found in the tissues or separated from them, it would seem important to abandon the designation phosphorized proteids as applied to these compounds with nucleic acid, and consider more carefully their true character. Since the protein bodies are now recognized as basic substances, there can be no question but that they can form true salts with nucleic acid. Miescher showed that the salmo-nucleic acid, and we, that tritico-nucleic acid is hexabasic, so that at least six different salts may be formed by each of these acids with any one of the protein bodies. Further, since the proteins are probably all polyacid bases, the number of possible salts that may be formed is still further increased, and consequently when nucleic acid and protein occur in the same solution a large number of different salts may be formed, according to the proportion in which the two substances exist and the nature and proportion of the other bases and acids present. In view of these facts it is not surprising that different investigators have obtained nucleins and nucleo-proteids with very different phosphorus content even when working under apparently similar conditions, nor is the present confusion which exists in regard to these substances to be wondered at.

That, in fact, a great variety of such nucleates can be obtained under different conditions from the same tissue, was shown by the writer[67] in studying the protein constituents of the wheat embryo. Extracts of the entire wheat kernel contained a small proportion of globulin, and also of albumin, which were obtained wholly free from phosphorus, while similar extracts of the embryo meal yielded a very much larger proportion of the same globulin and albumin which, in most cases, contained phosphorus, the proportion varying from an insignificant quantity to over 3 per cent. This phosphorus belonged to the tritico-nucleic acid, since when the amount of nucleic acid corresponding to the phosphorus content of the different preparations was subtracted from their analyses, the remainders all showed the composition of the globulin or albumin previously obtained, phosphorus-free, from the whole wheat kernel. By this investigation it is made evident that a considerable quantity of nucleic

[67] Report Conn. Agri. Expt. Station for 1899, also Jour. Am. Chem. Soc. 22, 379, 1900.

acid can combine with a protein substance without altering its behavior as a globulin or an albumin.

That existing conditions determine the proportion in which the nucleic acid combines with the protein is shown by the behavior of the extracts described in this paper.

The freshly prepared aqueous extract of the wheat embryo is at first neutral to litmus and contains a large amount of protein, chiefly albumin and some proteose, together with much nucleic acid, held in solution by the basic protein matter present in large proportion. If this neutral solution is saturated with sodium chloride, very little precipitate results, but if a small quantity of acid is added, a large precipitate forms at once which contains practically all of the nucleic acid. This precipitate is formed by the increase in the proportion of acid, since the soluble nucleates, containing a large proportion of protein base, can then no longer exist. The new compounds which are formed contain a much smaller proportion of the basic protein and are no longer soluble in the saturated salt solution nor in water. By digesting the resulting precipitate with pepsin, the proportion of protein is still further reduced and insoluble compounds are formed, which are incapable of further alteration by the pepsin. These products, which have the properties characteristic of "nucleins," are still merely protein salts of nucleic acid; no hydrolytic action is required to separate their two constituents; the nucleic acid can be largely removed as sodium nucleate by simply treating them with a solution of sodium acetate; and furthermore, the protein can be almost completely converted into protein picrate by adding picric acid to their alkaline solutions and acidifying with acetic acid, the nucleic acid remaining in solution as an alkaline nucleate.

It is evident, therefore, that there is no reason to assume that the union between the nucleic acid and the protein is different from that which exists between base and acid in other salts.

We have already stated that protein nucleates exist, which resemble globulins or albumins, the character of the nucleate being determined by the nature of the combined protein, the globulin yielding nucleates with the characteristics of globulin, the albumin those with the characteristics of albumin. In this respect nucleic acid behaves like other acids which, in small proportion, unite with protein substances to form salts, which, as the writer has shown in the case of edestin, have the properties of globulin and are obtained crystalline by dialysis or by cooling their warm, concentrated solutions.[68] There is, therefore, no reason for considering these protein compounds of nucleic acid as in any way different in character from those of the other acids.

Whether all of the many "nucleo-proteids" which have been obtained from various cells and tissues are protein nucleates cannot, of course, be determined without a special examination of each, but it is not at all improbable that they are such and it would seem highly probable that the nucleic acid is contained within the cell in salt-like combination. The lack of uniformity in the composition of the many preparations of these substances, obtained by various investigators, especially the wide variations in their content in phosphorus, points strongly to this view of their nature. If this be so, the products isolated from the cells cannot be regarded as necessarily existing, as such, in them, for the proportion in which the protein and the nucleic acid unite would depend upon the conditions prevailing at any given moment. As these conditions during life must be constantly changing, the protein nucleates must be changing also and their great physiological importance is doubtless due, in large measure, to this fact.

The high basicity of nucleic acid enables it to enter into the formation of a multitude of chemically different products, forming many different salts not only with one and the same protein, but with all other basic bodies, as well as mixed salts with the several different bases which may be present.

As to the occurrence of the nucleins in nature, much the same may be said.

The compounds of protamine with nucleic acid have been regarded as salts since Miescher first discovered them and these doubtless exist as such in the cell. As to the insoluble protein compounds, which contain a large proportion of nucleic acid, compared with the nucleo-proteids, the facts are not so clear. Certainly the "nuclein," which we obtained in this investigation from the wheat embryo, did not exist as such in the tissues of

[68] Zeit. f. physiol. Chem. 33, 240; also Report Conn. Agri. Expt. Station for 1900.

the seed, but was formed during the process of preparing the nucleic acid. Whether the nuclein obtained by Miescher, by digesting pus cells with pepsin until all the other constituents were removed and only the nuclein remained apparently but little, if at all, changed, so far as microscopic examination showed, represented the unaltered substance of the cell nuclei, or not, is not entirely certain, but it is quite possible that it did. Cohnheim[69] states that the "nucleins" do not occur in nature, as such, but are always splitting products of nucleo-proteids. He adopts Kossel's and Lillienfeld's view that the nucleo-proteids on splitting yield protein and nuclein, which latter when further decomposed yields protein and nucleic acid. In what way these groups are united is unknown, but such facts as are known incline him to the idea that the protein and nuclein are combined as salts. Cohnheim considers, however, that this is not proved and that the formation of nuclein is here left out of consideration.

It seems to us that the formation of the nuclein may be easily explained by considering the relation of the proteins to acids. These bodies unite with small proportions of acids to form salts, in which the protein molecule retains its original properties unchanged. Thus edestin forms definite crystalline salts with one and with two molecules of hydrochloric acid, and to these primary salts many of the nucleo-proteids probably correspond. Under the hydrolytic action of acids, the acid capacity of the protein increases, the first product, standing very near to the unchanged edestin, combining with at least three molecules of hydrochloric acid,[70] while the total acid capacity of edestin, as tested by tropaeolin, corresponds to twenty molecules. The behavior of the other native proteins is similar. With the formation of the proteoses, the acid-combining power increases greatly, as has long been known.

As the nucleins are always obtained from solutions containing relatively much acid, it is highly probable that the acid capacity of the protein is thereby greatly increased, and consequently each molecule combines with several of nucleic acid, thus forming the compounds now known as nucleins.

[69] Die Eiwesskorper. Braunschweig, 1901, p. 198.
[70] Osborne, Zeit. f. physiol. Chem. **33**, 225; also Report Conn. Agri. Expt. Station for 1900, p. 388.

Nothing in this view precludes the possibility that the nucleic acid may also exist in the cell in some other form of combination than as a salt. It is quite possible that esters may also occur, but the evidence in respect to this has not yet been presented.

The former statements that nucleic acid occurs free in the cell are now no longer considered to be correct, and in view of the large proportion of protein associated with nucleic acid it would seem to be quite impossible that any should remain uncombined therewith.

IX. Relation of Nucleic Acids to Guanylic Acid.

The conception of the nucleic acids as esters of a complex phosphoric acid, formed by the union of four $P(OH)_5$ groups, brings them into relation with guanylic acid, to which Bang has assigned a somewhat similar constitution. Both may be considered to be esters of a similar phosphoric acid, but differ materially from one another in many essential points.

Guanylic acid, unlike all the true nucleic acids that have been sufficiently well studied, contains no adenin; the proportion of guanin is decidedly greater and the pentose is probably not united directly to the phosphoric acid, but to glycerin.

Guanylic acid may be called a purin ester of a glycero-phosphoric acid, tritico-nucleic acid a mixed ester of a glyco-phosphoric acid.

Such decided differences in constitution must correspond to differences in their physiological relations. It would seem, therefore, to be doubtful that guanylic acid is a constituent of the cell nuclei and probable that its physiological relations are quite different from those of the nucleic acids proper.

In this connection it is important to recall that Levene[71] has obtained an acid from the pancreas which had the properties of a true nucleic acid, contained both guanin and adenin in abundance, probably contained thymin, and gave on analysis atomic ratios for carbon, hydrogen, nitrogen and phosphorus, which were very similar to those found for tritico-nucleic acid.

[71] Zeit. f. physiol. Chem. **32**, 541, 1901.

X. Relation of the Nucleic Acids to the Paranucleic Acids.

Some time ago one of us pointed out the possibility that those physiological phosphoric acids, which were not orthophosphoric acid, might prove to be pentahydroxyl phosphoric acid H_5PO_5, or its first anhydride $H_8P_2O_9$.[72] If this be so, the nucleic acids would be related to the paranucleic acids, as both would then be esters of a pentahydroxyl phosphoric acid.

Their genetic relations would lead one to suspect that a chemical relation exists between them, for the unincubated egg, which contains an abundance of paranucleic acid, but no true nucleic acid, contains much of the latter, after the embryo develops.

Levene and Alsberg,[73] who obtained from egg yolk vitellin preparations containing 10 per cent. of phosphorus, were unable, in any way, to further separate the protein which the substance still contained in abundance, although they used methods by which this was readily accomplished when applied to the protein compounds of true nucleic acids.

They conclude from their experiments, that it is probable that the phosphorus is in ester combination with the protein.

Osborne and Campbell (*l. c.*) found that by calculating the phosphorus of egg yolk vitellin as PO_4, the elementary composition of the remaining part was nearly the same as that of the similar part of the paranuclein derived from it, even when the phosphorus content of the latter was over five times greater than that of the original vitellin, as the following figures show:

			Calculated PO_4—free.	
	Vitellin.	Paranuclein.	Vitellin.	Paranuclein.
C	51.31	45.30	52.59	52.12
H	7.24	6.64	7.42	7.64
N	16.30	14.60	16.70	16.80
S	1.00	0.83	1.03	0.96
P	0.79	4.26	....	....
O	23.36	28.37	22.26	22.48
	100.00	100.00	100.00	100.00

[72] Osborne and Campbell, Report of the Connecticut Agri. Expt. Station for 1899, p. 346; also Jour. Am. Chem. Soc. 22, 413, 1900.

[73] Zeit. f. physiol. Chem. 31, 543, 1901.

If four $P(OH)_5$ groups were united in the paranucleic acid in the same way as they are represented to be in the tritico-nucleic acid, the ratio of phosphorus to oxygen would be as 1 to 4¼, which is so nearly equal to PO_4 that the result of the above calculation would not be materially changed if the analyses were calculated free from P_4O_{17} instead of from PO_4.

The fact that the paranucleic acid of the egg yolk, which serves as food for the growing embryo, gives place during development to the true nucleic acids, is strong evidence that the latter owe their origin to the presence of the former.

The experiments of Burian and Schur[74] show that, although only traces of the nuclein bases are to be found in milk, nevertheless, there is a great increase in the amount of these bases and also of nuclein phosphorus in the young animals which are fed exclusively therewith.

The fact that the embryo which develops in the egg is supplied with a large amount of paranucleic acid, among the substances which serve as its food, and that the growing mammal is also furnished with an abundant supply of the same, is a strong indication that this substance is essential for the rapidly growing organism and, as this is furnished in abundance at a time when the development of new cell nuclei is at a maximum, it seems most probable that the paranucleic acid is converted into the nucleic acid which forms a large part of the cell nuclei.

Whether paranucleic acids occur in plants is not yet demonstrated. Wiman,[75] according to the abstract by Hammarsten,[76] obtained a substance by extracting peas with dilute ammonia, which on digestion with pepsin, yielded variable amounts of an insoluble product, which contained phosphorus and which he regarded as a paranuclein. The product yielded "traces" of nuclein bases which were attributed to a contamination. He concludes that legumin is a nucleo-albumin and states that the legumin prepared according to the methods of Osborne and Campbell and of Ritthausen also yields this paranuclein. Whether the pea contains a nucleo-albumin, or not, cannot be determined from the rather indefinite statements contained in this abstract and we regret that we have been unable to refer to the original

[74] Zeit. f. physiol. Chem. 23, 55, 1897.

[75] Upsala Läkareförenings förhandlingar N. F. Bd. 2, 1897.

[76] Jahresberich für Thier-Chemie f., 1897.

paper. The statement that legumin prepared according to the method of Osborne and Campbell is a nucleo-albumin, is certainly incorrect, for in the purified preparations which we made from several different seeds we were not able to find any phosphorus whatever.

It is quite possible that nucleo-albumins may also exist in the pea, which, together with the legumin, are extracted from the seed by dilute ammonia. It is, however, certain that legumin, when properly prepared, is a true globulin and not a nucleo-albumin, as Wiman supposes.

It is indeed probable that true nucleic acid compounds exist in leguminous seeds, possibly together with paranucleic acid compounds, for these seeds, which contain no true endosperm, consist chiefly of an enlarged embryo in which the functions of the embyro and endosperm, of such seeds as wheat, are united.

That nucleo-albumins occur abundantly in seeds is certainly not true, and the repeated assertion that such is the case, founded on the uncertain experiments of Wiman, has led to grave errors and much confusion, respecting the true nature of their protein constituents.

XI. Conclusions.

1. The embryo of wheat contains a relatively considerable quantity of nucleic acid, for which the name tritico-nucleic acid is proposed. About 3.5 per cent. of the commercial embryo meal used in this investigation probably consisted of tritico-nucleic acid.

2. On keeping, the meal undergoes a change so that the unaltered nucleic acid is obtained from it in diminished quantity or not at all.

3. Tritico-nucleic acid has the properties of the true nucleic acids of animal origin, but is less soluble in water.

4. Its composition corresponds to the formula $C_{41}H_{61}N_{16}P_4O_{31}$. It forms acid salts with potassium, sodium or ammonium, which are readily soluble in water with a strongly acid reaction to litmus. In consequence of this, it is impossible to make preparations of the acid wholly free from base. The lack of agreement between the analyses of nucleic acids, heretofore published, is largely due to this fact.

5. On hydrolysis with acids, tritico-nucleic acid yields one molecule of guanin, one of adenin, two of uracyl and three of pentose, for every four atoms of phosphorus, and also an unidentified basic body.

6. Silver tritico-nucleotinate contains six atoms of silver for every four of phosphorus, from which the free acid is supposed to contain six hydroxyl groups.

7. The constitution of tritico-nucleic acid may be represented by the union of four $P(OH)_5$ groups in which the four atoms of phosphorus are united by three of oxygen, and all but six of the remaining fourteen hydroxyls are substituted by the groups named, thus forming a complicated ester of penta-hydroxyl phosphoric acid, an acid unknown in the free state, but which Stokes has shown forms stable esters.

8. By a brief hydrolysis with dilute acids, all the guanin and adenin are split off and, at the same time, about one-fourth of the phosphorus appears as orthophosphoric acid. By dilute alkalies, the purin bases are not easily split off, but orthophosphoric acid is rapidly and abundantly formed.

9. After a brief hydrolysis, in acid solution, a complicated phosphoric acid remains which contains no guanin or adenin and only two pentose groups for every three atoms of phosphorus. The composition of its barium salt indicates that it may be formed from the nucleic acid by splitting off one of the phosphorus atoms, to which are attached the guanin, adenin and one pentose.

10. Tritico-nucleic acid resembles the nucleic acids of animal origin, in that it contains the purin, pyrimidin and carbohydrate groups, together with phosphorus. The purin groups are the same in the animal and vegetable acids, but in the former the pyrimidin and carbohydrate groups are represented by thymin and hexose, in the latter by uracyl and pentose.

11. Tritico-nucleic acid closely resembles, and may be identical with, the nucleic acid of yeast, since both contain uracyl and a pentose and appear to have the same ultimate composition.

12. Tritico-nucleic acid resembles guanylic acid, in that both may be represented as complicated esters of a phosphoric acid formed by the union of four $P(OH)_5$ groups, but otherwise they present marked differences, which indicate different physiological relations.

13. The conception of tritico-nucleic acid as an ester of penta-hydroxyl phosphoric acid suggests a chemical relation that may possibly exist between paranucleic acid and the true nucleic acids, for the organic part of the paranuclein of egg yolk, as one of us has previously shown, has nearly the same composition as that of the organic part of the paranucleo-proteid from which it originated, as is seen when the analyses are calculated PO_4 free. (Four $P(OH)_5$ groups united by three oxygen atoms contain P:O::1:4¾).

14. The protein compounds of nucleic acid may be regarded as protein nucleates, those containing but little nucleic acid united with much protein forming the nucleo-proteids, those with much nucleic acid and little protein forming the nucleins. The proportion in which the protein and nucleic acid unite is determined by the relative proportion of bases and acids present in the solution at any given time.

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