CORRECTIONS.

Page 29. After No. 129, for E. F. Coe Fertilizer Co., read E. F. Coe Co.
Page 42. After No. 721, for Ammoniated Bone and Potash, read Animal Bone and Potash.
Page 44. After No. 638, for Reed substitute Read.
Page 258. Under Powdery Mildew of Apple, for *Sphoerotheca,* read *Sphaerotheca.*
Page 259. Under Apricot insert (*Prunus Armeniaca,* L.)
Page 260. Under Bean, 15th line, for *Phylophthora,* read *Phytophthora.*

State of Connecticut

PUBLIC DOCUMENT No. 24

TWENTY-FOURTH ANNUAL REPORT

OF

The Connecticut Agricultural Experiment Station

FOR THE YEAR ENDING OCTOBER 31

1900

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.

NEW HAVEN, CONN.:
THE TUTTLE, MOREHOUSE & TAYLOR COMPANY
1901

CONNECTICUT AGRICULTURAL EXPERIMENT STATION.

OFFICERS AND STAFF FOR 1900.

STATE BOARD OF CONTROL.

Ex officio.

HIS EXCELLENCY GEORGE E. LOUNSBURY, *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.	1901
JAMES H. WEBB, Hamden.	1902
Appointed by Board of Agriculture :	
T. S. GOLD, West Cornwall, *Vice-President.*	1901
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.*	

Executive Committee.

STATION STAFF.

Chemists.

E. H. JENKINS, PH.D., *Director.* — T. B. OSBORNE, PH.D.
S. W. JOHNSON. — A. W. OGDEN, PH.B.
A. L. WINTON, PH.B. — G. F. CAMPBELL, PH.B.
CLIFFORD LANGLEY, PH.B.

Botanist.
WILLIAM C. STURGIS, PH.D.

Horticulturist.
W. E. BRITTON, B.S.

Grass Gardener.
JAMES B. OLCOTT, South Manchester.

Stenographer and Clerk.
MISS V. E. COLE.

In charge of Buildings and Grounds.
CHARLES J. RICE.

Laboratory Helpers.
HUGO LANGE. — WILLIAM POKROB.

Sampling Agent.
V. L. CHURCHILL, New Haven.

CONTENTS

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, 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 for 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.

All other work proper to the Experiment Station that can be used for the public benefit will be done without charge. Work for the private use of individuals, when undertaken, is charged for at moderate rates. 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 immediate general interest are published in bulletins, copies of which are sent to each Post Office in the State, and to every citizen of the State who applies for them. The results of all the work of the Station are 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, and Terms for testing Fertilizers, Seeds, etc., for private parties sent on application.

☞ Parcels by Express, to receive attention, should be *prepaid.*

☞ Letters sent to individual officers are liable to remain unanswered in case the officer addressed is absent. All communications therefore should be directed simply to the

AGRICULTURAL EXPERIMENT STATION,
NEW HAVEN, CONN.,

and all remittances should be made payable to the undersigned.

☞ Station Grounds, Laboratories, and Office are on Huntington Street, five minutes walk west from Whitney Avenue and 1⅝ miles north of City Hall.

☞ Huntington Street may be reached by Whitney Avenue Electric Cars, which leave the corner of Chapel and Church Streets every twelve minutes day and evening, and between certain hours every six minutes.

☞ The Station has telephone connection.

☞ The Grass Garden, in charge of Mr. James B. Olcott, is near South Manchester, five minutes walk from the line of the Manchester Electric Cars, leaving City Hall Square, State Street, Hartford, every half hour. Conductors on this line can direct visitors to the Garden.

E. H. JENKINS, *Director.*

REPORT OF THE BOARD OF CONTROL

OF THE

CONNECTICUT AGRICULTURAL EXPERIMENT STATION.

To His Excellency, George E. Lounsbury, Governor of Connecticut:

The Board of Control of the Connecticut Agricultural Experiment Station herewith submits its Report for the year ending October 31st, 1900:

THE FERTILIZER CONTROL.

During April, May and June, Mr. V. L. Churchill, agent of the Station, visited eighty-nine towns and villages of the State and drew five hundred and twenty-eight samples, representing two hundred and thirty-nine of the brands of commercial fertilizers which have been entered for sale in Connecticut.

The total number entered for sale by manufacturers is two hundred and forty-nine, but some of them have not been brought into the State to sell, and of others only very small lots were brought in and were sold and used before our agent had opportunity to take samples of them.

With four exceptions, however, every brand of commercial fertilizers entered has been analyzed and a manuscript copy of the analysis sent to the manufacturer and to each dealer from whom a sample of the brand analyzed was drawn.

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

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

The detailed account of the fertilizer work has been arranged for publication, is now in type and will be published within a month.

Examination of Food Products.

During the year ending July 31st, 1900, agents of the Station have visited eighteen towns and villages of this State, and have purchased for examination eight hundred and twenty-four samples of food products.

During the same period the Dairy Commissioner and his deputy have submitted for examination four hundred and twenty samples.

Other samples sent in from various sources have made the whole number of analyses executed thirteen hundred and thirty-nine.

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

The results of the food investigation are nearly ready for printing.

Examination of Commercial Cattle Feeds.

The account of much of the work done on this subject since October 31st, 1899, was printed in our last Report in order to bring it before the public as speedily as possible.

Forty-eight analyses of feeds have since been made and our agent is actively engaged in drawing samples, the analyses of which will appear in the concluding pages of the Report of the Staff for 1900.

Other Chemical Work.

In connection with experiments on the availability of different forms of fertilizer nitrogen, the chemists named have made partial analyses of four hundred and nine samples of red-top grass and Hungarian grass.

A large amount of work has also been done in studying analytical methods, for the detection of adulterations in food products.

Study of Proteids.

During the past twelve months Dr. Osborne, with the assistance of Mr. Campbell, has made further studies of the composition and properties of nucleic acid prepared from the wheat embryo.

They have also determined the proportion of sulphur which can be removed by alkali from each of a large number of different proteids, in order to determine the number of sulphur atoms in the molecule of each and also obtain information regarding the molecular weights of these bodies.

They have further continued the study of the primary reactions of the vegetable proteids, so as to render available for publication a large amount of data previously obtained.

Horticultural Work.

Dr. Jenkins and Mr. Britton, with the coöperation of the Station chemists, have continued their study of the availability of organic nitrogen in various forms and particularly the effect of lime in making available the nitrogen in cotton seed meal and fine hard raw bone. Ninety-five cultures of Hungarian grass were made for this purpose in pots. Cultures of red-top grass, sixty-two in number, have also been continued.

In the forcing house, forty-eight cultures of tomatoes, twelve of carnations and eighteen of lettuce were made in plots on the benches, to determine the proper quantities of fertilizer ingredients to use in a soil of coal ashes and peat moss and with compost. Soil which had been partially sterilized by steam was used in comparison with other soils as a medium for growing lettuce.

Forty cultures of tomatoes were made out-of-doors during the summer. The plants in this series were grown from seed which had been very carefully selected according to weight, with a view of determining the influence of the absolute weight of the seed on the quantity and quality of the crop.

Entomological Work.

Mr. Britton has continued to do the necessary entomological work of the Station. More than fifty insects have been sent by farmers for identification. These have been in every case named and all available information given as to their habits and, where necessary, as to the best way of destroying them. Special attention has been given to the depredations of the "green pea louse" and the "clover hay-worm." Observations regarding the San José scale have also been continued, and

inspections have been made of ten different nurseries upon request of the owners.

The facilities of this department have been greatly increased by the addition of a microscope and accessories and by fitting up a new office and laboratory for Mr. Britton.

Chestnut Grafting.

Work in chestnut grafting has been continued by Mr. Britton. Over 1,000 chestnut cions were set between April 20 and June 12, to determine the best season for grafting the chestnut in Connecticut. A few of these were set in young seedlings at the Station, but over nine hundred cions were set in native three-year-old sprouts on wood land belonging to the Station, at Poquonock.

Seed Testing.

Within the twelve months covered by this Report, three hundred and two samples of seeds, chiefly of vegetable and garden crops, have been tested as to their germinating power, in the interest of seed growers and purchasers.

Botanical Work.

Dr. Sturgis has made two extensive experiments upon the susceptibility of peach foliage to injury from fungicides, and the value of the latter in checking the two fungous diseases commonly known as "Scab" (Cladosporium) and "Rot" (Monilia).

Incidentally, a series of observations was made upon the total thickness and the thickness of the component parts of leaves susceptible to injury from fungicides, and of leaves not susceptible.

A study has also been made on the cause of the rotting of tomatoes grown under glass.

The bacterial and fungous flora of the garden soil used in the green-houses, both before and after partial "sterilization" by steam heat, has been studied by Dr. Sturgis when opportunity offered.

Observations were made upon a wide-spread disease of peach-trees and raspberry-vines, related to the common "crown-gall," but far more destructive, and material was collected for future study.

Field Experiments.

Under the supervision of Dr. Jenkins the three experiments on the fertilization of peach orchards, chiefly to study the effects of different amounts of potash salts and of the forms of nitrogen best adapted to the crop, which were begun in 1896, have been continued, and in two of the orchards crops of peaches have been gathered this year.

Tobacco Experiments.

A new arrangement has been made with the Connecticut Tobacco Experiment Co. by which the Station secures the privilege to continue for six years the experiments it has begun at Poquonock, but may at any time give up the use of the land if desirable.

In coöperation with the Division of Soils, of the U. S. Department of Agriculture, a test has been made during 1900 of raising Sumatra tobacco in Connecticut, both in the open field and under an artificial shade. The final outcome will not be determined till the tobacco is fermented, which will require some weeks longer.

Station Publications.

The twenty-third Report of this Station for 1899, a volume of 402 pages, has been issued in an edition of ten thousand copies. Under the existing statute, the State pays for the printing of but 7,000 copies, while over 9,000 copies are necessary to supply applicants who are upon our mailing list. It has been necessary, therefore, for the Station to print 3,000 copies at its own expense to meet this demand.

Bulletin 130, printed in January last, forty pages, was entitled "Commercial Feeding Stuffs in the Connecticut Market" and was issued in an edition of ten thousand copies.

Bulletin 131, of about 28 pages, entitled "The Protection of Shade Trees in Cities and Towns," is now in the printer's hands.

In June last a one-page circular was issued on the Green Pea Louse, which was then just beginning its destructive work in this State, and a copy was sent to every newspaper and to the Secretary of every grange, farmers' club and Agricultural Society in the State, as well as to prominent market gardeners.

The substance of these publications will be reproduced in the Report of this Station for 1900, with appropriate emendations.

CORRESPONDENCE.

During the year ending October 31, 1900, more than 3,305 letters and manuscript reports of fertilizer and other analyses have been written on Station business.

CHANGES IN THE STATION STAFF.

At the annual meeting of this Board, held in January last, Prof. S. W. Johnson, who has been Director of this Station since its organization in 1877, resigned his position.

He remains connected with the Station staff as advising and consulting chemist.

At the same meeting Dr. E. H. Jenkins, who has also been connected with the Station since its organization, was appointed Director.

MEETINGS OF THE BOARD.

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

Within the year the Station has received a portion of a bequest under the will of Wm. R. Lockwood of Norwalk, which will be more particularly noticed in the Report of the Treasurer and Agent.

All of which is respectfully submitted.

WM. H. BREWER, *Secretary.*

REPORT OF THE TREASURER.

WM. H. BREWER, in account with the Connecticut Agricultural Experiment Station for the fiscal year ending September 30, 1900.

RECEIPTS.

State Appropriation, Agriculture	$10,000.00	
State Appropriation, Foods	2,500.00	
United States Appropriation	7,500.00	
Analysis Fees	8,255.10	
Sales of Tobacco	699.53	
Sales of other produce	40.41	
From the Lockwood Income	1,219.39	
Miscellaneous Receipts	144.09	
		$30,358.52

DISBURSEMENTS.

E. H. Jenkins, Salary	$2,712.09
W. H. Brewer, "	833.34
V. E. Cole, "	800.00
S. W. Johnson, "	1,638.85
W. C. Sturgis, "	2,000.00
T. B. Osborne, "	1,800.00
A. L. Winton, "	1,800.00
A. W. Ogden, "	1,700.00
G. F. Campbell, "	1,000.00
C. Langley, "	600.00
W. E. Britton, "	1,200.00
H. Lange, "	720.00
J. B. Olcott, "	800.00
C. J. Rice, "	600.00
V. L. Churchill, "	620.00
Labor	1,263.82
Publications	949.25
Postage	176.67
Stationery	203.28
Telephone and Telegraph	80.70
Freight and Express	116.98
Gas	316.82
Coal	777.60
Water	147.00
Chem. Laboratory Supplies	1,756.41
Agr. and Hort. Supplies	89.65
Miscellaneous Supplies	150.55

Fertilizers	$ 124.75	
Feeding Stuffs	122.75	
Library	634.35	
Tools and Implements	68.70	
Furniture and Fixtures	49.98	
Scientific Apparatus	127.37	
Traveling, by the Board	40.29	
Traveling, by the Staff	115.77	
Tobacco Experiments	1,566.06	
Fertilizer and Food Sampling	600.72	
Unclassified Sundries	717.91	
Betterments	603.66	
Repairs	615.98	
The Grounds and Establishment	117.22	
		$30,358.52

Memorandum—The accounts of the Treasurer have been duly audited by the State Auditors of the Public Accounts, and inspected by the Agent of the U. S. Department of Agriculture. The Report of the Treasurer for the fiscal year of the United States ending June 30th, 1900, was duly rendered to the Secretary of the Treasury of the United States, and a duplicate to the Secretary of Agriculture.

The above classification of disbursements is in accordance with the requirements of the State laws regarding the expenditures of State appropriations and with the requirements of the United States Secretary of Agriculture and of the U. S. Secretary of the Treasury. Except in the details specified below, they are also in accordance with the schedule prepared by the U. S. Secretary of Agriculture for use by all the experiment stations of the country. Owing, in part, to various special duties imposed by State law on its Experiment Station (such as Fertilizer and Food Analyses, Dairy and Butter matters, etc.), and in part to the fact that a considerable part of the receipts came from other sources than the State and National treasury, it is not deemed advisable (and indeed is not practicable) to follow the above named schedule in detail in its classes 8, 9, 16 and 17. Therefore, "Miscellaneous Supplies," "Fertilizers," and "Traveling by the Staff," do not include what has been expended in the Tobacco and Grass investigations and certain expenditures from the Lockwood Trust, nor in Food and Fertilizer sampling. The details of other subdivisions of Class 17 of the above schedule are not closely followed and include expenditures not provided for in that schedule.

In the year covered by this report, the Station has received a portion of a bequest by William R. Lockwood, Esq., deceased, late of Norwalk. He died June 10th, 1896, and left a will dated January 9, 1894, devising a portion of his estate to the Connecticut Agricultural Experiment Station, in trust. The Board of Control accepted the bequest and trust at its Autumn Meeting, October 13, 1896, which action was further confirmed, and Wm. H. Brewer was made special agent for purposes pertaining to the transaction of the necessary business, at a special meeting held January

5th, 1897. In February, 1900, a partial division of the estate was made, in which division the Connecticut Agricultural Experiment Station has received seventy-nine thousand seven hundred ninety dollars and thirty-one cents ($79,790.31) allotted by the probate court as capital, besides accrued income. Of the income, $1,219.39 have been used in this year's disbursements, and accredited in the above receipts.

Mr. Lockwood had been interested in this Station and its work from its very inception, and in directing the use of the income, he used essentially the language of the Act of Establishment of the Station in the 4th section of the will. "I give, devise and bequeath the other equal half part of said residue and remainder of my estate to the Connecticut Agricultural Experiment Station, a corporation or institution of that name, created and established by an Act of the General Assembly of the State of Connecticut, passed in the year 1877, and approved March 21, 1877, as trustee, in trust, to have, hold, manage and take care of the same, and to maintain the principal or capital thereof as a perpetual fund, for the following uses and purposes, to wit;" and giving authorization and power to the "said trustee, at its discretion" to sell, buy, invest, etc., for the preservation of the property bequeathed, to meet the expenses incident to its preservation and management, and "to use and apply all the balance or net income in the promotion of agriculture by scientific investigation and experiment, and by diffusing a knowledge of the practical results thereof among the people of the State of Connecticut in such manner as shall be deemed by the Board of Control or governing body of said institution for the time being, most practicable and generally useful."

The Act cited as establishing the Station begins its first section with the words, "That for the promotion of agriculture by scientific investigation and experiments, an institution is hereby established, to be known as the Connecticut Agricultural Experiment Station."

Mr. Lockwood was a frequent attendant at annual agricultural conventions held by the State Board of Agriculture and was familiar with all the facts relating to the original establishment of the Station, and with its later operations. He wisely left the use of the income in such shape that it might be applied to any line of scientific investigation for the promotion of agriculture, which the judgment of the board of control might deem most promising of practical results. He was reasonably familiar with the actual work of the Station and its results, and had often expressed his commendation.

This Station was the first of its kind in the country to be established by any State, as Mr. Lockwood well knew, and now he comes forward as the first person in America to bequeath any considerable sum as a permanent endowment for scientific agricultural research. He has the honor to be the leader in this special beneficence, of such far reaching importance to his native state and of wider benefit to all mankind. A brief biographical sketch will appear in the next annual report of this Station.

WM. H. BREWER,
Treasurer.

COMMERCIAL FERTILIZERS.

During 1900 fifty-one manufacturing firms have entered for sale in this State two hundred and forty-nine distinct brands of fertilizers, viz.:

Special manures for particular crops	103
Other nitrogenous superphosphates	92
Bone manures and "bone and potash"	33
Fish, tankage, castor pomace and chemicals	21
	249

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 and 4.

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 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 percentage 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 chemical composition may take account of the two ingredients, Nitrogen and Phosphoric Acid.

For Potash Salts give always the percentage of Potash (potassium oxide): 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 dealing in 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. 1901.

Firm.	*Brand of Fertilizer.*
Armour Fertilizer Works, The, Chicago, Ills.	Ammoniated Bone with Potash, Grain Grower, All Soluble, High Grade Potato.
Berkshire Fertilizer Co., Bridgeport, Conn.	Berkshire Complete Fertilizer, " Potato Phosphate, " Ammoniated Bone Phosphate, Pure Fine Bone.
Boardman, F. E., Little River, 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, " " Corn Manure, " " Grass Top Dressing and Forage Crop Manure, " " Potato and Vegetable Manure, Bowker's Potato and Vegetable Fertilizer, " Potato Phosphate, " Hill and Drill Phosphate, " Farm and Garden, or Ammoniated Bone Fertilizer, " Fish and Potash, Square Brand, " 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, Nitrate of Soda, Dissolved Bone Black, Muriate of Potash, Fresh Ground Bone, Bowker's Fisherman's Brand Fish and Potash, Tankage, Bowker's Dry Ground Fish, Canada Hardwood Ashes, Acid Phosphate, Castor Pomace.

Firm.	*Brand of Fertilizer.*
Bradley Fertilizer Co., 92 State St., Boston, Mass.	Eclipse Phosphate, High Grade Tobacco Manure, Farmers' New Method Fertilizer, Brightman's Fish and Potash, Fine Ground Bone, Complete Manure for Potatoes and Vegetables, Potato Manure, Superphosphate, Corn Phosphate, Potato Fertilizer, Niagara Phosphate, Complete Manure with 10% Potash, Tobacco Fertilizer, Triangle A Fish and Potash.
Brightman, Wm. E., General Agent, Tiverton, R. I.	Brightman's Ammoniated Bone and Potash, Brightman's Tobacco Special and Market Garden Fertilizer.
Buckingham, C., Southport, Conn.	XX Special Formula.
Clark's Cove Fertilizer Co., The, P. O. Box 1779, New York City.	Great Planet Manure, Potato Phosphate, Bay State Fertilizer, Complete Fertilizer, Potato Fertilizer, Bay State G. G., King Philip Guano, Defiance.
Cleveland Dryer Co., The, 92 State St., Boston, Mass.	Cleveland Potato Phosphate, " High Grade Complete Manure.
Coe, E. Frank Co., 133-137 Front St., New York City.	E. Frank Coe's High Grade Ammoniated Bone Superphosphate, " Gold Brand Excelsior Guano, " Ground Bone and Potash, " New England Tobacco Fertilizer.
Connecticut Valley Orchard Co., Berlin, Conn.	C. V. O. Co.'s Complete High Grade Fertilizer.
Cooper's Glue Factory, Peter, 17 Burling Slip, New York City.	Bone Dust.
Crocker Fertilizer and Chemical Co., Buffalo, N. Y.	Crocker's Ammoniated Corn Phosphate, " General Crop Phosphate, " Potato, Hop and Tobacco Phosphate, " New Rival Ammoniated Superphosphate.
Cumberland Bone-Phosphate Co., cor. State St. and Merchant's Row, Boston, Mass.	Cumberland Superphosphate, " Potato Fertilizer.

Firm.	*Brand of Fertilizer.*
Darling, L. B. Fertilizer Co., Pawtucket, R. I.	Potato and Root Crop Manure, Tobacco Grower, Dissolved Bone and Potash, Farm Favorite, Fine Bone.
Dennis, E. C., Stafford Springs, Conn.	Ground Bone.
Downs & Griffin, Derby, Conn.	Ground Bone.
East India Chemical Works, The, H. J. Baker & Bro., Agents, 100 William St., New York City.	Castor Pomace, Vegetable, Vine and Potato Manure, Complete Potato Manure, A. A. Ammoniated Superphosphate, Pure Ground Bone.
Ellsworth, F., Hartford, Conn.	Shoemaker's Swift Sure Superphosphate for General Use, " " Complete for Potatoes, " " Bone Meal.
Farmers' Union Fertilizer Co., Peabody, Mass.	Corn King, Market Garden Special, Complete Potato Fertilizer, Ammoniated Bone Fertilizer.
Frisbie, The L. T. Co., Hartford, Conn.	Pure Bone Meal.
Great Eastern Fertilizer Co., Rutland, Vt.	Great Eastern Northern Corn Special, " Vegetable, Vine and Tobacco, " General Fertilizer, " Grass and Oats Fertilizer.
Hess, S. M. & Bro., cor. 4th and Chestnut Sts., Phila., Pa.	Special Tobacco Phosphate, " Compound, Fish and Potash Manure, Potato and Truck Manure, Ground Bone.
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 Standard Pure Bone Superphosphate of Lime, " Potato Manure, " Success Fertilizer, Animal Bone and Potash, Special Potato Fertilizer, Crescent Bone Dust.
Lowell Fertilizer Co., 44 No. Market St., Boston, Mass.	Swift's Lowell Bone Fertilizer, " " Animal Brand, " " Potato Phosphate, " " Potato Manure, " " Ground Bone.

Firm.	*Brand of Fertilizer.*
Ludlam, Frederick, 108 Water St., New York City.	Cecrops, Cereal Brand.
Mapes F. & P. G. Co., The, 143 Liberty St., New York City.	Potato Manure, Tobacco Manure (wrapper brand), Economical Potato Manure, Average Soil Complete Manure, Grass and Grain Spring Top Dressing, Dissolved Bone, Tobacco Ash Constituents, Tobacco Starter, Improved, Fruit and Vine Manure, Vegetable Manure or Complete Manure for Light Soils, Corn Manure, Complete Manure ("A" Brand), Cereal Brand, Seeding Down Manure.
Miles, Geo. W., Agent, Milford, Conn.	Fish and Potash.
National Fertilizer Co., Bridgeport, Conn.	Chittenden's Complete Fertilizer, " Ammoniated Bone, " Fish and Potash, " Market Garden, " Potato Phosphate, " Universal Phosphate, " Fine Ground Bone.
Olds & Whipple, Hartford, Conn.	O. & W. Special Phosphate, " Castor Pomace, " Vegetable Potash and Phosphoric Acid.
Pacific Guano Co., State St., cor. Merchants Row, Boston, Mass.	High Grade General Fertilizer, Soluble Pacific Guano, Potato Special, Nobsque Guano, Grass and Grain Fertilizer.
Packers' Union Fertilizer Co., P. O. Box 1528, New York City.	Animal Corn Fertilizer, Potato Manure, Universal Fertilizer, Wheat, Oats and Clover, Gardeners' Complete Manure.
Parmenter & Polsey Fertilizer Co., Peabody, Mass.	"P. & P." Grain Grower, Plymouth Rock Brand, Special Potato Fertilizer, "P. & P." Potato Fertilizer, Star Brand Superphosphate, Pure Ground Bone.
Peck Bros., Northfield, Conn.	Pure Ground Bone.
Plumb & Winton Co., The, Bridgeport, Conn.	Ground Bone.
Pouleur, Auguste, Windsor, Conn.	Pure Carbonate of Potash Tobacco Starter.

Firm.	*Brand of Fertilizer.*
Quinnipiac Co., The, 92 State St., Boston, Mass.	Quinnipiac Phosphate, " Potato Manure, " Corn Manure, " Potato Phosphate, " Market Garden Manure, " Climax Phosphate, " Havana Tobacco Fertilizer.
Read Fertilizer Co., The, Box 3121, New York City.	Read's Standard, Bone, Fish and Potash, Vegetable and Vine, High Grade Farmer's Friend, Practical Potato Special.
Rogers & Hubbard Co., The, Middletown, Conn.	Hubbard's Pure Raw Knuckle Bone Flour, " Strictly Pure Fine Bone, " Fertilizer for Oats and Top Dressing, " All Soils and All Crops, " Potato Phosphate, " Soluble Potato Manure, " Fairchild's Formula Corn and General Crops, " Soluble Tobacco Manure, " Grass and Grain Fertilizer, " Corn Phosphate.
Rogers Mfg. Co., The, Rockfall, Conn.	Pure Ground Bone, High Grade Soluble Potato, Complete Potato, Complete Corn, Oats and Top Dressing, High Grade Tobacco Manure, Grass and Grain Manure, Fish and Potash, All Round Fertilizer.
Russia Cement Co., Gloucester, Mass.	Essex Dry Ground Fish, " XXX Fish and Potash, " Potato Fertilizer, " Corn Fertilizer, " Complete Manure for Potatoes, Roots and Vegetables, " Complete Manure for Corn, Grain and Grass, " Odorless Lawn Dressing, " Special Tobacco Fertilizer, " Tobacco Starter.
Sanderson, L., New Haven, Conn.	Sanderson's Mixed Formula A, " Old Reliable Superphosphate, " Potato Manure, " Special with 10% Potash, " Nitrate of Soda, " Muriate of Potash, " Dissolved Bone Black, " Blood, Bone and Meat, " Fine Ground Bone, " Sulphate of Potash, " Pulverized Bone and Meat, " Fish, Luce Bro's. Bone, Fish and Potash.

Firm.	*Brand of Fertilizer.*
Shay, C. M., Groton, Conn.	Mystic Gilt Edge Potato Manure, Pure Bone Dust.
Shoemaker & Co., M. L., *See Ellsworth, F.*	
Standard Fertilizer Co., Farlow Building, State St., Boston, Mass.	Standard Complete Manure, " Fertilizer, " Special for Potatoes.
Tucker, Henry F. Co., Farlow Building, State St., Boston, Mass.	Tucker's Special Potato Fertilizer, " Imperial Bone Superphosphate.
Wheeler, M. E. & Co., Rutland, Vt.	Corn Fertilizer, Potato Manure, Havana Tobacco Grower, Superior Truck Fertilizer, Bermuda Onion Grower, Grass and Oats Fertilizer, Electrical Dissolved Bone.
Wilcox Fertilizer Works, The, Mystic, Conn.	Potato, Onion and Tobacco Manure, Complete Bone Superphosphate, Potato Manure, High Grade Fish and Potash, Dry Ground Fish Guano.
Williams & Clark Fertilizer Co., 26 Broadway, New York City.	Americus High Grade Special, " Superphosphate, " Potato Phosphate, " Royal Bone, " Prolific, " Potato Manure, " Fish and Potash, " Corn Phosphate, " Special with 10% Potash, " Pure Bone Meal, " Carteret Ground Bone.

SAMPLING AND COLLECTION OF FERTILIZERS.

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

Litchfield County	3
Hartford County	24
Tolland County	6
Windham County	9
New London County	14
Middlesex County	10
New Haven County	12
Fairfield County	11
	89

In these places five hundred and twenty-eight samples were taken, representing two hundred and thirty-nine of the brands which have been entered for sale in this State. Samples of two other brands, sent in by individuals, and of four brands sent by their manufacturers, as required by the fertilizer law, were also analyzed.

Four brands, which the sampling agent was unable to find on sale and of which no samples were received from the manufacturers, are the following:

Bowker's Stockbridge Special Tobacco Manure.
" Grass Top Dressing and Forage Crop Manure.
Bradley's Brightman's Fish and Potash.
Wilcox's Complete Bone Superphosphate.

It has not been possible, therefore, for the Station to make analyses of these four fertilizers.

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, four hundred and sixty-six samples of commercial fertilizers and manurial waste-products have been analyzed. A classified list of them is given on page 20.

Analyses of a few of these samples were made for private parties and charged for accordingly. Several were analyzed at the request of other experiment stations in order to compare and test analytical methods. Results of the examination of all the samples, with these exceptions, 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 super-

*Prepared and revised by Prof. S. W. Johnson.

phosphates, 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,* which all 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 $50 per ton, has very little or no value to the purchaser, because the quantity of it which can commonly go upon 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 sulphate, 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 practised at this Station, consists in calculating the *retail Trade-value* or *cash-cost* (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 $50 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 1900.*

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 Jersey markets during 1899 were as follows:

*Adopted at a conference of representatives of the Connecticut, Massachusetts, New Jersey, and Rhode Island Stations held in March, 1900.

	Cents per pound.
Nitrogen in ammonia salts	17
in nitrates	13½
Organic nitrogen, in dry and fine-ground fish, meat and blood, and in mixed fertilizers	15½
in fine* bone and tankage	15½
in coarse* bone and tankage	10½
Phosphoric acid, water-soluble	4½
citrate-soluble†	4
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,
Nitrate of Soda,
Dried Blood,
Azotin,
Ammonite,
Muriate of Potash,
Sulphate of Potash,
Plain Superphosphates,
Dry Ground Fish,
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 1/6 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," because these grades have practically disappeared from bone manures.

†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,* 15½ 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 1900 the average selling price of Ammoniated Superphosphates and Guanos was $30.00 per ton, the average valuation was $19.75, and the difference $10.25, an advance of 51.9 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 $32.73, the average valuation $22.49, and the difference $10.24 or 45.5 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 footnote, page 16), and we separately

*This concession gives the dishonest manufacturer the opportunity to defraud the consumer very easily and very seriously, 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.

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 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 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 doubt 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.

Percentage Difference Between Cost and Valuation.

Among the 85 brands of fertilizers classed in this Report as "Nitrogenous Superphosphates," whose analyses are tabulated on pages 48-61, Nos. 490 and 700 stand at the extremes; the retail price of the former being $24 and that of the latter $30. The Station Valuation of the former is $22.37, and the Station Valuation of the latter is $12.58. It is easily reckoned that the cost of the first is a fifth less than that of the second and that the valuation of the first is nearly

double that of the second, but to make a close comparison of these with each other and with the 83 other brands requires a somewhat different calculation.

We obtain a just basis for comparing any number of fertilizers by taking the valuation in each one as 100 and reckoning by "rule of three" the proportionate cost. This calculation is illustrated as follows, with the two fertilizers above noted and four others whose analyses are given in the same table.

Station No.	Cost.	Valuation.				Difference of cost and valuation.		Percentage difference of cost and valuation.
490	($24)	$22.37	:	100	::	1.67	:	7.4
575	(25)	19.76	:	100	::	5.24	:	26.5
423	(39)	30.68	:	100	::	8.32	:	27.1
638	(36)	23.82	:	100	::	12.18	:	51.1
494	(25)	16.37	:	100	::	8.63	:	52.7
576	(27)	12.77	:	100	::	14.23	:	111.4
700	(30)	12.58	:	100	::	17.42	:	138.5

In all the above named fertilizers the cost is greater than the valuation. Accordingly, to find the cost (at average rates) of 100 cents' worth of fertilizer chemicals in these factory mixtures, the percentage difference must be added to 100.

Thus in **490** one dollar's worth of the fertilizer chemicals cost in the mixed fertilizer $1.07. In **494**, which costs by the ton a dollar more than **490**, one dollar's worth costs $1.52.

In **423** one dollar's worth costs $1.27, while in **700**, which costs per ton nine dollars less than **423**, one dollar's worth of fertilizer chemicals cost $2.38½.

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.

RAW MATERIALS.

1. *Containing Nitrogen as the chief valuable ingredient.*

	No. of samples.
Nitrate of Soda	7
Sulphate of Ammonia	1
Dried Blood	1
Cotton Seed Meal	52
Castor Pomace	6

2. *Containing Phosphoric Acid as the chief valuable ingredient.*

Dicalcium Phosphate	1
Dissolved Bone Black	2
Dissolved Rock Phosphate	4

3. *Containing Potash as the chief valuable ingredient.*

Carbonate of Potash	1
Nitrate of Potash	1
High Grade Sulphate of Potash	7
Double Sulphate of Potash and Magnesia	5
Muriate of Potash	11
Kainit	2

4. *Containimg Nitrogen and Phosphoric Acid.*

Bone Manures	38
Tankage	8
Dry Ground Fish	6

MIXED FERTILIZERS.

Bone and Potash	6
Bone and Wood Ashes	1
Nitrogenous Superphosphates	102
Special Manures	105
Home Mixtures	18

MISCELLANEOUS FERTILIZERS AND MANURES.

Cotton Hull Ashes	42
Unleached Wood Ashes	19
Lime	5
Lime Kiln Ashes	3
Land Plaster	1
Tobacco Stems	4
Muck	1
Crematory Ashes	1
Sheep Dung	1
Street Sweepings	2
Silk Mill Waste	1
Waste from Acetylene Manufacture	1
	466

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.

Nitrate of Soda not uncommonly contains sodium perchlorate. Experiments in Germany have shown that beets and potatoes are likely to be damaged if dressed with nitrate containing more than one and a half per cent. of sodium perchlorate, while the cereals may be damaged by a smaller percentage. The use as a fertilizer of nitrate containing more than one per cent. of perchlorate is declared by the Association of German Experiment Stations to be unsafe. None of the samples, whose analyses follow, contained more than a half of one per cent. of perchlorate of sodium, as appears below.

386. Sold by the Bowker Fertilizer Co., Boston. Sampled from stock of J. A. Lewis' Estate, Willimantic.

1815. Sold by the Berkshire Fertilizer Co., Bridgeport. Sampled from stock of J. G. Schwink, Meriden.

710. Stock of L. Sanderson, New Haven.

426. Sold by National Fertilizer Co., Bridgeport. Sampled by E. A. Austin, Suffield, from stock bought by him.

164. Sampled from stock bought by S. D. Woodruff & Sons, Orange.

*This chapter has been prepared for publication by the Director. The analyses of fertilizers have all been made by Messrs. Winton, Ogden, and Langley, chemists of the Station, with the assistance of Mr. Lange.

ANALYSES OF NITRATE OF SODA.

	386	1815	710	426	164
Nitrogen, found	15.80	15.68	15.76	15.56	15.51
Nitrogen, guaranteed	15.0	15.6	16.0	----	----
Equivalent Nitrate of Soda	95.9	95.2	95.7	94.4	94.1
Guaranteed Nitrate of Soda	91.9	95.0	97.1	----	----
Sodium perchlorate	0.38	0.48	0.45	0.52	0.35
Cost per ton	$45.00	45.00	45.00	47.00	----
Nitrogen costs cents per pound	14.2	14.3	14.3	15.1	----

The average cost of nitrogen in form of nitrate of soda has been 14.3 cents per pound.

SULPHATE OF AMMONIA.

This article, now made on a large scale as a by-product of gas-works and coke ovens, usually contains over twenty per cent. of nitrogen, the equivalent of 94–97 per cent. of ammonium sulphate.

1818. Sold by Olds & Whipple, Hartford.

ANALYSIS.

	1818
Nitrogen	20.30
Equivalent Sulphate of Ammonia	95.7
Guaranteed Nitrogen	19.9
Cost per ton	$75.00
Nitrogen costs cents per pound	18.5

At present prices Sulphate of Ammonia cannot be economically used as a fertilizer.

DRIED BLOOD.

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

382. Dried Blood sold by the Bowker Fertilizer Co., Boston. Sampled from stock of E. E. Burwell, New Haven. Cost $36.00 per ton. Guarantee 9.75 per cent. nitrogen. The sample contained 10.19 per cent. of nitrogen.

Nitrogen costs per pound, 17.7 cents.

Eighty-four per cent. of the nitrogen is soluble in acid pepsin solution, see page 95, which indicates that the sample is substantially free from forms of nitrogen which are regarded as inert to vegetation.

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, page 24, are given the percentages of nitrogen found in forty-four 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 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 cost of cotton seed meal has been much higher than in the previous year, about $25.20 per ton. The percentage of nitrogen has ranged from 6.46 to 7.79 and has averaged 7.26. The cost of nitrogen per pound has ranged from 13.0 to 17.5 cents, averaging 14.3 cents per pound, nearly a cent and a half per pound more than last year.

The large foreign demand for cotton seed meal has raised its price, so that at present the nitrogen in it costs nearly as much per pound as does that of other nitrogenous matters which are readily available to plants.

The following samples of cotton seed meal did not contain the percentage of nitrogen which was guaranteed:

No.	Sold by	Nitrogen. Found.	Guaranteed
131	Olds & Whipple, Hartford	7.22	7.5
130	Olds & Whipple, Hartford	6.92	7.0
436	C. H. Dexter & Sons, Windsor Locks	6.46	7.0

Nitrogen Solubility.

Experiments have shown that the nitrogen of cotton seed meal is quickly available to plants and is also in large proportion soluble in pepsin solution.

Analyses of Cotton Seed Meal.

Station No.	Dealer.	Sampled by	Per cent. of nitrogen.	Cost per ton.	Nitrogen costs cents per pound.
234	Olds & Whipple, Hartford	Eugene Brown, Poquonock	7.42	$23.50	13.0
103	Olds & Whipple, Hartford	Station Agent	7.33	23.50	13.0
73	Daniels Mill Co., Hartford	H. S. Hatheway, Windsor Locks	7.58	24.25	13.1
131	Olds & Whipple, Hartford	Clark Brothers, Poquonock	7.22	23.50	13.2
485	Arthur Sikes, Mapleton	E. N. Austin, Suffield	7.55	24.50	13.3
132	W. F. Fletcher, Southwick, Mass.	A. H. Griffin, Granby	7.38	24.25	13.4
399	Olds & Whipple, Hartford	Station Agent	7.11	23.50	13.4
105	Arthur Sikes, Mapleton	R. P. Mather, Suffield	7.61	25.00	13.5
54	Daniels Mill Co., Hartford	E. S. Seymour, Windsor Locks	7.00	23.50	13.6
228	Arthur Sikes, Mapleton	J. F. Brockett, Suffield	7.27	24.25	13.6
56	W. F. Fletcher, Southwick, Mass.	D. A. Merriam, Granby	7.30	24.25	13.6
268	A. Pouleur, Windsor	H. H. Ellsworth, Windsor	7.31	24.50	13.7
486	E. N. Austin, Suffield	E. N. Austin, Suffield	7.66	25.50	13.7
72	Daniels Mill Co., Hartford	F. B. Hatheway, Windsor Locks	7.52	25.00	13.7
229	Arthur Sikes, Mapleton	J. F. Brockett. Suffield	7.18	24.25	13.8
55	Daniels Mill Co., Hartford	E. S. Seymour, Windsor Locks	6.91	23.50	13.8
48	Arthur Sikes, Mapleton	Arthur Sikes, Mapleton	7.22	24.25	13.8
130	Olds & Whipple, Hartford	Clark Brothers, Poquonock	6.92	23.50	13.8
68	Olds & Whipple, Hartford	Olin Wheeler, Buckland	7.79	26.00	13.9
244		J. H. Simonds, Warehouse Point	7.47	25.50	14.1
143	Arthur Sikes, Mapleton	Geo. A. Douglass, Thompsonville	7.11	24.50	14.1
237	Arthur Sikes, Mapleton	Arthur Sikes, Mapleton	7.31	25.00	14.1

Analyses of Cotton Seed Meal—*Continued.*

Station No.	Dealer.	Sampled by	Per cent. of nitrogen.	Cost per ton.	Nitrogen costs cents per pound.
487	Geo. R. Robinson, Jr., 18 Broadway, N. Y. City	E. N. Austin, Suffield	7.45	$25.50	14.1
596	H. K. Brainard, Thompsonville	Station Agent	7.60	26.00	14.2
243	J. E. Soper & Co., Boston, Mass.	J. H. Simonds, Warehouse Point	7.39	25.50	14.3
266	R. A. Parker, Warehouse Point	E. F. Thompson, Warehouse Point	7.26	25.25	14.3
236	Arthur Sikes, Mapleton	E. B. Loomis, Suffield	7.28	25.25	14.3
529	Bowker Fertilizer Co., Hartford Branch	A. P. Hills, Silver Lane	7.57	26.00	14.3
102	Olds & Whipple, Hartford	Eugene Brown, Poquonock	7.47	26.00	14.5
435	Arthur H. Rice, Granby	H. Starr Holcombe, Granby	7.27	26.00	14.8
148	C. D. Cannon, Windsor Locks	Norton Hatheway, Windsor Locks	7.28	26.00	14.8
594	H. C. Aborn & Son, Ellington	Station Agent	7.21	26.00	15.0
75	A. Sikes, Suffield	J. C. Eddy, Simsbury	6.50	24.00	15.0
433	S. D. Viets, Springfield, Mass.	Frank H. Abbe, Enfield	7.18	26.00	15.0
530	A. D. Bridge, Hazardville	L. A. Gowdy, Somersville	7.53	27.00	15.0
449	I. B. Barnard, Tariffville	I. B. Barnard, Tariffville	7.48	27.00	15.1
445	Ira Barnard, Bloomfield, Agt. Bowker Fertil. Co.	R. W. Cowles, Tariffville	7.00	25.75	15.2
227	Humphreys, Godwin & Co., Memphis, Tenn.	Ackley, Hatch & Marsh, N. Milford	7.00	25.85	15.3
595	H. K. Brainard, Thompsonville	Station Agent	7.05	26.00	15.3
247		L. B. Yale, Meriden	6.66	25.00	15.5
135	I. B. Barnard, Tariffville	James A. Waugh, Tariffville	7.25	27.00	15.6
599	S. D. Viets & Co., Springfield, Mass.	L. F. Woodworth, Thompsonville	7.34	27.50	15.7
465		Ackley, Hatch & Marsh, N. Milford	7.16	27.50	16.1
436	C. H. Dexter & Sons, Windsor Locks	L. C. Seymour, Windsor Locks	6.46	27.00	17.5

Eighty-nine per cent. of the nitrogen of sample **486**, and ninety-one per cent. of the nitrogen of sample **599** were found to be soluble in pepsin solution by the method noticed on page 95.

Analyses requiring Special Notice.

No. **174**, sent by Ackley, Hatch & Marsh, New Milford, was stated to be from a car lot sold to them as "prime tagged meal," for $23.00 per ton. As it was not tagged and was dark in color, they refused to receive it and sent sample for analysis. The sample contained only 3.85 per cent. of nitrogen and was not clear decorticated meal.

No. **172** was sent to the Station with the statement that it represented meal made by the Tennessee Fiber Co. at Memphis, Tenn. This sample contained 3.82 per cent. of nitrogen. Such goods as these are uneconomical to buy at any price at which they have been offered in this State. "Cheap" cotton seed meal is costly.

No. **10** was sent by Arthur Sikes, Mapleton, as "off color," dark meal, offered at a reduced price. It contained 6.68 per cent. of nitrogen.

In December, 1899, two samples, Nos. **371** and **372**, of cotton seed meal, received, duly authenticated, from E. S. Seymour, Windsor Locks, were found to contain 7.0 and 6.91 per cent. respectively of nitrogen. As 7.0 per cent. of nitrogen had been guaranteed, the purchaser claimed a rebate from the Hartford dealer, and he in turn from the Memphis firm, which had shipped the stock. Some three months later we received a sample of cotton seed meal mailed, unsealed, in a paper bag, from a Memphis firm with request for analysis. We found 7.20 per cent. of nitrogen. On sending the result with bill for the work, the firm which had ordered the analysis, declined to pay the bill, explaining that this sample was from the stock represented by the previous samples, had been sent first to Hartford, then to Memphis and then back to us for analysis, and as its analysis differed from the others our work "must certainly be incorrect!"

Reply was made to the firm that all "the analyses above referred to are absolutely correct and your statement made to us and to others that they 'must certainly be incorrect' is absurd and has not a particle of proof to support it."

The differences between the analyses are "due either to errors in sampling—which are more common than errors in analysis —or to carelessness in packing and shipping."

It is safe to say that a sample of cotton seed meal could not be sent by mail in a paper bag from Memphis here at any season of the year and have the same percentage of moisture and nitrogen on its arrival that it had when shipped.

All samples should be sent to the Station, sealed in tin or glass, securely packed.

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.

385. From stock of Olds & Whipple, Hartford.

395. From John A. DuBon, Poquonock.

384. Made by East India Chemical Co., New York.

708. Made by East India Chemical Co., N. Y. Sampled and sent by Olin Wheeler, Buckland.

All of the above samples were from goods solds by Olds & Whipple, Hartford.

593. Sold by Bowker Fertilizer Co., Branch, Hartford.

437. Sampled and sent by W. J. Stevens, Hockanum. It represents thirteen tons said to have heated in the bags during shipment.

ANALYSES OF CASTOR POMACE.

	385	395	384	708	593	437
Nitrogen	6.13	6.05	4.78	4.61	5.08	5.21
Phosphoric Acid	1.94	1.87	1.85	1.59	---	2.47
Potash	1.11	0.92	1.16	1.18	---	0.86
Cost per ton	$21.00	21.00	21.00	21.00	21.00	---
Nitrogen costs cents per pound*	15.0	15.4	19.2	20.1	18.1	---

The pomace sold by Olds & Whipple was of two distinct grades; one containing over six per cent. of nitrogen, the other

*Reckoning phosphoric acid and potash at 4 and 5 cents per pound, respectively.

about four and three-quarters per cent. The prices being alike, the lower grade was much less economical to purchase. The nitrogen solubility of these samples ranged from 91.5 to 74.0, and averaged 84.6 per cent. The indications furnished by this test are fully explained on page 95.

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

DICALCIUM PHOSPHATE.

This material has been occasionally in the market as a fertilizer at prices which made it economical to purchase.

No. **633** was a chemically pure preparation, made for vegetation experiments and contained 40.67 per cent. of phosphoric acid.

DISSOLVED BONE BLACK.

Bone black, made by subjecting bone to a red heat without access of air, is 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 two samples have been analyzed.

380. Sold by L. Sanderson, New Haven.

383. Sold by E. E. Burwell, New Haven.

ANALYSES OF DISSOLVED BONE BLACK.

	380	383
Soluble phosphoric acid	15.86	13.54
Reverted phosphoric acid	1.28	2.13
Insoluble phosphoric acid	0.74	0.71
Total phosphoric acid	17.88	16.38
Cost per ton	$22.00	21.00
"Available" phosphoric acid costs cents per pound	6.4	6.6

The "available" phosphoric acid found in each sample was above the guaranteed amount.

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.

Four samples have been analyzed as follows:

381. Acid Phosphate from Bowker Fertilizer Co., Boston. Sampled from stock of E. E. Burwell, New Haven.

167. Acid Phosphate, bought by S. D. Woodruff & Sons, Orange, for home-mixing.

129. Acidified Tennessee Rock. Sold by E. F. Coe Fertilizer Co. Sampled and sent by E. R. Kelsey, Branford.

600. Electrical Dissolved Bone. Made by M. E. Wheeler & Co., Rutland, Vt. Sampled from stock of August Grulich, Meriden.

ANALYSES OF DISSOLVED ROCK PHOSPHATE.

	381	167	129	600
Soluble phosphoric acid	10.88	9.49	12.90	9.52
Reverted phosphoric acid	4.59	4.00	2.27	5.28
Insoluble phosphoric acid	1.25	2.53	5.28	1.50
Total phosphoric acid	16.72	16.02	20.45	16.30
"Available" phosphoric acid found	15.47	13.49	15.17	14.80
"Available" phosphoric acid guaranteed	14.0	14.0	----	14.00
Cost per ton	$15.00	----	----	20.00
"Available" phosphoric acid costs cents per pound	4.7	----	----	6.6

Wheeler's so-called "Electrical Dissolved Bone" is simply an acidulated mineral phosphate.

III. RAW MATERIALS OF HIGH GRADE CONTAINING POTASH.

536. Hydrated Carbonate of Potash, made by the German Kali Works. Sampled and sent by August Pouleur, Windsor, Conn. This is a dry, white, crystalline powder, which does not draw moisture and liquefy as quickly as the anhydrous carbonate of potash. It is used by Mr. Pouleur in a mixture for a tobacco fertilizer.

The goods are guaranteed to contain 83½ per cent. of pure anhydrous carbonate, which is equivalent to 56.18 per cent. of actual potash. The sample contained 57.37 per cent. of actual potash, which is equivalent to 84.1 per cent. of anhydrous carbonate.

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.

392. Sold by Bowker Fertilizer Co., Boston. Sampled from Bowker's Branch, Hartford.

430. Sampled and sent by E. N. Austin, Suffield, from his own stock.

597. Sold by Bowker Fertilizer Co.'s Branch Store, Hartford. Sampled and sent by William Roberts, Silver Lane.

1816. Sold by Bowker Fertilizer Co., Boston. Sample drawn from stock of J. A. Lewis' Estate, Willimantic.

1819. Sample drawn from stock of Olds & Whipple, Hartford.

ANALYSES OF HIGH GRADE SULPHATE OF POTASH.

	392	430	597	1816	1819
Potash	48.33	48.70	48.62	47.24	48.10
Equivalent sulphate of potash	88.4	90.1	89.9	87.4	89.0
Guaranteed sulphate of potash	90.0	---	---	90.0	90.0
Chlorine	7.71	2.88	8.96	6.80	3.53
Cost per ton	$48.00	49.00	48.00	50.00	53.00
Potash costs cents per pound	5.0	5.0	4.9	5.3	5.5

The percentages of chlorine found in these samples are very much larger than has been observed in any former year.

Sulphate of potash containing over fourteen per cent. of muriate of potash cannot fairly be called "High Grade."

None of the samples contains as high a percentage of potash as is guaranteed.

Sample **539** was sent by A. P. Hills, Silver Lane, who stated that it was bought of Bowker Fertilizer Co., Hartford, for high grade sulphate of potash.

He wrote, "this sample represents 6 bags (1200 pounds) which were not in original packages. No seal on it. I want to know if it is straight?"

The sample contained 31.19 per cent. of actual potash together with considerable phosphoric acid and nitrate. It was evidently not a high grade sulphate, but a mixture of various fertilizer chemicals.

Mr. Hills settled for the goods as for double sulphate of potash.

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.

390. Sold by L. Sanderson, New Haven.

391. Sold by E. E. Burwell, New Haven.

427. Sampled and sent by E. N. Austin, Suffield, from his own stock.

1817. Sold by Berkshire Fertilizer Co., Bridgeport. Sampled from stock of J. G. Schwink, Meriden.

1820. Sold by Olds & Whipple, Hartford.

ANALYSES OF DOUBLE SULPHATE OF POTASH AND MAGNESIA.

	390	391	427	1817	1820
Potash	27.24	28.32	25.80	26.51	27.17
Equivalent sulphate of potash	50.4	52.4	47.7	49.0	50.3
Guaranteed sulphate of Potash	50.0	48.1	---	48.0	48.0
Chlorine	1.84	36.96	1.64	2.07	1.92
Cost per ton	$30.00	29.00	29.00	27.00	30.00
Potash costs cents per pound	5.5	5.1	5.6	5.1	5.5

The percentages of chlorine in four of the samples are normal.

391 is not a pure double sulphate of potash and magnesia, for while it contains the same percentage of potash as the salt named, it contains a large amount of chlorine.

It would be scarcely better for use as a fertilizer on sugar beets, potatoes, or tobacco than the muriate which costs considerably less per pound of potash.

In view of the experience of this year, growers of tobacco and potatoes, at least, should require a guarantee of not over two per cent. of chlorine in sulphate of potash and should have these salts tested for chlorine before using them.

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.

The following table includes nine analyses of muriate. The percentages of potash found range from 54.18 to 43.97—too wide a fluctuation. The cost of potash per pound in these samples has ranged from 4.0—4.8 cents, and the average is 4.3 cents.

389. Sold by Bowker Fertilizer Co., Boston. Sampled from stock of J. A. Lewis' Estate, Willimantic.

428. Sampled and sent by E. N. Austin, Suffield, from stock of National Fertilizer Co., Bridgeport.

438. Sampled by A. C. Lake, Bethlehem, from a single sack bought of the Berkshire Fertilizer Co., Bridgeport.

447. Sampled by N. D. Platt, Milford, from stock bought of L. Sanderson, New Haven.

464. Sampled and sent by E. C. Warner, New Haven.

538. Sampled by Station Agent from single sack. Stock of Berkshire Fertilizer Co., Bridgeport.

540. Sampled by Station Agent from eight sacks, stock of Berkshire Fertilizer Co., Bridgeport.

388. Sold by L. Sanderson, New Haven.

166. Sampled by S. D. Woodruff & Sons from stock bought by them.

ANALYSES OF MURIATE OF POTASH.

	389	428	438	447	464	538	540	388	166
Potash soluble in water	54.16	50.76	43.97	52.01	48.80	49.86	51.98	46.72	54.18
Equivalent muriate of potash	85.6	80.2	69.5	82.2	77.1	78.8	82.12	73.82	85.60
Guaranteed muriate of potash	80.0	---	80.0	80.0	80.0	80.0	80.0	79.0	79.0
Cost per ton	$45.00	46.00	41.00	43.00	39.00	41.00	41.00	45.00	---
Potash costs, cents per pound	4.2	4.5	4.7	4.1	4.0	4.1	4.0	4.8	---

The percentage of potash in **388** is quite too low for muriate of good quality. Still lower is the potash content of **438.** This sample was sent by Mr. A. C. Lake, of Bethlehem, with the statement that it represented the contents of one sack bought of the Berkshire Fertilizer Co., of Bridgeport, which when received, was sealed with the usual lead seal. The dark color of the goods made him suspicious of them. As soon as it was found that the sample contained only 43.97 per cent. of potash, the sampling agent visited the Berkshire Fertilizer Co.'s warehouse and drew a sample from 8 bags of muriate (No. **540** in the table, page 32) which contained 51.98 per cent. of potash. No. **538** represents a sample taken from a single bag containing muriate of darker color, with 49.86 per cent. of potash.

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.

387. Sold by Bowker Fertilizer Co., Boston. Sampled from stock of J. A. Lewis' Estate, Willimantic.

588. Sold by Standard Fertilizer Co., Boston. Stock of H. F. Childs, Woodstock.

ANALYSES OF KAINIT.

	387	588
Potash	12.89	12.66
Potash guaranteed	12.0	12.0
Cost per ton	$18.00	17.00
Potash costs cents per pound	7.0	6.7

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.

ANALYSES OF BONE

Station No.	Name of Brand.	Manufacturer.
537	Self Recommending Fertilizer	Valentine Bohl, Waterbury
507	Pure Bone Dust	Peter Cooper's Glue Factory, New York
509	Ground Bone	Plumb & Winton Co., Bridgeport
1802	Frisbie's Pure Bone Meal	The L. T. Frisbie Co., Hartford
409	Pure Ground Bone	The Rogers Mfg. Co., Rockfall
402	Ground Bone	L. Sanderson, New Haven
510	Hubbard's Strictly Pure Fine Bone	The Rogers & Hubbard Co., Middletown
407	Bone Meal	M. L. Shoemaker & Co., Philadelphia
401	Pure Bone Dust	C. M. Shay, Groton
511	Hubbard's Pure Raw Knuckle Bone Flour	The Rogers & Hubbard Co., Middletown
527	Ground Bone	Lowell Fertilizer Co., Boston
644	Fine Ground Bone	L. B. Darling Fertil. Co., Pawtucket, R. I.
379	Pure Ground Bone	Lederer & Co., New Haven
505	Ground Bone	Berkshire Fertilizer Co., Bridgeport
504	Bowker's Fresh Ground Bone	Bowker Fertilizer Co., Boston
508	Ground Bone	Downs & Griffin, Derby
711	Ground Bone	National Fertilizer Co., Bridgeport
506	Fine Ground Bone	Bradley Fertilizer Co., Boston
526	Pure Ground Bone	Parmenter & Polsey, Peabody, Mass.
512	Ground Bone	E. C. Dennis, Stafford Springs
713	Pure Ground Bone	East India Chemical Works, H. J. Baker & Bro., Agents, New York
513	Ground Bone	Peck Bros., Northfield
621	Pure Bone Meal	Williams & Clark Fertilizer Co., N. Y.
615	Ground Bone	S. M. Hess & Bro., Phila.
614	Increase Crescent Bone Dust	Lister's Agri. Chem. Works, Newark, N. J.

1. *Bone Manures Sampled by Station Agents.*

In the table below are given twenty-five 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 $27.08 per ton; the average valuation $25.51; showing that the Station valuation is only slightly lower than is justified by the average selling price of ground bone in Connecticut.

MANURES.

Dealer.	Dealers' 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.
D. B. Wilson, Waterbury	**$24.00**	$28.63	16.2*	3.62	*3.7*	24.31	*24.1*	76	24
Apothecaries' Hall, Waterbury	30.00	----	----	----	----	----	----	--	--
Geo. Beaumont, Wallingford	**22.00**	24.41	9.9*	1.88	*0.9*	27.06	*26.7*	58	42
Manufacturer	**28.00**	28.05	0.2*	4.06	*5.4*	23.12	*18.0*	65	35
Manufacturer	**26.00**	25.37	2.5	3.90	*3.5*	20.85	*23.4*	58	42
J. A. Lewis, Estate, Willimantic	**30.00**	29.17	2.8	3.80	*4.0*	26.01	*21.0*	62	38
Manufacturer	30.00	----	----	----	----	----	----	--	--
Manufacturer	**28.00**	26.75	4.7	2.30	*2.5*	26.32	*20.0*	81	19
N. W. Dayton, New London	30.00	----	----	----	----	----	----	--	--
N. W. Dayton, New London	30.00	26.79	8.3	4.00	*3.5*	22.80	*22.0*	55	45
H. W. Andrews, Wallingford	**28.00**	----	----	----	----	----	----	--	--
	29.00	----	----	----	----	----	----	--	--
Olds & Whipple, Hartford	**36.00**	33.05	8.9	5.29	*4.1*	24.10	----	74	26
G. M. Williams Co., New London	**30.00**	27.26	10.1	2.53	*2.6*	27.16	*25.0*	71	29
Manufacturer	30.00	----	----	----	----	----	----	--	--
Geo. A. Tucker, West Cheshire	**32.50**	29.38	10.6	3.87	*3.5*	24.46	*24.5*	75	25
S. E. Frisbie, Milford	32.00	----	----	----	----	----	----	--	--
H. A. Bugbee, Willimantic	**30.00**	27.09	10.7	2.08	*2.5*	28.21	*23.0*	75	25
W. W. Cooper, Suffield	**31.00**	27.97	10.8	2.78	*2.5*	26.94	*23.0*	73	27
Manufacturer	**30.00**	25.85	16.1	2.08	*2.2*	25.78	*26.6*	83	17
Z. J. Hinman, Collinsville	**30.00**	25.41	18.1	3.82	*2.5*	20.20	*20.0*	67	33
Bowker's Branch, Hartford	**30.00**	25.01	20.0	2.48	*2.3*	25.22	*24.0*	62	38
Manufacturer	**30.00**	24.70	21.5	4.16	*3.3*	25.24	*23.8*	9	91
Gault Bros., Westport	**32.00**	25.96	23.3	4.30	*3.0*	20.17	*20.0*	58	42
C. L. Comstock, Danbury	32.00	24.79	25.1	3.17	*2.5*	21.81	*21.0*	67	33
E. E. Scofield, Stamford	30.00	----	----	----	----	----	----	--	--
	31.00	----	----	----	----	----	----	--	--
H. F. Childs, Woodstock	**29.00**	22.44	29.2	1.95	*2.0*	23.12	*16.0*	68	32
Manufacturer	**28.00**	21.56	29.9	3.87	*4.2*	20.15	*20.5*	17	83
Saxton & Strong, Bristol	**35.00**	26.42	32.5	3.62	*2.5*	23.13	*22.0*	60	40
W. H. Scott, Pequabuck	**29.00**	21.80	33.0	3.96	----	20.72	----	13	87
F. B. Austin, Silver Mine	**32.00**	23.11	38.5	3.00	*2.5*	20.95	*20.0*	59	41
D. W. Barnes, Windsor	**32.00**	22.11	44.7	3.40	*2.8*	20.02	*22.0*	40	60
Southington Lumber Co., Southingt'n	**22.50**	14.72	52.9	2.84	*2.3*	10.49	*11.0*	50	50
A. I. Martin, Wallingford	25.00	----	----	----	----	----	----	--	--

* Valuation exceeds cost.

BONE MANURES. SAMPLED BY

Station No.	Name of Brand.	Manufacturer.
	Sampled by Manufacturers.	
79	Bone Dust	Valentine Bohl, Waterbury
646	Carteret Ground Bone	Williams & Clark Fertz. Co., N. Y.
	Sampled by Purchasers.	
104	Bone	The Challenge Knife Corp., Bridgeport.
12	Pure Bone Meal "Fine"	L. T. Frisbie & Co., Hartford
463	Ground Bone	
13	Pure Bone Meal "Coarse"	L. T. Frisbie & Co., Hartford
249	Bone	L. Sanderson, New Haven
448	Fresh Ground Bone	
107	Bone	Geo. Taylor & Co., N. Y.

Boiled and steamed bone, quite finely ground, are put on our Connecticut market by large manufacturing establishments at prices much lower than are quoted by our small local manufacturers for ground raw bone.

In six of the twenty-five brands represented in the table, the percentage of nitrogen found is less than the percentage guaranteed by the manufacturer. In four, the same is true of the percentage of phosphoric acid.

The brands which are thus deficient, are the following:

509. Made by Plumb & Winton, nitrogen found 4.06, guaranteed 5.4.
409. Made by Rogers Mfg. Co., nitrogen found 3.80, guaranteed 4.0.
402. Made by L. Sanderson, nitrogen found 2.30, guaranteed 2.5.
527. Made by Lowell Fertilizer Co., nitrogen found 2.08, guaranteed 2.5.
379. Made by Lederer & Co., nitrogen found 2.08, guaranteed 2.2.
512. Made by E. C. Dennis, nitrogen found 3.87, guaranteed 4.2.

1802. Made by Frisbie & Co., phosphoric acid found 20.85, guaranteed 23.4.
379. Made by Lederer & Co., phosphoric acid found 25.78, guaranteed 26.6.
512. Made by E. C. Dennis, phosphoric acid found 20.15, guaranteed 20.5.
615. Made by S. M. Hess & Bro., phosphoric acid found 20.02, guaranteed 22.0.

The last brand in the table, **614**, Lister's Crescent Bone Dust, is a waste product containing only about half as much phosphoric acid, 10.49 per cent., as pure ground bone of average quality.

MANUFACTURERS AND BY PURCHASERS.

Sampled by	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.
Manufacturer	$25.00	$29.60	15.5*	3.71	*3.7*	24.57	*24.5*	82	18
Manufacturer	----	20.35	----	1.83	*1.7*	20.42	----	72	28
W. I. Lobdell, Stratford	20.00	28.14	28.9*	3.89	----	24.50	----	60	40
C. J. Dewey, Buckland	25.00	29.63	15.6*	3.87	----	24.44	----	78	22
E. C. Warner, Station A, New Haven	23.70	27.59	14.1*	2.72	*2.0*	25.60	*22.0*	83	17
C. J. Dewey, Buckland	25.00	27.83	10.2*	4.52	*2.4*	21.46	*26.8*	62	38
O. G. Beard, Shelton	25.00	27.27	8.3*	5.10	*2.5*	18.38	*20.0*	63	37
N. D. Platt, Milford	24.50	21.85	12.1	3.16	----	18.59	----	59	41
A. E. Plant, Branford	----	28.09	----	2.52	----	27.02	----	83	17

* Valuation exceeds cost.

Solubility of the Bone-Nitrogen.

The solubility in acid pepsin solution of the nitrogenous matter in each of the samples of bone included in the table pages 34 and 35, has been determined by the method described on page 95.

The percentages of the total nitrogen soluble in the reagent ranged from 99.4 to 69.9 and the average solubility was 87.0 per cent.

These results indicate the absence of any considerable amount of inferior forms of nitrogen in any of the samples tested.

2. *Bone Manures Sampled by Manufacturers and by Purchasers.*

In the table above are given analyses of seven samples of bone which were sent by purchasers, and of two samples deposited by manufacturers, representing brands which were not found in market by our sampling agent.

The Station is responsible for the correct subdivision and analysis of the small samples placed in its possession, but not for the accuracy with which those samples represent the several articles specified,—though it requires that a certificate be filed by the person drawing the sample, stating that it has been fairly drawn according to the printed directions furnished by the Station.

Composition of Residue of Bone buried for Three Years.

106 is a sample of bone sent by A. E. Plant of Branford, who stated that, when planting peach trees three years ago, a double handful of bone was put in each hole in which a tree was set. He had recently dug up one of these trees and found the bone still there and to appearance hardly changed.

The sample contained 0.38 per cent. of nitrogen and 20.72 per cent. of phosphoric acid.

As neither the weight of the bone which was placed in the hole nor that of the bone which was taken up after three years is known, it is not possible to say how much of each fertilizer ingredient is gone, but it is clear from the figures that relatively little phosphate and relatively much of the nitrogen have been removed.

Dissolved Bone Meal.

Because it is not so easy as formerly to buy acid phosphate cheaply, other forms of "available phosphoric acid" are being used, as far as possible, in its place.

German experiments indicate that the phosphoric acid of raw bone is made much more quickly available to crops when, by treating the bone with a relatively small quantity of oil of vitriol, the larger part of the phosphate is converted into the dibasic state, which is insoluble in water, but readily soluble in ammonium citrate solution—"reverted" phosphoric acid.

At the suggestion of the Station, Mr. E. R. Kelsey of Branford made the following test, with a lot of bone containing 27 per cent. of phosphoric acid.

"I followed the formula you gave me. I emptied 200 lbs. of bone in a box, 8 feet long, 3½ feet wide and 10 inches deep, put 6 gallons of water on the bone and stirred it with a hoe so as to make the bone uniformly damp, then I put 86 lbs. of 50 degree Sulphuric Acid on it and had two men with hoes stir the mixture as fast as possible so as to make the contact as uniform as we could get it, then we would commence at one end of the box, hoe the mixture over, then go to the other end and hoe it back again and repeat this process three or four times, then shoveled in a wheelbarrow and emptied it in a pile and in two or three days I would shovel over the pile and it would be just as dry and fine as flour."

A sample of the resulting mixture contained:

	443
Nitrogen	1.62
Soluble phosphoric acid	6.21
Reverted phosphoric acid	11.45
Insoluble phosphoric acid	0.67
Total phosphoric acid	18.33

The figures show the success of the process in that very little insoluble tribasic phosphoric acid is left—0.67 per cent.—while the larger part is in forms soluble in ammonium citrate solution, "reverted phosphoric acid."

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 table, pages 40 and 41, are given five analyses of this material, four drawn by a Station agent and one by a purchaser. These analyses show the usual differences in chemical composition.

The percentage amounts of total nitrogen which are soluble in acid pepsin solution range from 82.8 to 73.1 and average 76.3. There is, therefore, no evidence of admixture of inferior forms of nitrogen with any of these samples.

A single sample, **403**, Sanderson's Pulverized Bone and Meat contains less nitrogen than is guaranteed; the percentages being 4.39 found and 4.9 guaranteed.

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.

405. Essex Dry Ground Fish made by Russia Cement Co., Gloucester, Mass. Sampled from stock of the J. A. Lewis Estate, Willimantic, and from stock of W. J. Cox, East Hartford.

ANALYSIS AND VALUATIONS OF

Station No.	Name of Brand.	Manufacturer.
374	Tankage	Bowker Fertilizer Co., Boston
408	Tankage	Bowker Fertilizer Co., Boston
404	Blood, Bone and Meat	L. Sanderson, New Haven
403	Pulverized Bone and Meat	L. Sanderson, New Haven
168	Tankage	

431. Made by the Wilcox Fertilizer Works, Mystic. Sampled by Ernest N. Austin, Suffield, from his own stock.

398. Essex Dry Ground Fish. Made by Russia Cement Co., Gloucester, Mass. Sampled from stock of J. A. DuBon, Poquonock.

488. Sold by L. Sanderson, New Haven. Sampled by E. N. Austin, Suffield.

400. Made by the Wilcox Fertilizer Works, Mystic. Sampled from stock of Olds & Whipple, Hartford.

592. Sold by Bowker Fertilizer Co., Boston, Mass. Sampled from stock of W. F. Andross, East Hartford, and from Bowkers Branch, Hartford.

ANALYSES OF DRY GROUND FISH.

	405	431	398	488	400	592
Nitrogen as ammonia	0.08	0.18	0.15	1.34	0.14	0.40
Organic nitrogen	8.34	8.76	8.29	6.98	8.82	7.13
Total nitrogen found	8.42	8.94	8.44	8.32	8.96	7.53
Total nitrogen guaranteed	8.0	---	8.0	---	8.5	8.0
Soluble phosphoric acid	0.77	0.34	0.93	0.00	0.54	0.53
Reverted phosphoric acid	8.01	5.23	7.98	5.37	4.75	3.86
Insoluble phosphoric acid	4.40	2.08	4.24	0.92	2.22	2.62
Total phosphoric acid found	13.18	7.65	13.15	6.29	7.51	7.01
Total phosphoric acid guaranteed	11.0	---	11.0	---	6.0	6.0
Cost per ton	$30.00	29.00	31.00	28.00	33.00	32.00
Valuation per ton	$34.98	33.09	35.13	30.87	33.00	28.08
Percentage difference between cost and valuation	*14.2	*12.3	*11.8	*9.2	0.0	13.9

* Valuation exceeds cost.

GROUND TANKAGE.

Sampled from Stock of	Dealers' 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.
F. T. Bradley, Saybrook	$30.00	$26.18	14.6	6.76	----	11.76	----	54	46
W. H. Baldwin, Meriden	27.00	23.46	15.1	5.03	*4.8*	14.83	*14.9*	50	50
Manufacturer	30.00	25.05	19.8	5.83	*5.8*	12.13	*10.0*	67	33
Manufacturer	33.00	26.94	22.5	4.39	*4.9*	20.37	*16.0*	65	35
S. D. Woodruff & Sons, Orange	----	28.38	----	7.72	*7.0*	11.03	----	56	44

The valuations of four out of the six samples were higher than the cost, indicating that during the present year, as was also the case last year, dry fish has been a cheap source of nitrogen and phosphoric acid.

The percentage of the total nitrogen which is soluble in acid pepsin solution, using the method described on page 95, has been determined in five of the samples of fish with the following results:

		Percentage of the total nitrogen soluble in acid pepsin.
405	Russia Cement Co.'s	87.6
431	Wilcox Fertilizer Co.'s	74.6
488	Sanderson's	61.5
400	Wilcox Fertilizer Co.'s	74.0
592	Bowker's	69.8

There is, therefore, no evidence of admixture of any inferior forms of nitrogen with these goods.

The percentage of nitrogen in **592**, sold by the Bowker Fertilizer Co., Boston, is less than the amount guaranteed by about a half per cent.

MIXED FERTILIZERS.

BONE AND WOOD ASHES.

452. Bone and wood ash fertilizer, made by the Bowker Fertilizer Co., Boston. Sampled from stock of City Coal & Wood Co., New Britain, and A. L. Hitchcock, Plainville.

ANALYSIS.

	452
Nitrogen as nitrates	0.68
Nitrogen, organic	1.04
Total nitrogen found	1.72
Total nitrogen guaranteed	1.50
Soluble phosphoric acid	0.00
"Reverted" phosphoric acid	8.54
Insoluble phosphoric acid	4.73
Total phosphoric acid found	13.27
Total phosphoric acid guaranteed	8.00
Potash soluble in water	2.29
Potash guaranteed	2.00
Cost per ton	$26.00

This fertilizer appears to be a mixture of nitrate of soda, bone and wood ashes.

BONE AND POTASH.

Samples of six brands bearing the name Bone and Potash have been analyzed, as follows:

450. Ammoniated Bone with Potash, made by Armour Fertilizer Co., Chicago. Sampled from stock of D. B. Wilson, Waterbury, Andrew Ure, Highwood, and E. A. Buck & Co., Willimantic.

493. Dissolved Bone and Potash, made by L. B. Darling Fertilizer Co., Pawtucket. Sampled from stock of Loomis Bros., Granby, L. M. Bristol, Canton Center, and W. D. Stanley, New Britain.

616. Square Brand Bone and Potash, made by Bowker Fertilizer Co., Boston. Stock of Simeon Pease, Greenfield Hill and C. A. Young, Danielson.

702. Ground Bone with Potash, made by E. Frank Coe Co., New York. Stock of Wheeler & Howe, Bridgeport.

681. Ammoniated Bone and Potash, made by W. J. Brightman & Co., Tiverton, R. I. Stock of William Crane, Broad Brook.

721. Ammoniated Bone and Potash, made by Listers Agricultural Chemical Works, Newark, N. J. Stock of A. I. Martin, Wallingford, and W. D. Stanley, New Britain.

ANALYSES AND VALUATIONS OF BONE AND POTASH.

	450	493	616	702	681	721
Nitrogen as nitrate	---	---	---	---	0.42	---
Nitrogen, organic	2.96	2.52	1.70	1.44	1.63	---
Total nitrogen found	2.96	2.52	1.70	1.44	2.05	---
Total nitrogen guaranteed	2.47	2.48	1.00	2.00	1.65	---
Soluble phosphoric acid	2.59	6.46	---	---	6.69	7.76
Reverted phosphoric acid	5.35	3.01	---	---	2.86	1.73
Insoluble phosphoric acid	2.82	0.29	---	---	1.67	0.67
Total phosphoric acid found	10.76	9.76	12.80	16.77	11.22	10.16
Total phosphoric acid guaranteed	8.0	7.0	12.00	---	9.00	10.00
Available phosphoric acid found	7.94	9.47	---	---	9.55	9.49
Available phosphoric acid guaranteed	6.0	6.0	6.0	---	8.00	7.50
Potash found	3.25	9.95	2.19	2.92	3.34	4.60
Potash guaranteed	2.0	10.0	2.00	2.50	3.00	5.00
Cost per ton	$27.00	34.00	24.00	30.00	30.00	24.00
Valuation per ton	$19.70	24.61	16.17	19.35	18.00	12.83
Percentage difference between cost and valuation	37.1	38.2	48.4	55.0	66.7	87.0

Two of these samples, **616** and **702**, made by the Bowker Fertilizer Co. and the E. F. Coe Co., are evidently what their name implies, mixtures of bone and potash salts. The other four are not such mixtures, but contain acid phosphates and, in one case, nitrates. Lister's "Bone and Potash," is simply a mixture of dissolved phosphate and potash salts containing no nitrogen whatever.

The percentage of nitrogen in the E. F. Coe Co.'s brand and the percentage of potash in Lister's brand are below that guaranteed by the manufacturer.

The percentage amount of the total nitrogen which is soluble in pepsin solution—see page 95—ranges from 58.1 to 88.2 and averages 77.6.

The minimum figure, 58.1, found in Armour's brand, **450**, is much lower than we have found in any other sample of bone this year.

NITROGENOUS SUPERPHOSPHATES AND GUANOS.

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

1. *Samples drawn by Station Agents.*

In the tables on pages 48 to 61 are given analyses of ninety samples belonging to this class, arranged according to the percentage differences between their cost prices and valuations.

Guarantees.

Of the ninety analyses of nitrogenous superphosphates given in the tables, fifteen are below the manufacturer's minimum guarantee in respect of one ingredient and three in respect of two ingredients. Exactly one-fifth of the whole number have therefore failed in some respect to come up to the claims of the manufacturer.

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

575 Conn. Valley Orchard Co.'s Fertilizer, nitrogen found 2.57, guaranteed 2.8.

677 Hess & Bro.'s Fish and Potash, nitrogen found 1.76, guaranteed 2.0.

695 Sanderson's Old Reliable, nitrogen found 2.20, guaranteed 2.4.

696 Chittenden's Complete Fertilizer, nitrogen found 3.42, guaranteed 3.7.

701 Chittenden's Market Garden Fertilizer, nitrogen found 1.68, guaranteed 2.5.

425 Mapes' Average Soil Complete Manure, phosphoric acid found 7.57, guaranteed 8.0.

451 Armour's All Soluble, phosphoric acid found 9.38, guaranteed 10.0.

656 Cleveland Dryer Co.'s H. G. Complete, phosphoric acid found 8.75, guaranteed 9.0.

472 Hubbard's All Soils All Crops, phosphoric acid found 11.10, guaranteed 12.0.
Available phoshoric acid found 9.77, guaranteed 10.0.

641 Clark's Cove Great Planet, phosphoric acid found 8.87, guaranteed 9.0.

640 Clark's Cove Complete, phosphoric acid found 6.73, guaranteed 7.0.

420 Parmenter & Polsey's Grain Grower, phosphoric acid found 7.91, guaranteed 8.0.
Available phosphoric acid 6.60, guaranteed 7.0.

660 Bradley's Complete with 10 per cent. potash, potash found 9.54, guaranteed 10.0.

563 Boardman's Complete for General Crops, potash found 9.41, guaranteed 10.0.

645 Hubbard's Fairchild's Formula, potash found 10.58, guaranteed 12.5.

657 Pacific Guano Co.'s H. G. General, nitrogen found 3.15, guaranteed 3.3.
Potash found 6.76, guaranteed 7.0.

638 Reed's H. G. Farmers' Friend, nitrogen found 3.18, guaranteed 3.3.
potash found 9.25, guaranteed 10.0.

704 Sanderson's Special 10 per cent. potash, phosphoric acid found 7.74, guaranteed 9.0.
Potash found 7.56, guaranteed 10.0.

Of these, Hubbard's Fairchild's Formula, **645**, is a mixture of dry ground bone and chemicals. It is quite impossible to make mixtures of dry 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. In such cases deficiency of one ingredient is likely to be offset by an amount of another ingredient quite in excess of the manufacturer's claims.

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, in order to give opportunity for explanation or correction as regards the price. When the data thus gathered show a wide range of prices further correspondence is required and the manufacturers 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 nitrogenous superphosphates is $30.00. The average valuation is $19.75 and the percentage difference 51.9.

Last year the corresponding figures were:

Average cost $29.54, average valuation $19.55, percentage difference 51.1.

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.

Solubility of Nitrogen.

This Station has been for some years, and is still, engaged in a study of methods for determining approximately the relative availability of nitrogen.

Some notice of this work will be found on pages 95 to 97 of this Report. Each of the nitrogenous fertilizers in the table on pages 48 to 61 has been tested with regard to the solubility of its nitrogen in acid pepsin solution.

On the average, 74.8 per cent. of the total organic nitrogen in these superphosphates is soluble in acid pepsin solution. The highest solubility found was 91.7 per cent. and the lowest, with two exceptions, was 57.6.

In G. W. Miles' Fish and Potash, **676,** the nitrogen had a solubility of 49.5 per cent., which is twenty-five per cent. below the average and eight per cent. lower than was found in any other case, but one.

Parmenter and Polsey's Grain Grower, **420,** contains but 0.90 per cent. of nitrogen, and of this only 18.9 per cent. is soluble in acid pepsin solution.

Analyses requiring Special Mention.

The National Fertilizer Co. states that analyses of their Market Garden Manure made in other States show a percentage of nitrogen fully up to the guarantee, while the analysis made

at this Station, No. **701,** see pages 56 and 57, shows 1.68 per cent. of nitrogen, the guarantee being 2.2 per cent. The company also states that, to the best of its knowledge and belief, the goods which in another state showed 2.49 per cent. of nitrogen and those which our analysis showed to contain but 1.68 per cent., came out of the same pile.

The sample drawn from J. F. Buckhout contained 1.76 per cent. of nitrogen and that drawn from Hallock & Co. contained 1.68 per cent. The analysis was made on a mixture of these two samples.

The last analysis in the table of nitrogenous superphosphates is **420,** Parmenter's and Polsey's Grain Grower, to which no valuation has been attached. As noted above, the nitrogen in this fertilizer has a very low solubility in pepsin solution; very much lower than that of fish, bone, blood, tankage, or vegetable forms of nitrogen.

For this reason it is very doubtful whether this nitrogen is in a form which farm experience has shown to be easily available to plants. Where there is good reason for such doubt the Station will not make a valuation.

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

In the table on page 61 are four analyses of four brands which were not found on sale in the State. The samples analyzed were therefore those sent to the Station by the manufacturers as required by statute.

The table also includes analyses of four fertilizers which were sent to the Station for the purpose by purchasers.

2. *Sampled by Manufacturers.*

716. Cumberland Superphosphate, made by Cumberland Bone Phosphate Co., Boston, Mass.

717. Success Fertilizer, made by Listers Agricultural Chemical Works, Newark, N. J.

714. Fish and Potash, and **715** Special with ten per cent. Potash, both made by Williams & Clark Fertilizer Co., New York.

NITROGENOUS SUPERPHOSPHATES.

Station No.	Name of Brand.	Manufacturer.	Dealer.	Dealer's cash price per ton.	* Valuation per ton.
490	Bone, Fish and Potash	E. R. Kelsey, Branford	Loomis Bros., Granby	$24.00	$22.37
			Wilson & Burr, Middletown	25.00	
625	XX Formula	C. Buckingham, Southport	Manufacturer	30.00	26.01
523	High Grade Fish and Potash	Wilcox Fertz. Works, Mystic	Manufacturer	26.00	21.82
			I. W. Dennison & Co., Mystic	26.00	
415	Market Garden Special	Farmer's Union Fertz. Co., Peabody, Mass.	W. J. Cox, East Hartford	33.00	26.53
			J. P. Kingsley, Plainfield	34.00	
			J. T. Peckham, Norwich	30.00	
				32.00	
676	Fish and Potash	G. W. Miles, Agt., Milford	Manufacturer	25.00	20.33
670	Market Garden Manure	Quinnipiac Co., Boston	C. Buckingham, Southport	30.00	24.22
1829	Bone, Fish and Potash	L. Sanderson, New Haven	M. A. Tinker, Chesterfield	25.00	20.07
			N. W. Dayton, New London	25.00	
			F. O. Ives, West Cheshire	25.00	
563	Complete Fertilizer for Potatoes and General crops	F. E. Boardman, Little River	Manufacturer	30.00	24.06
406	Pure Fine Bone dissolved in Sulphuric Acid	Mapes' F. and P. G. Co., N. Y.	Mapes' Branch, Hartford	29.00	23.24
730	Special Fertz. with 10% Potash	L. Sanderson, New Haven	Atwater Bros., New Haven	35.00	27.77
645	Hubbard's Fairchild's Formula for Corn and General Crops	Rogers & Hubbard Co., Middletown	H. W. Andrews, Wallingford	44.00	34.82
575	Fertilizer	Conn. Valley Orchard Co., Deep River	Manufacturer	25.00	19.76
423	Vegetable Manure or Complete for Light Soil	Mapes' F. and P. G. Co., N. Y.	Mapes' Branch, Hartford	39.00	30.68
			J. P. Barstow, Norwich	40.00	
618	Middlesex Special	Bowker Fertilizer Co., Boston	W. H. Baldwin, Meriden	25.00	21.02
				27.00	
654	Complete Manure	Standard Fertilizer Co., Boston	J. G. Bromley, Taftville	32.00	24.66

ANALYSES AND VALUATIONS.

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.
490	7.2	----	0.72	3.51	4.23	*3.3*	2.13	3.31	0.93	6.37	*4.0*	5.44	----	0.46	4.17	*4.0*
625	15.3	2.34	----	1.36	3.70	*3.3*	4.48	4.27	2.46	11.21	*10.0*	8.75	*8.0*	4.67	7.74	*7.0*
523	19.2	----	0.24	3.58	3.82	*3.3*	3.23	2.51	1.12	6.86	*6.0*	5.74	*5.0*	5.33	5.33	*4.0*
415	20.6	0.52	----	3.26	3.78	*3.3*	3.74	6.19	1.60	11.53	*9.0*	9.93	----	7.07	7.12	*7.0*
676	23.0	----	0.77	2.08	2.85	*2.5*	6.56	1.71	2.30	10.57	*7.0*	8.27	*6.0*	0.83	3.19	*3.0*
670	23.9	1.16	0.45	1.75	3.36	*3.3*	6.96	1.65	0.38	8.99	*9.0*	8.61	*8.0*	7.53	7.53	*7.0*
1829	24.6	----	0.85	2.64	3.49	*2.5*	1.58	4.19	0.75	6.52	*4.0*	5.77	---	4.62	4.62	*4.0*
563	24.7	----	----	2.78	2.78	*2.4*	5.74	2.53	0.63	8.90	----	8.27	*8.0*	9.41	9.41	*10.0*
406	24.8	----	----	2.53	2.53	*2.1*	5.50	11.48	3.18	20.16	----	16.98	*12.0*	----	----	----
730	26.0	----	----	2.74	2.74	*2.5*	4.05	7.28	2.13	13.46	*9.0*	11.33	*5.0*	10.54	10.54	*10.0*
645	26.4	3.59	----	2.18	5.77	*5.5*	---	----	----	14.17	*12.0*	----	----	10.58	10.58	*12.5*
575	26.5	0.32	----	2.25	2.57	*2.8*	6.37	1.90	2.93	11.20	*11.0*	8.27	*6.0*	4.12	4.12	*4.0*
423	27.1	2.73	0.36	2.59	5.68	*4.9*	2.62	4.76	1.28	8.66	*8.0*	7.38	*6.0*	0.84	7.51	*6.0*
618	28.4	0.37	----	1.93	2.30	*2.1*	6.27	3.21	1.65	11.13	*6.0*	9.48	----	6.08	6.08	*6.0*
654	29.8	1.13	----	2.12	3.25	*3.3*	6.06	3.52	1.19	10.77	*9.0*	9.58	*8.0*	7.40	7.40	*7.0*

NITROGENOUS SUPERPHOSPHATES.

Station No.	Name of Brand.	Manufacturer.	Dealer.	Dealer's cash price per ton.	Valuation per ton.
425	Average Soil Complete Manure	Mapes F. and P. G. Co., N. Y.	Birdsey & Raven, Meriden	$34.00	$25.36
			Mapes' Branch, Hartford	33.00	
567	Fish and Potash	Rogers Mfg. Co., Rockfall	Manufacturer	28.00	21.42
			Wm. Orr, Southington	26.00	
			J. F. Blakeslee, North Haven	28.00	
620	Fisherman's Brand Fish and Potash	Bowker Fertilizer Co., Boston	J. E. Leonard & Son, Jewett City	24.00	17.38
			Simeon Pease, Greenfield Hill	22.00	
				23.00	
451	All Soluble	Armour Fertilizer Works, Chicago, Ill.	D. B. Wilson, Waterbury	30.00	21.67
			Andrew Ure, Highwood	32.00	
			E. A. Buck & Co., Willimantic	26.00	
				29.00	
569	All Round Fertilizer	Rogers Mfg. Co., Rockfall	Meeker Coal Co., Norwalk	30.00	17.83
			Lewis Ford, Fair Ground Norwich	28.00	
			Manufacturer	24.00	
656	High Grade Complete Manure	Cleveland Dryer Co., Boston	Latham Avery, Groton	32.00	23.69
554	Essex Fish and Potash	Russia Cement Co., Gloucester, Mass.	J. A. Lewis' Estate, Willimantic	26.00	19.86
			W. J. Cox, East Hartford	29.00	
			J. W. Palmer, Stamford	25.00	
				27.00	
699	Fish and Potash	National Fertilizer Co., Bridgeport	J. F. Buckhout, Greenwich	29.00	21.26
			G. A. Williams, East Hartford	30.00	
719	Superphosphate for General Use	M. L. Shoemaker & Co., Phila.	Loomis Bros., Granby	34.00	24.71
			E. B. Clark Co., Milford	33.00	
			Olds & Whipple, Hartford	35.00	
705	Formula A	L. Sanderson, N. Haven	E. B. Clark Co., Milford	33.00	25.40
			A. B. Morse & Son, Guilford	33.00	
			Manufacturer	35.00	
664	Gold Brand Excelsior Guano	E. Frank Coe Co., New York	J. R. Babcock, Mystic	32.00	23.14
			C. F. Tallard & Son, Broad Brook	33.00	

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. Found.	Total Nitrogen. Guaranteed.	Soluble.	Reverted.	Insoluble.	Total. Found.	Total. Guaranteed.	Available. Found.	Available. Guaranteed.	Found. As Muriate.	Found. Total.	Guaranteed.
425	30.1	2.26	0.14	2.25	4.65	*4.1*	3.30	3.44	0.83	7.57	*8.0*	6.74	*6.0*	1.03	5.90	*5.0*
567	30.7	----	0.06	3.44	3.50	*2.3*	2.24	4.63	3.38	10.25	*6.0*	6.87	*4.0*	4.11	4.11	*3.7*
620	32.3	----	----	2.67	2.67	*2.3*	1.86	3.68	1.94	7.48	*6.0*	5.54	*4.0*	4.36	4.36	*4.0*
451	33.8	----	0.16	2.84	3.00	*2.8*	3.78	4.94	0.66	9.38	*10.0*	8.72	*8.0*	0.29	4.76	*4.0*
569	34.6	0.04	----	1.81	1.85	*1.6*	5.23	4.54	3.11	12.88	*10.0*	9.77	*8.0*	2.97	2.97	*2.0*
656	35.1	2.18	----	1.23	3.41	*3.3*	6.66	1.53	0.56	8.75	*9.0*	8.19	*8.0*	7.72	7.72	*7.0*
554	36.0	----	----	2.42	2.42	*2.0*	3.92	5.50	4.95	14.37	*12.0*	9.42	----	2.88	2.88	*2.2*
699	36.4	0.50	0.09	2.33	2.92	*3.0*	3.97	4.11	1.25	9.33	*6.0*	8.08	----	0.92	5.16	*4.0*
719	37.6	0.81	----	2.09	2.90	*2.5*	6.66	4.95	3.14	14.75	----	11.61	*9.0*	0.74	4.94	*4.0*
705	37.8	0.05	0.49	3.06	3.60	*2.8*	3.14	6.23	1.90	11.27	*10.0*	9.37	*6.0*	6.50	6.50	*6.0*
664	38.3	----	0.25	2.08	2.33	*2.4*	6.21	2.45	1.60	10.26	*8.3*	8.66	*7.3*	0.66	7.75	*6.5*

NITROGENOUS SUPERPHOSPHATES.

Station No.	Name of Brand.	Manufacturer.	Dealer.	Dealer's cash price per ton.	*Valuation per ton.*
660	Complete Manure with 10% Potash	Bradley Fertilizer Co., Boston	J. & H. Woodford, Avon	35.00	$25.30
561	Market Garden Fertilizer	Bowker Fertilizer Co., Boston	Bowker's Branch, Hartford	34.00	23.96
			Simeon Pease, Greenfield Hill	29.00	
421	Ammoniated Bone Fertilizer	Farmers' Union Fertz. Co., Peabody, Mass.	J. P. Kingsley, Plainfield	27.00	18.32
			A. H. Bates, Windham	25.00	
				26.00	
550	Farm Favorite	L. B. Darling Fertz. Co., Pawtucket, R. I.	Loomis Bros., Granby	29.00	20.42
			J. S. Warner, Glastonbury	30.00	
696	Chittenden's Complete Fertilizer	National Fertilizer Co., Bridgeport	G. A. Williams, East Hartford	36.00	25.14
			J. F. Buckhout, Greenwich	37.00	
517	Animal Brand	Lowell Fertilizer Co., Boston	F. E. Weed & Co., New Canaan	31.00	20.94
			S. W. Bray, Milford	32.00	
			H. A. Bugbee, Willimantic	28.00	
				30.00	
655	Superior Truck Fertilizer	M. E. Wheeler & Co., Rutland, Vt.	August Grulich, Meriden	35.00	24.41
417	Plymouth Rock Brand	Parmenter & Polsey Fertilizer Co., Peabody, Mass.	J. P. Kingsley, Plainfield	30.00	20.62
			A. H. Bates, Windham	----	
			W. J. Cox, East Hartford	30.00	
396	Swift Sure Superphosphate for General Use	M. L. Shoemaker & Co., Phila.	J. A. DuBon, Poquonock*	35.00	23.96
472	Hubbard's All Soils and All Crops	The Rogers & Hubbard Co., Middletown, Ct.	N. W. Dayton, New London	28.00	18.90
			J. H. Miner, Waterford	28.00	
657	H. G. General Fertilizer	Pacific Guano Co., Boston	W. S. Crane, Willimantic	36.00	24.15
617	Square Brand Fish and Potash	Bowker Fertilizer Co., Boston	City Coal & Wood Co., New Britain	26.00	18.08
				27.00	
671	Gardeners' Complete Manure	Packers' Union Fertilizer Co., N. Y.	T. A. Tillinghast, Brooklyn	35.00	23.16
638	High Grade Farmers' Friend	Read Fertilizer Co., N. Y.	C. W. Fulton, West Hartford	36.00	23.82
718	Special Superphosphate	Wilcox Fertilizer Wks., Mystic	T. H. Eldridge, Norwich	27.00	17.82
			J. E. Leonard & Son, Jewett City	27.00	

* Not a dealer.

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. Found.	Total Nitrogen. Guaranteed.	Soluble.	Reverted.	Insoluble.	Total. Found.	Total. Guaranteed.	Available. Found.	Available. Guaranteed.	Found. As Muriate.	Found. Total.	Guaranteed.
660	38.3	0.93	----	2.41	3.34	*3.2*	3.63	4.12	1.59	9.34	*7.0*	7.75	*6.0*	9.54	9.54	*10.0*
561	41.9	0.32	0.21	2.07	2.60	*2.3*	5.06	2.80	1.40	9.26	*7.0*	7.86	*6.0*	10.37	10.37	*10.0*
421	41.9	----	----	2.50	2.50	*1.6*	4.06	4.90	1.30	10.26	*8.0*	8.96	----	2.92	2.92	*2.5*
550	42.6	0.07	----	2.43	2.50	*2.1*	7.21	3.31	0.46	10.98	*9.0*	10.52	*8.0*	3.98	3.98	*3.0*
696	43.2	1.28	----	2.14	3.42	*3.7*	5.89	4.19	1.02	11.10	*10.0*	10.08	*8.0*	7.05	7.05	*6.0*
517	43.3	----	0.25	2.36	2.61	*2.4*	5.71	3.29	2.80	11.80	*10.0*	9.00	*9.0*	3.13	4.35	*4.0*
655	43.4	1.42	---	2.10	3.52	*3.3*	6.24	2.80	0.75	9.79	----	9.04	*8.0*	6.95	6.95	*7.0*
417	45.5	----	----	3.00	3.00	*2.4*	4.27	4.64	0.56	9.47	*9.0*	8.91	----	4.18	4.18	*4.0*
396	46.1	0.87	----	1.88	2.75	----	7.01	3.70	4.22	14.93	----	10.71	----	0.70	4.92	----
472	48.1	0.94	----	1.49	2.43	*2.3*	5.23	4.54	1.33	11.10	*12.0*	9.77	*10.0*	3.37	3.37	*3.0*
657	49.1	1.77	----	1.38	3.15	*3.3*	6.13	4.12	1.30	11.55	*9.0*	10.25	----	6.76	6.76	*7.0*
617	49.3	0.07	0.19	2.16	2.42	*2.3*	3.02	3.88	2.30	9.20	*8.0*	6.90	----	4.47	4.47	*4.0*
671	51.1	0.87	----	1.86	2.73	---	3.09	3.10	1.43	7.62	----	6.19	----	10.84	10.84	----
638	51.1	0.67	----	2.51	3.18	*3.3*	3.87	3.26	0.71	7.84	*7.0*	7.13	*6.0*	9.25	9.25	*10.0*
718	51.5	0.11	---	1.51	1.62	*1.0*	7.36	4.72	1.54	13.62	*11.0*	12.08	*10.0*	2.14	2.14	*1.5*

NITROGENOUS SUPERPHOSPHATES.

Station No.	Name of Brand.	Manufacturer.	Dealer.	Dealer's cash price per ton.	Valuation per ton.
494	New Rival Ammoniated Superphosphate	Crocker Fertilizer and Chemical Co., Buffalo, N. Y.	T. S. Bidwell, Canton Center	$25.00	16.37
			O. H. Meeker, Danbury	28.00	
680	A. A. Ammoniated Superphosphate	East India Chemical Co., H. J. Baker & Bro., Agents, N. Y.	Saxton & Strong, Bristol	31.50	20.61
641	Great Planet	Clark's Cove Fertilizer Co., N. Y.	Phineas Platt, Milford	37.00	24.20
520	A Brand Manure	Mapes F. & P. G. Co., N. Y.	Birdsey & Raymond, Meriden	33.00	21.30
			Southington Lumber Co., Southington	33.00	
604	Cereal Brand Cecrops Fertilizer	Fred'k Ludlam, N. Y.	J. M. Beckwith, Chesterfield	23.00	14.83
			J. J. Applely, Canterbury	----	
652	Americus High Grade Special	Williams & Clark Fertilizer Co., N. Y.	F. B. Austin, Silver Mine	38.00	24.49
495	Complete Fertilizer	Berkshire Fertilizer Co., Bridgeport	Manufacturer	32.00	20.54
			Z. J. Hinman, Collinsville	35.00	
707	Pure Bone Superphosphate of Lime	Lister's Agri. Chem. Wks., Newark, N. J.	A. I. Martin, Wallingford	32.00	20.19
525	Americus Ammoniated Bone Superphosphate	Williams & Clark Fertilizer Co., N. Y.	J. A. Reeve, Burlington	30.00	18.87
			D. B. Wilson, Waterbury	30.00	
			Lewis Ford, Fair Ground, Norwich	32.00	
457	Bowker's Farm and Garden Phosphate	Bowker Fertilizer Co., Boston	Lightbourn & Pond Co., New Haven	33.00	17.58
			C. W. Michaels, Yalesville	32.00	
496	Bowker's Hill and Drill Phosphate	Bowker Fertilizer Co., Boston	Simeon Pease, Greenfield Hill	28.00	19.43
			W. O. Goodsell, Bristol	30.00 32.00	
522	Cereal Brand	Mapes F. & P. G. Co., N. Y.	G. W. Green, Torrington	31.00	16.91
			A. N. Clark, Milford	26.00 28.00	
476	Patent Superphosphate	Bradley Fertilizer Co., Boston	C. L. Comstock, Danbury	27.00	19.93
			E. E. Scofield, Stamford	32.00 32.00	
			C. O. Jelliff & Co., Southport	30.00	

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. Found.	Total Nitrogen. Guaranteed.	Soluble.	Reverted.	Insoluble.	Total. Found.	Total. Guaranteed.	Available. Found.	Available. Guaranteed.	Found. As Muriate.	Found. Total.	Guaranteed.
494	52.7	tr'ce	----	1.54	1.54	*1.2*	5.86	3.83	1.96	11.65	*9.0*	9.69	*8.0*	2.93	2.93	*2.0*
680	52.8	1.10	0.50	1.30	2.90	*2.5*	6.56	3.04	1.25	10.85	*10.0*	9.60	*9.0*	3.62	3.62	*2.0*
641	52.9	1.13	0.46	1.89	3.48	*3.3*	6.93	1.29	0.65	8.87	*9.0*	8.22	*8.0*	7.29	7.29	*7.0*
520	54.9	0.75	----	2.23	2.98	*2.4*	3.73	6.55	2.30	12.58	*12.0*	10.28	*10.0*	3.34	3.34	*2.5*
604	55.1	0.35	0.14	0.72	1.21	*0.8*	4.64	6.22	2.16	13.02	*10.0*	10.86	*8.0*	1.35	1.35	*1.0*
652	55.2	1.13	0.50	1.88	3.51	*3.3*	7.31	0.94	0.50	8.75	*8.0*	8.25	*6.0*	7.51	7.51	*7.0*
495	55.8	0.68	----	2.00	2.68	*2.4*	5.63	3.57	1.20	10.40	*10.0*	9.20	*8.0*	4.81	6.13	*6.0*
707	58.5	----	0.21	2.17	2.38	*2.3*	8.74	3.12	1.80	13.66	*12.0*	11.86	*10.0*	1.38	1.87	*1.5*
525	59.0	0.81	----	1.84	2.65	*2.4*	7.09	2.48	1.33	10.90	*9.0*	9.57	*7.0*	1.23	2.35	*2.0*
457	59.3	0.26	----	1.73	1.99	*1.5*	6.86	3.19	1.83	11.88	*11.0*	10.05	*9.0*	2.43	2.43	*2.0*
496	59.5	0.50	----	2.08	2.58	*2.2*	6.69	3.53	1.93	12.15	*9.0*	10.22	*7.0*	2.37	2.37	*2.0*
522	59.6	0.12	----	2.10	2.22	*1.6*	3.87	4.13	1.22	9.22	*8.0*	8.00	*6.0*	3.31	3.31	*3.0*
476	60.6	0.49	----	2.31	2.80	*2.5*	6.51	3.50	1.58	11.59	*9.0*	10.01	*7.0*	0.86	2.29	*2.0*

NITROGENOUS SUPERPHOSPHATES.

Station No.	Name of Brand.	Manufacturer.	Dealer.	Dealer's cash price per ton.	*Valuation per ton.*
640	Complete Fertilizer	Clark's Cove Fertilizer Co., N. Y.	Phineas Platt, Milford	37.00	$22.80
677	Fish and Potash	S. M. Hess & Bro., Phila.	D. W. Barnes, Windsor	30.00	18.46
694	Bay State Fertilizer	Clark's Cove Fertilizer Co., N. Y.	C. C. Pierce, Thompson	30.00	18.40
519	Universal Fertilizer	Packers' Union Fertilizer Co., N. Y.	G. W. Eaton, Bristol	28.00	16.52
			T. A. Tillinghast, Brooklyn	27.00	
577	Quinnipiac Phosphate	Quinnipiac Co., Boston	G. M. Williams Co., New London	31.00	18.14
			C. A. Young, Danielson	29.00	
				30.00	
500	Farmers' New Method Fertilizer	Bradley Fertilizer Co., Boston	D. L. Clark, Milford	29.00	17.52
			Wilson & Burr, Middletown	30.00	
556	Special Compound	S. M. Hess & Bro., Phila.	E. J. & B. S. Brown, Campville	27.00	16.79
			W. D. Penfield, Cobalt	29.00	
				28.00	
474	O. and W.'s Special Phosphate	Olds & Whipple, Hartford	Manufacturer	33.00	19.74
701	Chittenden's Market Garden* Fertilizer	National Fertilizer Co., Bridgeport	J. F. Buckhout, Greenwich	32.00	19.06
			Hallock & Co., Derby	----	
704	Special with 10% Potash	L. Sanderson, New Haven	F. O. Ives, West Cheshire	35.00	20.67
			Manufacturer	35.00	
661	Bone, Fish and Potash	Read Fertilizer Co., N. Y.	T. A. Tillinghast, Brooklyn	28.00	16.33
658	Triangle A Fish and Potash	Bradley Fertilizer Co., Boston	C. S. Gillette, Cheshire	28.00	16.31
582	Soluble Pacific Guano	Pacific Guano Co., Boston	Carlos Bradley, Ellington	28.00	16.75
			Jas. A. Nichols, Danielson	30.00	
				29.00	
683	High Grade Ammoniated Bone Superphosphate	E. Frank Coe Co., N. Y.	J. R. Babcock, Old Mystic	28.00	17.31
			J. P. Barstow & Co., Norwich	32.00	
				30.00	
698	Ammoniated Bone Phosphate	National Fertilizer Co., Bridgeport	G. A. Williams, East Hartford	32.00	17.31
			Gault Bros., Westport	30.00	
			J. F. Buckhout, Greenwich	30.00	

* See page 47.

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.
640	62.3	0.90	0.30	1.46	2.66	*2.4*	5.04	1.27	0.42	6.73	*7.0*	6.31	----	10.70	10.70	*10.0*
677	62.5	----	----	1.76	1.76	*2.0*	5.44	5.36	1.20	12.00	----	10.80	*8.0*	0.88	3.46	*3.0*
694	63.0	0.77	----	1.91	2.68	*2.4*	6.69	2.42	1.23	10.34	*10.0*	9.11	*9.0*	2.29	2.29	*2.0*
519	63.4	0.32	----	1.13	1.45	*0.8*	4.34	4.07	2.48	10.89	----	8.41	*8.0*	4.70	4.70	*4.0*
577	65.4	0.93	----	1.68	2.61	*2.4*	6.78	2.16	1.33	10.27	*10.0*	8.94	*9.0*	2.42	2.42	*2.0*
500	65.5	0.71	----	1.39	2.10	*1.6*	6.43	2.58	1.49	10.50	*10.0*	9.01	*8.0*	3.34	3.34	*3.0*
556	66.8	----	----	1.08	1.08	*0.8*	4.66	5.53	2.22	12.41	----	10.19	*8.0*	4.64	4.64	*4.0*
474	67.2	----	----	2.70	2.70	*2.5*	7.68	2.33	1.70	11.71	*10.0*	10.01	*9.0*	0.44	1.99	*2.0*
701	67.9	0.27	----	1.41	1.68	*2.5*	6.24	3.44	1.04	10.72	*9.0*	9.68	*8.0*	6.08	6.08	*6.0*
704	69.3	0.35	----	2.31	2.66	*1.6*	3.25	3.53	0.96	7.74	*9.0*	6.78	*5.0*	7.56	7.56	*10.0*
661	71.5	----	0.36	1.98	2.34	*2.0*	1.78	4.02	1.33	7.13	*6.0*	5.80	----	4.26	4.26	*4.0*
658	71.6	----	----	2.04	2.04	*2.0*	2.26	3.25	2.95	8.46	*6.0*	5.51	----	4.92	4.92	*4.0*
582	73.1	0.55	----	1.73	2.28	*2.0*	6.11	2.33	2.02	10.46	*10.0*	8.44	*8.0*	2.03	2.03	*1.5*
683	73.3	----	----	1.88	1.88	*1.8*	7.34	2.21	1.48	11.03	*11.0*	9.55	*9.0*	0.20	2.54	*2.2*
698	73.3	0.28	----	1.44	1.72	*1.8*	4.86	5.71	2.13	12.70	*10.0*	10.57	*8.0*	2.71	2.71	*2.0*

NITROGENOUS SUPERPHOSPHATES.

Station No.	Name of Brand.	Manufacturer.	Dealer.	Dealer's cash price per ton.	Valuation per ton.
695	Old Reliable Superphosphate	L. Sanderson, New Haven	R. H. Hall, East Hampton	$28.00	$17.12
			Manufacturer	30.00	
689	Quinnipiac Climax Phosphate	Quinnipiac Co., Boston	J. P. Lathrop, Plainfield	26.00	14.80
679	Bowker's Sure Crop Phosphate	Bowker Fertilizer Co., Boston	Hubbell & Bradley, Saugatuck	28.00	15.63
687	Prolific Crop Producer	Williams & Clark Fertilizer Co., N. Y.	W. H. Chappell, Chesterfield	24.00	13.36
609	General Fertilizer	Great Eastern Fertilizer Co., Rutland, Vt.	T. E. Green, Plainfield	26.00	15.02
			Elmer Keeler, Danbury	30.00	
			Jas. H. Elliott, Campville	28.00	
				27.00	
578	Star Brand Superphosphate	Parmenter & Polsey Fertilizer Co., Peabody, Mass.	E. F. Strong, Colchester	28.00	15.38
			J. E. Leonard & Son, Jewett City	29.00	
574	Eclipse Phosphate	Bradley Fertilizer Co., Boston	W. W. Sheldon, South Woodstock	27.00	14.39
			D. L. Clark, Milford	28.00	
459	Ammoniated Bone Phosphate	Berkshire Fertilizer Co., Bridgeport	J. W. Palmer, Stamford	28.00	14.39
			Manufacturer	27.00	
			Johnson Bros., Jewett City	27.00	
690	General Crop Phosphate	Crocker Fertilizer and Chem. Co., Buffalo, N. Y.	F. P. Williams, South Coventry	26.00	13.82
684	Standard Fertilizer	Standard Fertilizer Co., Boston	J. W. Howe & Son, South Glastonbury	32.00	17.00
515	Standard Superphosphate	Read Fertilizer Co., N. Y.	Lewis Ford, Fair Ground, Norwich	28.00	14.80
			F. L. Dimmock, Waterford	26.00	
			J. R. Babcock, Old Mystic	28.00	
611	King Philip Alkaline Guano	Clark's Cove Fertilizer Co., N. Y.	Phineas Platt, Milford	29 00	13.97
			J. M. Burk, South Manchester	25 00	
				27.00	
678	Bay State G. G.	Clark's Cove Fertilizer Co., N. Y.	J. M. Burk, South Manchester	32.00	16.23
460	Niagara Phosphate	Bradley Fertilizer Co., Boston	C. S. Gillette, Cheshire	25.00	12.23
			Wilson & Burr, Middletown	25.00	

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. Found.	Total Nitrogen. Guaranteed.	Soluble.	Reverted.	Insoluble.	Total. Found.	Total. Guaranteed.	Available. Found.	Available. Guaranteed.	Found. As Muriate.	Found. Total.	Guaranteed.
695	75.2	0.20	....	2.00	2.20	*2.4*	4.62	3.99	1.98	10.59	*10.0*	8.61	*7.0*	2.64	2.64	*2.0*
689	75.7	....	....	1.14	1.14	*1.0*	6.14	3.18	1.96	11.28	*9.0*	9.32	*8.0*	2.85	2.85	*2.0*
679	79.1	....	....	1.03	1.03	*0.8*	6.16	4.73	3.22	14.11	*11.0*	10.89	*9.0*	2.15	2.15	*2.0*
687	79.6	0.04	....	1.24	1.28	*0.8*	5.48	2.97	1.53	9.98	*8.0*	8.45	*7.0*	1.75	1.75	*1.0*
609	79.8	....	....	1.13	1.13	*0.8*	4.70	3.58	2.29	10.57	....	8.28	*8.0*	4.13	4.13	*4.0*
578	82.1	....	....	1.93	1.93	*1.6*	3.90	3.88	0.97	8.75	*8.0*	7.78	....	2.82	2.82	*2.5*
574	87.6	0.04	....	1.18	1.22	*1.0*	6.56	2.64	1.62	10.82	*9.0*	9.20	*8.0*	2.30	2.30	*2.0*
459	87.6	....	....	1.15	1.15	*0.8*	4.44	3.43	4.12	11.99	*10.0*	7.87	*8.0*	0.33	2.48	*2.0*
690	88.1	....	....	1.16	1.16	*0.8*	5.76	2.99	1.71	10.46	*9.0*	8.75	*7.0*	2.32	2.32	*1.0*
684	88.2	0.43	0.14	1.75	2.32	*2.0*	6.29	2.99	1.34	10.62	*10.0*	9.28	*8.0*	1.58	1.58	*1.5*
515	89.2	....	....	1.06	1.06	*0.8*	6.00	2.39	1.50	9.89	*9.0*	8.39	*8.0*	4.24	4.24	*4.0*
611	93.3	....	....	1.20	1.20	*1.0*	6.56	2.41	1.26	10.23	*9.0*	8.97	*8.0*	2.26	2.26	*2.0*
678	97.2	0.62	....	1.46	2.08	*2.0*	5.07	3.99	2.03	11.09	*10.0*	9.06	*8.0*	1.73	1.73	*1.5*
460	104.4	0.05	....	1.13	1.18	*0.8*	5.18	2.64	1.58	9.40	*8.0*	7.82	*7.0*	1.40	1.40	*1.0*

NITROGENOUS SUPERPHOSPHATES.

Station No.	Name of Brand.	Manufacturer.	Dealer.	Dealer's cash price per ton.	Valuation per ton.
576	Defiance Complete Manure	Clark's Cove Fertilizer Co., N. Y.	E. Bishop, New London	$28.00	$12.77
			Phineas Platt, Milford	26.00	
				27.00	
583	Nobsque Guano for All Crops	Pacific Guano Co., Boston	Jas. A. Nichols, Danielson	30.00	14.18
			Carlos Bradley, Ellington	26.00	
686	Imperial Bone Superphosphate for All Crops	Henry F. Tucker Co., Boston	L. A. Fenton, Norwich Town	30.00	14.11
700	Universal Phosphate	National Fertilizer Co., Bridgeport	Gault Bros., Westport	30.00	12.58
643	Cecrops Brand	Frederick Ludlam, New York	J. L. Applely, Canterbury	----	25.46
693	Royal Bone Phosphate	Williams & Clark Fertilizer Co., N. Y.	J. A. Paine, East Killingly	----	14.25
420	"P. & P." Grain Grower*	Parmenter & Polsey Fertilizer Co., Peabody, Mass.	J. P. Kingsley, Plainfield	22.00	
			J. E. Leonard & Son, Jewett City	24.00	
				23.00	

3. *Sampled by Purchasers.*

462. Bone, Fish and Potash, made by E. R. Kelsey, Branford. Sampled and sent by E. C. Warner, New Haven.

250. Sanderson's Special Phosphate, made by L. Sanderson, New Haven. Sampled and sent by O. G. Beard, Shelton.

256. Conn. Valley Orchard Co.'s Fertilizer, made by Conn. Valley Orchard Co., Deep River. Sampled and sent by G. E. Wagner, Deep River.

598. Fertilizer, made by Berkshire Fertilizer Co., Bridgeport. Sampled and sent by W. H. Hunt, Newington.

* See page 47.

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. Found.	Total Nitrogen. Guaranteed.	Soluble.	Reverted.	Insoluble.	Total. Found	Total. Guaranteed.	Available. Found.	Available. Guaranteed.	Found. As Muriate.	Found. Total.	Guaranteed.
576	111.4	----	----	1.26	1.26	*0.8*	4.85	2.95	2.27	10.07	*8.0*	7.80	7.0	1.44	1.44	*1.0*
583	111.6	0.04	----	1.21	1.25	*1.0*	6.36	2.47	1.61	10.44	*9.0*	8.83	*8.0*	2.33	2.33	*2.0*
686	112.6	----	----	1.18	1.18	*1.0*	6.30	2.91	1.22	10.43	*9.0*	9.21	*8.0*	2.30	2.30	*2.0*
700	138.5	0.44	----	0.56	1.00	*0.8*	5.31	3.94	1.23	10.48	*10.0*	9.25	*8.0*	1.45	1.45	*1.0*
643	----	0.90	----	2.68	3.58	*3.0*	5.81	3.04	1.35	10.20	----	8.85	7.0	7.67	7.67	7.0
693	----	0.04	----	1.20	1.24	*1.0*	6.30	2.90	1.18	10.38	*10.0*	9.20	*8.0*	2.31	2.31	*2.0*
420	----	----	----	0.90	0.90	*0.8*	3.68	2.92	1.31	7.91	*8.0*	6.60	7.0	2.36	2.36	*2.0*

ANALYSES OF NITROGENOUS SUPERPHOSPHATES SENT BY MANUFACTURERS AND PURCHASERS. (*See pages 47 and 60.*)

	716	717	714	715	462	250	256	598
Nitrogen as nitrate	---	---	---	---	---	0.09	0.40	0.84
Nitrogen as ammonia	---	---	---	0.84	0.66	0.09	---	---
Nitrogen, organic	2.26	1.50	2.14	2.02	3.49	2.77	2.04	1.76
Total nitrogen found	2.26	1.50	2.14	2.86	4.15	2.95	2.44	2.60
Total nitrogen guaranteed	2.06	1.20	1.50	2.47	4.00	2.50	2.45	---
Soluble phosphoric acid	5.54	7.63	1.98	4.82	2.22	3.30	6.53	6.51
Reverted phosphoric acid	4.66	3.12	3.72	2.48	3.32	2.41	2.03	3.35
Insoluble phosphoric acid	1.19	2.00	2.31	0.55	0.97	2.20	3.26	1.37
Total phosphoric acid found	11.39	12.75	8.01	7.85	6.51	7.91	11.82	11.23
Total phosphoric acid guaranteed	10.00	9.50	6.00	6.50	4.00	9.00	11.00	---
Available phosphoric acid found	10.20	10.75	5.70	7.30	5.54	5.71	8.56	9.86
Available phosphoric acid guaranteed	8.00	---	4.00	6.00	---	5.00	6.50	---
Potash found	1.82	2.59	5.85	10.30	4.10	10.66	4.09	7.70
Potash guaranteed	1.50	2.00	4.00	10.00	4.00	10.00	4.00	---
Cost per ton	---	---	---	---	24.00	30.00	25.00	35.00
Valuation	$17.76	17.06	17.28	25.74	22.12	23.98	19.68	23.37
Per cent. difference between cost and valuation	---	---	---	---	8.5	25.1	27.0	49.7

735. Guano from Porto Rico. Sent for analysis by Joseph Anderson, Jr., Woodmont.

This is a phosphatic guano, containing but little nitrogen and of very moderate value.

ANALYSIS.

Nitrogen as nitrates	none
Nitrogen as ammonia	none
Nitrogen, organic	0.36
Soluble phosphoric acid	1.28
Reverted phosphoric acid	4.01
Insoluble phosphoric acid	4.16
Potash soluble in water	0.47

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 68 to 83 are given analyses of one hundred brands represented by samples drawn by the Station agents.

GUARANTEES.

Of the one hundred analyses, fourteen do not fulfill the manufacturer's guarantee in respect of one ingredient, and two are each deficient in respect of two ingredients.

The brands which thus failed to support the claims made in the guarantee are as follows:

729 Quinnipiac Co.'s Havana Tobacco Fertilizer, nitrogen found 5.46, guaranteed 5.8.

469 Hubbard's Fertilizer for Oats and Top Dressing,* nitrogen found 8.59, guaranteed 8.8.

572 Rogers Mfg. Co.'s High Grade Complete Corn Manure, nitrogen found 3.36, guaranteed 3.6.

613 Rogers Mfg. Co.'s Grass and Grain Fertilizer,* nitrogen found 2.66, guaranteed 3.0.

566 Russia Cement Co.'s Essex Tobacco Starter, nitrogen found 2.31, guaranteed 2.5.

* See remarks on page 66.

722 Packers' Union Fertilizer Co.'s, Wheat, Oats and Clover, phosphoric acid found 10.22, guaranteed 11.0.

723 Wheeler & Co.'s Grass and Oats Fertilizer, available phosphoric acid found 10.38, guaranteed 11.0.

622 Armour's High Grade Potato Manure, potash found 9.64, guaranteed 10.0.

639 Bowker's Tobacco Ash Fertilizer, potash found 12.75, guaranteed 13.0.

627 Bradley's High Grade Tobacco Manure, potash found 9.34, guaranteed 10.0.

471 Hubbard's Grass and Grain Fertilizer,* potash found 12.09, guaranteed 12.5.

706 Lister's Special Potato Manure, potash found 2.88, guaranteed 3.0.

703 Sanderson's Potato Manure, potash found 5.23, guaranteed 6.0.

637 Wheeler's Tobacco Grower, potash found 8.78, guaranteed 10.0.

557 Hess' Potato and Truck Manure, nitrogen found 2.14, guaranteed 2.5.
potash " 5.44, " 6.0.

624 Mapes' Seeding Down Manure,* phosphoric acid found 18.64, guaranteed 19.0.
Potash found 10.29, guaranteed 11.0.

See also analyses specially noticed on pages 63 to 67.

COST AND VALUATION.

The average cost per ton of the one hundred special manures included in the table was $32.73, the valuation $22.49 and the percentage difference 45.5.

In 1899 the corresponding figures were: average cost, $32.64; average valuation, $21.76; percentage difference, 50.0.

Analyses requiring Special Notice.

No. **636** is a sample drawn from stock of A. H. Peck, Ellington, and from bags marked Havana Tobacco Fertilizer, with the name and address of the Quinnipiac Co. The analysis does not at all correspond with the guarantee of the Tobacco Fertilizer, but the manufacturer states that it agrees fairly with that of their Potato Manure. At the request of the Quinnipiac Co. another sample was drawn of Havana Tobacco Fertilizer from stock of A. D. Fillmore, Warehouse Point.

Its analysis, No. **729**, is given in the table on pages 70 and 71, and is here reproduced for comparison.

* See remarks on page 66.

ANALYSES OF THE QUINNIPIAC CO.'S HAVANA TOBACCO FERTILIZER.

	636	729	Guarantee.
Nitrogen as nitrates	0.87	1.52	....
Nitrogen as ammonia	0.00	2.96	....
Nitrogen, organic	1.65	0.98	....
Nitrogen, total	2.52	5.46	5.78
Soluble phosphoric acid	3.50	5.34	....
Reverted phosphoric acid	2.71	1.40	....
Insoluble phosphoric acid	1.68	0.51	....
Total phosphoric acid	7.89	7.25	6.00
Available phosphoric acid	6.21	6.74	5.00
Potash as muriate	6.68	0.92	....
Potash, total	6.68	10.51	10.00
Cost per ton	$44.00	44.00	....
Valuation per ton	$19.14	33.70	....
Percentage difference between cost and valuation	129.9	30.6	....

No. **691** is a sample of Ammoniated Wheat and Corn Phosphate, made by Crocker Fertilizer Co., Buffalo, N. Y.

The sample was drawn from stock of T. S. Bidwell, Canton Center. The analysis shows a considerable deficiency of nitrogen, a large excess of phosphoric acid and a moderate excess of potash as compared with the guarantee. The manufacturers stated that they had no record of sales of this brand to Mr. Bidwell, nor did the analysis represent the average composition. Another sample, No. **733**, was therefore drawn from stock of F. P. Williams, South Coventry. The analysis appears in the table, pages 78 and 79, and is here reproduced for comparison.

ANALYSES OF CROCKER'S AMMONIATED WHEAT AND CORN PHOSPHATE.

	691	733	Guarantee.
Nitrogen as nitrates	0.91	....	....
Nitrogen, organic	0.48	2.28	....
Nitrogen, total	1.39	2.28	2.00
Soluble phosphoric acid	8.30	6.66	....
Reverted phosphoric acid	2.49	4.49	....
Insoluble phosphoric acid	1.21	1.26	....
Total phosphoric acid	12.00	12.41	10.00
Available phosphoric acid	10.79	11.15	8.00
Potash, as muriate	2.33	1.86	....
Potash, total	2.33	1.86	1.50
Cost per ton	$29.00	29.00	....
Valuation per ton	$15.87	18.73	....
Percentage difference between cost and valuation	82.7	54.8	....

No. **720** is a sample of the E. Frank Coe Co.'s Tobacco and Onion Fertilizer, drawn from stock of C. F. Tallard & Co., Broad Brook. This analysis does not at all correspond with the manufacturer's guarantee in respect of either nitrogen or phosphoric acid, and the manufacturer objects that it does not at all represent the composition of this brand as it is sold to farmers. The analysis is as follows:

	720
Nitrogen as nitrate	0.24
Nitrogen, organic	0.64
Total nitrogen found	0.88
Nitrogen guaranteed	3.30
Soluble phosphoric acid	7.65
Reverted phosphoric acid	2.47
Insoluble phosphoric acid	1.37
Total phosphoric acid found	11.49
Total phosphoric acid guaranteed	8.00
Available phosphoric acid found	10.12
Available phosphoric acid guaranteed	8.00
Potash as muriate	0.52
Total potash found	8.18
Potash guaranteed	8.00
Cost per ton	$35.00
Valuation per ton	$20.15

All these samples which have been specially noticed were drawn by the Station in a way to insure accuracy, from bags either tagged or marked with the names of the brands as given above.

No error was made in the analyses, and if the goods were not as they left the manufacturer's hands they have been tampered with in some way unknown to us.

It is doubtless the case that agents sometimes rebag stock while in their possession and it is possible that bags are used which originally held other brands and still bear their names.

The last special manure in the table, page 82, is the Russia Cement Co.'s Odorless Lawn Dressing, No. **653**.

No ton price is attached to this fertilizer. It is sold in bags holding from five to one hundred pounds, for use on lawns.

534. Pure Carbonate of Potash Tobacco Starter. Made by Auguste Pouleur, Windsor, Conn. Sample sent by the manufacturer. The analysis of this fertilizer is as follows:

	534
Nitrogen as nitrates	2.51
Nitrogen, organic	0.97
Nitrogen, total	3.48
Soluble phosphoric acid	0.00
Reverted phosphoric acid	8.10
Insoluble phosphoric acid	1.85
Total phosphoric acid	9.95
Potash as muriate	0.21
Potash as carbonate	15.07
Total potash	15.28
Chlorine	0.16

It is stated that the potash in this fertilizer is in form of pure, dry carbonate of potash, an analysis of which appears in this report, page 29. This statement is supported by the fact that the fertilizer is practically free from both sulphates and chlorides. Potash in form of carbonate, derived from cotton hull ashes, has cost during the present year, as appears on page 86, 7.5 cents per pound.

White, hydrated carbonate of potash is quoted at the present time (September, 1900), in New York, at 5 cents per pound *wholesale,* which is equivalent to 8.7 cents per pound for actual potash at wholesale.

If the potash is valued at this figure, 8.7 cents, the total ton valuation of the fertilizer is $43.41; if valued as in cotton hull ashes, 7.5 cents per pound, the valuation will be $29.80.

The manufacturer recommends the use of 600 pounds of this fertilizer, with one ton of cotton seed meal per acre, as a suitable dressing for tobacco lands. The two together would supply 161 pounds of nitrogen, 123 pounds of phosphoric acid and 129 pounds of potash.

The following special manures are mixtures of raw bone and chemicals:

469. Hubbard's Fertilizer for Oats and Top Dressing.
471. Hubbard's Grass and Grain Fertilizer.
613. Rogers Manufacturing Co.'s Grass and Grain Fertilizer.
624. Mapes' Seeding Down Manure.

No one of them meets the manufacturer's guarantee in all respects. It should be said, however, that 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.

Solubility of Nitrogen.

The solubility of the organic nitrogen in each of the special manures included in the table has been tested by the method described on page 97. On the average, 76.4 per cent. of the total nitrogen is soluble in the reagent used for the tests, while in individual cases as high as 100 per cent. and as low as 57.8 per cent. were found. In no case is there reason to suspect the presence of any very large admixture of insoluble (and agriculturally inert) forms of nitrogen.

Special Manures. Sampled by the Station.

Station No.	Name of Brand.	Manufacturer.	Dealer.	Dealers' cash price per ton.	Valuation per ton.
613	Grass and Grain Fertilizer	Rogers Mfg. Co., Rockfall	Wm. Orr, Southington	$38.00	$33.38
			J. A. Reeve, Burlington	37.00	
728	Essex Special Tobacco Manure	Russia Cement Co., Gloucester, Mass.	J. B. Parker, Poquonnock	41.00	34.38
524	Potato Manure	Wilcox Fertilizer Works, Mystic	I. W. Dennison & Co., Mystic	25.00	20.96
			Manufacturer	25.00	
			Olds & Whipple, Hartford	32.00	
622	High Grade Potato	Armour Fertilizer Works, Chicago	E. A. Buck & Co., Willimantic	28.00	23.22
650	Potato, Onion and Tobacco Manure	Wilcox Fertilizer Works, Mystic	I. W. Dennison & Co., Mystic	31.00	25.38
549	Tobacco Grower	L. B. Darling Fertz. Co., Pawtucket, R. I.	L. M. Bristol, Canton Center	40.00	31.88
			J. S. Warner, Glastonbury	39.00	
552	Essex Complete Manure for Potatoes, Roots and Vegetable	Russia Cement Co., Gloucester, Mass.	W. J. Cox, East Hartford	37.00	30.24
			J. A. Lewis' Estate, Willimantic	35.00	
			H. T. Hale, Gildersleeve	38.00	
662	Mystic Gilt Edge Potato Manure	C. M. Shay, Groton	Manufacturer	30.00	24.47
471	Hubbard's Grass and Grain Fertilizer	Rogers & Hubbard Co., Middletown	H. W. Andrews, Wallingford	37.00	30.18
			Geo. A. Tucker, W. Cheshire	35.00	
			N. W. Dayton, New London	38.00	
571	High Grade Soluble Tobacco Manure	Rogers Mfg. Co., Rockfall	E. E. Alcott, Glastonbury	----	35.04
			Strickland Bros., Addison	42.00	
			Manufacturer	44.00	
591	Bowker's Tobacco Ash Elements	Bowker Fertilizer Co., Boston, Mass.	H. K. Brainard, Thompsonville	43.00	
579	Hubbard's Soluble Tobacco Manure	Rogers & Hubbard Co., Middletown		30.00	23.94
			S. E. Frisbie, Milford	42.00	32.21
			H. W. Andrews, Wallingford	41.00	
624	Seeding Down Manure	Mapes F. & P. G. Co., New York	Mapes' Branch, Hartford	38.00	29.69
635	Tobacco Manure, Wrapper Brand	Mapes F. & P. G. Co., New York	Mapes' Branch, Hartford	44.00	34.15

Analyses and Valuations.

Station No.	Percentage difference between cost and valuation.	Nitrogen					Phosphoric Acid.							Potash.		
		Nitrogen as Nitrates.	Nitrogen as Ammonia.	Nitrogen Organic.	Total Nitrogen. Found.	Total Nitrogen. Guaranteed.	Soluble.	Reverted.	Insoluble.	Total. Found.	Total. Guaranteed.	Available. Found.	Available. Guaranteed.	Found. As Muriate.	Found. Total.	Guaranteed.
613	10.8	----	----	2.66	2.66	*3.0*	----	----	----	17.72	*16.0*	-----	----	15.60	15.60	*12.5*
728	19.3	----	1.16	3.60	4.76	*4.5*	4.38	3.45	1.46	9.29	*8.5*	7.83	----	0.13	12.02	*12.0*
524	19.3	0.32	----	2.45	2.77	*2.0*	2.96	5.00	4.00	11.96	*7.0*	7.96	*6.0*	4.99	4.99	*4.5*
622	20.6	----	----	1.66	1.66	*1.6*	4.85	4.25	2.00	11.10	*10.0*	9.10	----	0.96	9.64	*10.0*
650	22.1	0.96	0.20	2.16	3.32	*3.3*	5.58	3.43	1.10	10.11	*8.0*	9.01	*7.0*	0.40	7.27	*6.0*
549	22.3	----	2.26	2.60	4.86	*1.5*	3.81	2.78	0.29	6.88	*5.0*	6.59	*4.0*	0.96	10.51	*10.0*
552	22.4	0.96	----	3.29	4.25	*3.7*	4.42	4.80	2.22	11.44	*9.0*	9.22	----	0.65	8.84	*8.5*
662	22.6	0.73	----	2.93	3.66	*3.0*	3.12	7.08	1.16	11.36	*9.0*	10.20	*8.0*	5.28	5.28	*5.0*
471	22.6	0.05	----	2.78	2.83	*2.5*	----	----	----	17.55	*16.5*	-----	----	12.09	12.09	*12.5*
571	22.7	1.68	----	3.50	5.18	*5.0*	2.04	5.39	2.47	9.90	*8.0*	7.43	----	0.92	12.65	*11.0*
591	25.3	----	----	----	----	----	0.26	7.30	2.25	9.81	----	7.56	*6.0*	1.25	17.16	*15.0*
579	27.3	2.12	----	2.86	4.98	*5.0*	1.12	6.37	3.51	11.00	*10.0*	7.49	*7.0*	1.42	10.32	*10.0*
624	28.0	1.41	----	1.43	2.84	*2.8*	----	----	----	18.64	*19.0*	-----	----	10.29	10.29	*11.0*
635	28.8	3.07	1.22	1.84	6.13	*6.2*	0.10	4.40	1.60	6.10	*4.5*	4.50	----	1.10	11.92	*10.5*

SPECIAL MANURES. SAMPLED BY THE STATION.

Station No.	Name of Brand.	Manufacturer.	Dealer.	Dealer's cash price per ton.	Valuation per ton.
470	Hubbard's Soluble Potato Manure	Rogers & Hubbard Co., Middletown	S. E. Frisbie, Milford	$38.00	$28.68
			Edw. L. Bradley, Norwalk	37.00	
			H. W. Andrews, Wallingford	37.00	
456	Bowker's Early Potato Manure	Bowker Fertilizer Co., Boston	Bowker's Branch, Hartford	35.00	25.54
			Simeon Pease, Greenfield Hill	29.00	
				33.00	
469	Hubbard's Fertilizer for Oats and Top Dressing	Rogers & Hubbard Co., Middletown	Geo. A. Tucker, West Cheshire	49.00	37.64
			J. H. Miner, Waterford	49.00	
731	Swift Sure Superphosphate for Potatoes	M. L. Shoemaker & Co., Philadelphia	E. B. Clark Co., Milford	33.00	25.34
729	Havana Tobacco Fertilizer*	Quinnipiac Co., Boston	A. D Fillmore, Warehouse Point	44.00	33.70
551	Essex Complete for Corn, Grain & Grass	Russia Cement Co., Gloucester	H. T. Hale, Gildersleeve	38.00	28.98
			E. N. Pierce & Co., Plainville	38.00	
475	Economical Potato Manure	Mapes F. & P. G. Co., New York	Mapes' Branch, Hartford	33.00	25.02
			Southington Lumber Co., Southington	34.00	
570	High Grade Fertilizer for Oats and Top Dressing	Rogers Mfg. Co., Rockfall	Manufacturer	44.00	32.46
			R. H. Hall, East Hampton	42.00	
				43.00	
416	Corn King	Farmers' Union Fertz. Co., Peabody, Mass.	A. H. Bates, Windham	28.00	20.33
			J. T. Peckham, Norwich	27.00	
732	High Grade Soluble Tobacco and Potato Manure	Rogers Mfg. Co., Rockfall	Wm. Orr, Southington	38.00	28.42
			Manufacturer	38.00	
453	Bowker's Special Potato and Vegetable	Bowker Fertilizer Co., Boston, Mass.	Simeon Pease, Greenfield Hill	27.00	22.39
			E. B. Clark Co., Milford	28.00	
				30.00	

* See page 63.

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. Found.	Total Nitrogen. Guaranteed.	Soluble.	Reverted.	Insoluble.	Total. Found.	Total. Guaranteed.	Available. Found.	Available. Guaranteed.	Found. As Muriate.	Found. Total.	Guaranteed.
470	29.0	2.39	----	2.81	5.20	*5.0*	1.26	6.78	3.10	11.14	*10.0*	8.04	7.0	0.84	5.86	*5.0*
456	29.2	0.76	0.10	2.72	3.58	*3.0*	7.00	2.21	0.96	10.17	*9.0*	9.21	7.0	7.37	7.37	*7.0*
469	30.2	7.18	----	1.41	8.59	*8.8*	----	----	----	9.19	*7.8*	----	----	8.45	8.45	*8.3*
731	30.2	0.86	----	1.88	2.74	*2.4*	7.02	3.69	3.18	13.89	----	10.71	*8.0*	7.82	7.82	*6.0*
729	30.6	1.52	2.96	0.98	5.46	*5.8*	5.34	1.40	0.51	7.25	*6.0*	6.74	*5.0*	0.92	10.51	*10.0*
551	31.1	1.08	----	2.92	4.00	*3.7*	4.75	4.35	2.00	11.10	*9.5*	9.10	----	9.94	9.94	*9.5*
475	31.9	1.41	0.28	2.01	3.70	*3.3*	2.21	3.39	1.30	6.90	*6.0*	5.60	*4.0*	1.23	8.99	*8.0*
570	32.5	4.32	0.14	2.00	6.46	*6.3*	2.36	5.71	2.47	10.54	*9.0*	8.07	7.0	7.58	7.58	*7.5*
416	32.8	----	----	2.74	2.74	*2.4*	4.19	4.96	0.68	9.83	*9.0*	9.15	----	4.50	4.50	*4.0*
732	33.7	0.68	----	3.18	3.86	*3.5*	1.68	7.30	2.21	11.19	*9.0*	8.98	7.0	0.71	8.60	*8.7*
453	34.0	0.50	0.10	2.01	2.61	*2.2*	8.85	2.98	1.35	13.18	*11.0*	11.83	*9.0*	4.21	4.21	*4.0*

Special Manures. Sampled by the Station.

Station No.	Name of Brand.	Manufacturer.	Dealer.	Dealer's cash price per ton.	Valuation per ton.
572	High Grade Complete Corn	Rogers Mfg. Co., Rockfall	Manufacturer	$36.00	$26.09
			Meeker Coal Co., Norwalk	33.00	
			J. F. Blakeslee, North Haven	34.00	
639	Bowker's Tobacco Ash Fertilizer	Bowker Fertilizer Co., Boston, Mass.	Bowker's Branch, Hartford	35.00	
424	Potato Manure	Mapes F. & P. G. Co., New York	J. P. Barstow & Co., Norwich	40.00	29.76
			Birdsey & Raven, Meriden	37.00	26.46
			Mapes' Branch, Hartford	37.00	
521	Grass & Grain Spring Top Dressing	Mapes F. & P. G. Co., New York	Mapes' Branch, Hartford	36.00	
			Southington Lumber Co., Southington	38.00	27.64
602	Mapes Tobacco Ash Constituents	Mapes F. & P. G. Co., New York	Mapes' Branch, Hartford	39.00	
			F. S. Bidwell, Windsor Locks	30.00	21.67
663	Tobacco Special and Market Garden	W. E. Brightman, Genl. Agt., Tiverton, R. I.	William Crane, Broad Brook	31.00	
491	Potato and Root Crop Manure	L. B. Darling Fertilizer Co., Pawtucket, R. I.	Loomis Bros., Granby	35.00	25.12
			L. M. Bristol, Canton Center	35.00	24.98
			M. D. Stanley, New Britain	35.00	
627	High Grade Tobacco Manure	Bradley Fertilizer Co., Boston	D. T. Dyer, Collinsville	33.00	
455	Stockbridge Potato & Vegetable	Bowker Fertilizer Co., Boston	J. A. Lewis' Estate, Willimantic	45.00	31.99
			Bowker's Branch, Hartford	38.00	26.20
642	Special Potato Fertilizer	Parmenter & Polsey Fertilizer Co., Peabody, Mass.	J. E. Leonard & Son, Jewett City	37.00	
555	Essex Potato Fertilizer	Russia Cement Co., Gloucester, Mass.	W. J. Cox, East Hartford	37.00	26.07
			J. A. Lewis' Estate, Willimantic	31.00	22.49
			H. T. Hale, Gildersleeve	33.00	
516	Potato Phosphate	Lowell Fertilizer Co., Boston	H. A. Bugbee, Willimantic	32.00	
			F. E. Weed & Co., New Canaan	30.00	22.45
			S. W. Bray, Milford	33.00	
				33.00	
				32.00	

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.
572	34.2	1.32	----	2.04	3.36	*3.6*	4.62	5.00	2.76	12.38	*8.0*	9.62	*6.0*	8.18	8.18	*7.0*
639	34.4	3.18	----	0.33	3.51	*3.0*	0.16	6.60	5.35	12.11	----	6.76	*5.0*	1.06	12.75	*13.0*
424	36.1	1.58	0.36	1.77	3.71	*3.7*	3.55	4.81	1.57	9.93	*8.0*	8.36	*8.0*	1.04	7.96	*6.0*
521	37.5	1.88	0.34	2.96	5.18	*4.9*	2.00	3.52	1.20	6.72	*6.0*	5.52	*5.0*	8.37	8.37	*7.0*
602	38.4	----	----	0.73	0.73	*0.5*	----	3.06	3.23	6.29	*5.7*	3.06	----	1.56	15.90	*15.0*
663	39.3	1.94	----	1.26	3.20	*3.3*	7.06	2.04	0.70	9.80	*9.0*	9.10	*8.0*	0.73	7.82	*7.0*
491	40.1	0.30	0.17	2.93	3.40	*2.3*	6.24	3.25	0.32	9.81	*9.0*	9.49	*8.0*	7.25	7.25	*7.0*
627	40.7	1.32	2.58	1.80	5.70	*5.7*	3.02	2.03	1.73	6.78	----	5.05	*4.0*	1.96	9.34	*10.0*
455	41.2	0.85	----	2.49	3.34	*3.2*	5.95	2.22	0.70	8.87	*8.0*	8.17	*6.0*	10.31	10.31	*10.0*
642	41.9	0.58	----	2.92	3.50	*3.3*	4.11	5.76	0.61	10.48	*9.0*	9.87	----	5.23	7.68	*7.0*
555	42.3	0.53	----	1.77	2.30	*2.0*	3.39	7.60	3.86	14.85	*11.0*	10.99	----	5.76	5.76	*5.0*
516	42.5	----	----	2.65	2.65	*2.4*	6.06	1.97	1.85	9.88	*9.0*	8.03	*8.0*	0.47	6.53	*6.0*

Special Manures. Sampled by the Station.

Station No.	Name of Brand.	Manufacturer.	Dealer.	Dealer's cash price per ton.	Valuation per ton.
651	High Grade Special Potato and Tobacco	Williams & Clark Fertilizer Co., New York	W. H. Chappell, Chesterfield	35.00	24.50
649	Bermuda Onion Grower	M. E. Wheeler & Co., Rutland, Vt.	W. H. Baldwin, Cheshire	26.00	18.19
454	Stockbridge Corn Manure	Bowker Fertilizer Co., Boston	J. A. Lewis' Estate, Willimantic	38.00	25.11
			E. B. Clark Co., Milford	34.00	
418	Complete Potato Fertilizer	Farmers' Union Fertilizer Co., Peabody, Mass.		36.00	
			J. E. Leonard & Son, Jewett City	30.00	19.51
			J. T. Peckham, Norwich	28.00	
			Thos. McLyman, Preston	28.00	
			W. J. Cox, East Hartford	29.00	
665	Complete Potato Manure	East India Chemical Works	Saxton & Strong, Bristol	39.00	26.33
		H. J. Baker & Bro., Agents, N. Y.	E. H. Talcott, Torrington	37.00	
477	Complete Manure for Potatoes and Vegetables	Bradley Fertilizer Co., Boston		38.00	
			C. O. Jelliff & Co., Southport	33.00	24.15
			D. L. Clark, Milford	35.00	
			C. L. Comstock, Danbury	36.00	
489	Potato Manure	Quinnipiac Co., Boston	Olds & Whipple, Hartford	32.00	20.60
			G. M. Williams Co., New London	31.00	
			C. Buckingham, Southport	27.00	
473	Hubbard's Potato Phosphate	Rogers & Hubbard Co., Middletown		30.00	
			N. W. Dayton, New London	30.00	20.52
			J. H. Miner, Waterford	30.00	
			S. E. Frisbie, Milford	30.00	
422	Corn Manure	Mapes F. & P. G. Co., New York	Mapes' Branch, Hartford	32.00	21.83
			J. P. Barstow & Co., Norwich	34.00	
568	Complete Potato and Vegetable	Rogers Mfg. Co., Rockfall	Wm. Orr, Southington	30.00	21.80
			Meeker Coal Co., Norwalk	35.00	
			Manufacturer	32.00	

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. Found.	Total Nitrogen. Guaranteed.	Soluble.	Reverted.	Insoluble.	Total. Found.	Total. Guaranteed.	Available. Found.	Available. Guaranteed.	Found. As Muriate.	Found. Total.	Guaranteed.
651	42.9	1.33	----	2.07	3.40	*3.3*	6.06	3.28	1.02	10.36	*9.0*	9.34	*9.0*	7.07	7.07	*7.0*
649	42.9	trace	----	1.12	1.12	*0.6*	6.42	2.97	0.41	9.80	----	9.39	*9.0*	7.53	7.53	*7.0*
454	43.4	0.82	----	2.57	3.39	*3.0*	6.48	2.95	1.02	10.45	*10.0*	9.43	----	7.45	7.45	*6.0*
418	43.5	----	----	2.08	2.08	*1.6*	4.70	3.48	0.88	9.06	*7.0*	8.18	----	6.70	6.70	*6.0*
665	44.3	0.93	1.21	1.46	3.60	*3.3*	4.99	1.48	0.94	7.41	*7.0*	6.47	*6.0*	6.53	10.11	*10.0*
477	44.9	1.12	0.34	1.88	3.34	*3.3*	7.06	1.69	0.79	9.54	*9.0*	8.75	*8.0*	7.20	7.20	*7.0*
489	45.6	0.44	0.16	2.20	2.80	*2.4*	4.78	2.88	1.65	9.31	*7.0*	7.66	*6.0*	5.63	5.63	*5.0*
473	46.2	0.82	----	1.43	2.25	*2.0*	5.41	4.85	1.25	11.51	*10.0*	10.26	*9.0*	5.45	5.45	*5.0*
422	46.6	0.75	0.25	1.65	2.65	*2.4*	2.99	5.73	1.89	10.61	*10.0*	8.72	*8.0*	6.82	6.82	*6.0*
568	46.8	0.56	----	1.54	2.10	*2.0*	6.40	4.69	3.15	14.24	*10.0*	11.09	*8.0*	5.59	5.59	*5.0*

SPECIAL MANURES. SAMPLED BY THE STATION.

Station No.	Name of Brand.	Manufacturer.	Dealer.	Dealer's cash price per ton.	Valuation per ton.
668	Potato Manure	Listers Agricultural Chem. Works, Newark, N. J.	A. N. Clark, Milford	$38.00	$25.75
559	Potato Phosphate	Williams & Clark Fertilizer Co., N. Y.	W. H. Chappell, Chesterfield	28.00	20.31
			F. C. Benjamin & Co., Danbury	30.00	
			D. B. Wilson, Waterbury	30.00	
			Geo. Beaumont, Wallingford	32.00	
703	Potato Manure	L. Sanderson, New Haven	R. H. Hall, East Hampton	28.00	20.27
			N. W. Dayton, New London	30.00	
			Manufacturer	30.00	
626	Tobacco Fertilizer	Bradley Fertilizer Co., Boston	D. T. Dyer, Collinsville	37.00	24.29
			S. J. Stevens, Glastonbury	35.00	
669	Special Tobacco Phosphate	S. M. Hess & Bro., Philadelphia		36.00	
562	Bowker's Tobacco Starter	Bowker Fertilizer Co., Boston	D. W. Barnes, Windsor	38.00	25.56
			W. A. Strickland, Addison	35.00	22.15
682	Essex Tobacco Starter	Russia Cement Co., Gloucester, Mass.	Bowker's Branch, Hartford	33.00	
419	"P. & P." Potato Fertilizer	Parmenter & Polsey Fertz. Co., Peabody, Mass.	W. J. Cox, East Hartford	33.00	22.04
			J. E. Leonard & Son, Jewett City	30.00	19.31
			W. J. Cox, East Hartford	29.00	
557	Potato and Truck Manure	S. M. Hess & Bro., Philadelphia	W. D. Penfield, Cobalt	33.00	21.29
			E. J. & B. S. Brown, Campville	31.00	
697	Chittenden's Potato Phosphate	National Fertilizer Co., Bridgeport	G. A. Williams, East Hartford	32.00	
			Hallock & Co., Derby	30.00	21.46
				35.00	
648	Vegetable and Vine	Read Fertilizer Co., New York	Adams & Canfield, Winnipauk	32.50	
674	Quinnipiac Potato Phosphate	Quinnipiac Co., Boston	Meeker Coal Co., Norwalk	32.00	21.13
659	Potato Phosphate	Clark's Cove Fertilizer Co., New York	Phineas Platt, Milford	30.00	19.79
				33.00	21.55

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. Found.	Total Nitrogen. Guaranteed.	Soluble.	Reverted.	Insoluble.	Total. Found.	Total. Guaranteed.	Available. Found.	Available. Guaranteed.	Found. As Muriate.	Found. Total.	Guaranteed.
668	47.6	0.49	1.43	1.92	3.84	*3.7*	5.63	2.14	2.04	9.81	*8.5*	7.77	*7.5*	7.08	7.08	*7.0*
559	47.7	0.44	----	2.45	2.89	*2.4*	4.70	2.36	2.10	9.16	*7.0*	7.06	*6.0*	5.36	5.36	*5.0*
703	48.0	----	0.34	2.46	2.80	*1.6*	2.54	5.03	1.81	9.38	*9.0*	7.57	*5.0*	5.23	5.23	*6.0*
626	48.2	----	----	3.79	3.79	*3.3*	6.22	2.97	0.97	10.16	*8.0*	9.19	*6.0*	0.62	4.26	*4.0*
669	48.7	0.73	----	2.53	3.26	*3.2*	6.22	2.74	0.50	9.46	----	8.96	*8.0*	0.64	7.86	*7.0*
562	49.0	0.38	----	2.24	2.62	*2.2*	8.43	2.70	0.91	12.04	*10.0*	11.13	*8.0*	0.80	4.19	*3.0*
682	49.8	1.44	----	1.42	2.86	*2.5*	3.82	6.89	3.08	13.79	*12.0*	10.71	----	0.36	3.62	*2.5*
419	50.2	----	----	2.16	2.16	*1.6*	4.34	3.54	1.13	9.01	*7.0*	7.88	----	6.37	6.37	*6.0*
557	50.3	----	----	2.14	2.14	*2.5*	6.05	4.50	2.47	13.02	----	10.55	*8.0*	5.44	5.44	*6.0*
697	51.4	0.55	----	1.71	2.26	*2.1*	5.49	4.35	1.35	11.19	*10.0*	9.84	*8.0*	6.72	6.72	*6.0*
648	51.4	----	----	2.33	2.33	*2.1*	5.41	3.69	0.84	9.94	*9.0*	9.10	*8.0*	6.76	6.76	*6.0*
674	51.6	0.31	----	2.35	2.66	*2.4*	5.89	4.46	1.50	11.85	*10.0*	10.35	*9.0*	1.96	2.48	*2.0*
659	53.1	0.61	----	2.43	3.04	*2.4*	4.32	3.47	1.29	9.08	*7.0*	7.79	*6.0*	5.71	6.04	*5.0*

SPECIAL MANURES. SAMPLED BY THE STATION.

Station No.	Name of Brand.	Manufacturer.	Dealer.	Dealer's cash price per ton.	Valuation per ton.
603	Tobacco Starter Improved	Mapes F. & P. G. Co., New York	Mapes' Branch, Hartford	$33.00	$21.53
			F. S. Bidwell, Windsor Locks	34.00	
492	Potato, Hop & Tobacco Phosphate	Crocker Fertilizer and Chem. Co., Buffalo, N. Y.	O. H. Meeker, Danbury	28.00	19.20
			T. S. Bidwell, Canton Center	31.00	
566	Essex Tobacco Starter	Russia Cement Co., Gloucester, Mass.		29.50	
			H. T. Hale, Gildersleeve	33.00	20.72
			J. B. Parker, Poquonock	31.00	
733	Ammoniated Wheat & Corn Phosphate*	Crocker Fertilizer and Chem. Co., Buffalo, N. Y.	F. P. Williams, South Coventry	32.00	
666	Vegetable, Vine and Potato Manure	East India Chemical Works, H. J. Baker & Bro., Agts., N. Y.	Lockwood & Palmer, Stamford	29.00	18.73
623	Grain Grower	Armour Fertilizer Works, Chicago	E. A. Buck & Co., Willimantic	35.00	22.56
667	Potato Manure	Packers' Union Fertilizer Co., N. Y.		25.00	16.11
580	Hubbard's Corn Phosphate	Rogers & Hubbard Co., Middletown	G. W. Eaton, Bristol	33.00	21.21
			Nelson W. Dayton, New London	24.00	15.98
			Geo. A. Tucker, West Cheshire	25.00	
478	Potato Manure	Bradley Fertilizer Co., Boston	J. H. Miner, Waterford	25.00	
			C. L. Comstock, Danbury	32.00	20.42
			E. E. Scofield, Stamford	32.00	
564	Potato Manure	M. E. Wheeler & Co., Rutland, Vt.	D. L. Clark, Milford	29.00	
			W. H. Baldwin, Cheshire	29.00	18.47
			J. F. Blakeslee, North Haven	30.00	
553	Essex Corn Fertilizer	Russia Cement Co., Gloucester, Mass.	J. A. Lewis' Estate, Willimantic	33.00	19.87
			Henry Davis, Durham	30.00	
498	Corn Phosphate	Bradley Fertilizer Co., Boston		31.50	
			W. H. Scott, Pequabuck	28.00	18.89
			G. W. Eaton, Bristol	33.00	
			D. L. Clark, Milford	29.00	
608	Vegetable, Vine and Tobacco	Great Eastern Fertilizer Co., Rutland, Vt.		30.00	
			T. E. Green, Plainfield	32.00	19.98
			Silas Finch, Greenwich	----	
			Elmer Keeler, Danbury	32.00	

* See page 64.

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.
603	53.3	1.45	0.62	2.41	4.48	*4.1*	1.78	4.10	3.05	8.93	*8.0*	5.88	*6.0*	0.56	**2.01**	*1.0*
492	53.6	0.56	----	1.76	2.32	*2.0*	6.05	3.40	1.87	11.32	*10.0*	9.45	*8.0*	3.89	3.89	*3.0*
566	54.4	1.08	----	1.23	2.31	*2.5*	4.46	**6.40**	4.07	14.93	*12.0*	10.86	----	0.24	3.27	*2.5*
733	54.8	----	----	**2.28**	2.28	*2.0*	6.66	4.49	1.26	12.41	*10.0*	11.15	----	1.86	1.86	*1.5*
666	55.1	1.65	0.22	0.79	2.66	*2.4*	4.62	2.33	0.41	7.36	*6.5*	6.95	*6.0*	10.26	10.26	*10.0*
623	55.2	----	----	1.80	1.80	*1.6*	2.18	7.20	2.02	11.40	*10.0*	9.38	*9.0*	0.26	2.04	*2.0*
667	55.6	0.73	----	1.65	2.38	*2.0*	4.93	4.85	1.93	11.71	----	9.78	*8.0*	5.92	5.92	*6.0*
580	56.4	0.35	----	0.85	1.20	*1.0*	5.47	4.41	1.70	11.58	*10.0*	9.88	*8.0*	3.83	3.83	*3.5*
478	56.7	0.65	----	2.17	2.82	*2.4*	4.82	2.80	1.54	9.16	*7.0*	7.62	*6.0*	5.56	5.56	*5.0*
564	57.0	0.32	----	2.19	2.51	*2.0*	6.08	3.01	0.47	9.56	----	9.09	*8.0*	3.24	3.24	*3.2*
553	58.5	0.38	----	1.96	2.34	*2.0*	3.73	5.41	4.64	13.78	*11.0*	9.14	----	3.77	3.77	*3.0*
498	58.8	----	----	2.48	2.48	*2.0*	6.91	3.25	1.62	11.78	*10.0*	10.16	*8.0*	2.04	**2.04**	*1.5*
608	60.2	0.61	----	1.67	2.28	*2.0*	5.63	2.95	1.37	9.95	----	8.58	*8.0*	6.08	6.08	*6.0*

SPECIAL MANURES. SAMPLED BY THE STATION.

Station No.	Name of Brand.	Manufacturer.	Dealer.	Dealer's cash price per ton.	Valuation per ton.
499	Potato Fertilizer	Bradley Fertilizer Co., Boston	D. L. Clark, Milford	$28.00	$17.98
			Wilson & Burr, Middletown	30.00	
				29.00	
560	Americus Potato Manure	Williams & Clark Fertilizer Co., N. Y.	Lewis Ford, Fair Ground, Norwich	30.00	17.81
			F. C. Benjamin & Co., Danbury	28.00	
				29.00	
673	Corn Manure	Quinnipiac Co., Boston	C. A. Young, Danielson	27.00	16.58
637	Havana Tobacco Grower	M. E. Wheeler & Co., Rutland, Vt.	E. E. Pitney, Ellington	35.00	21.40
706	Special Potato Fertilizer	Listers Agricultural Chemical Works, Newark, N. J.	Southington Lumber Co., Southington	28.00	17.59
			A. I. Martin, Wallingford	30.00	
				29.00	
458	Potato Phosphate	Berkshire Fertilizer Co., Bridgeport	Johnson Bros., Jewett City	30.00	18.14
			Manufacturer	30.00	
610	Potato Fertilizer	Clark's Cove Fertilizer Co., N. Y.	E. Bishop, New London	28.00	18.08
			J. M. Burk, So. Manchester	32.00	
				30.00	
675	Animal Corn Fertilizer	Packers' Union Fertilizer Co., New York	Rockville Milling Co., Rockville	31.00	18.58
692	Potato Phosphate	Cleveland Dryer Co., Boston	Latham Avery, Groton	28.00	16.72
518	Bone Fertilizer for Corn and Grain	Lowell Fertilizer Co., Boston	H. A. Bugbee, Willimantic	28.00	16.69
			S. W. Bray, Milford	28.00	
			F. E. Weed & Co., New Canaan	28.00	
685	Special Potato Fertilizer	Henry F. Tucker Co., Boston	L. A. Fenton, Norwich Town	30.00	17.64
634	Fruit and Vine Manure	Mapes' F. & P. G. Co., New York	J. P. Barstow, Norwich	40.00	23.50
607	Northern Corn Special	Great Eastern Fertilizer Co., Rutland, Vt.	Silas Finch, Greenwich	----	18.66
			Elmer Keeler, Danbury	32.00	
605	Potato Manure	Lowell Fertilizer Co., Boston	H. A. Bugbee, Willimantic	28.00	16.81
			Wm. T. Parks, Manchester	30.00	
				29.00	

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. Found.	Total Nitrogen. Guaranteed.	Soluble.	Reverted.	Insoluble.	Total. Found.	Total. Guaranteed.	Available. Found.	Available. Guaranteed.	Found. As Muriate.	Found. Total.	Guaranteed.
499	61.3	0.60	----	1.63	2.23	*2.1*	6.30	2.66	1.57	10.53	*9.0*	8.96	*8.0*	3.39	3.39	*3.0*
560	62.8	0.76	----	1.44	2.20	*2.0*	6.57	2.54	1.30	10.41	*9.0*	9.11	*8.0*	3.34	3.34	*3.0*
673	62.8	0.31	----	1.95	2.26	*2.0*	6.72	2.23	1.08	10.03	*10.0*	8.95	*8.0*	1.68	1.68	*1.5*
637	63.5	1.65	----	0.95	2.60	*2.4*	3.47	3.38	1.77	8.62	----	6.85	*6.0*	8.78	8.78	*10.0*
706	64.9	----	0.20	1.66	1.86	*1.6*	5.68	4.10	2.31	12.09	*9.0*	9.78	*8.0*	2.88	2.88	*3.0*
458	65.4	0.09	----	2.03	2.12	*1.6*	3.71	2.97	3.36	10.04	*8.0*	6.68	*6.0*	2.79	4.97	*4.0*
610	65.9	0.64	----	1.46	2.10	*2.0*	6.56	2.88	1.80	11.24	*9.0*	9.44	*8.0*	3.41	3.41	*3.0*
675	66.8	1.16	----	1.55	2.71	*2.4*	6.87	2.63	1.00	10.50	----	9.50	*9.0*	2.31	2.31	*2.0*
692	67.5	0.29	----	1.85	2.14	*2.0*	5.36	2.57	1.43	9.36	----	7.93	*8.0*	3.24	3.24	*3.0*
518	67.8	----	----	1.76	1.76	*1.6*	4.21	4.64	1.70	10.55	*9.0*	8.85	*8.0*	1.30	3.24	*3.0*
685	70.1	0.83	----	1.28	2.11	*2.0*	6.62	2.73	1.05	10.40	*10.0*	9.35	*8.0*	3.38	3.38	*3.0*
634	70.2	0.75	----	1.47	2.22	*1.6*	2.30	3.66	1.82	7.78	*7.0*	5.96	*5.0*	1.56	11.41	*10.0*
607	71.5	----	----	2.78	2.78	*2.4*	5.85	3.03	0.72	9.60	----	8.88	*8.0*	2.42	2.42	*2.0*
605	72.5	----	----	1.80	1.80	*1.6*	4.80	1.86	2.51	9.17	*8.0*	6.66	*7.0*	0.20	4.45	*4.0*

SPECIAL MANURES. SAMPLED BY THE STATION.

Station No.	Name of Brand.	Manufacturer.	Dealer.	Dealer's cash price per ton.	Valuation per ton.
558	Americus Corn Phosphate	Williams & Clark Fertilizer Co., N. Y.	W. H. Chappell, Chesterfield	28.00	16.74
			Lewis Ford, Fair Ground, Norwich	30.00	
				29.00	
581	Potato Special	Pacific Guano Co., Boston	Jas. A. Nichols, Danielson	32.00	17.19
			Carlos Bradley, Ellington	28.00	
				30.00	
688	Potato Fertilizer	Cumberland Bone-Phosphate Co., Boston	Kahn Bros., Yantic	**32.00**	18.28
			W. B. Ingraham, Vernon Center	32.00	
565	Corn Fertilizer	M. E. Wheeler & Co., Rutland, Vt.	W. O. Goodsell, Bristol	**29.00**	16.56
			G. F. Wagner, Deep River	30.00	
672	Special for Potatoes	Standard Fertilizer Co., Boston	J. W. Howe & Son, So. Glastonbury	**32.00**	18.18
619	Bowker's Potato Phosphate	Bowker Fertilizer Co., Boston	The Lightbourn & Pond Co., New Haven	33.00	16.93
				30.00	
514	Practical Potato Special	Read Fertilizer Co., New York	T. A. Tillinghast, Brooklyn	**28.00**	15.47
			Lewis Ford, Fair Ground, Norwich	30.00	
			J. R. Babcock, Old Mystic	28.00	
497	Bowker's Corn Phosphate	Bowker Fertilizer Co., Boston	E. Bishop, New London	**28.00**	15.37
			S. E. Dowd, Clinton	28.00	
722	Wheat, Oats and Clover	Packers' Union Fertilizer Co., New York	Rockville Milling Co., Rockville	**21.00**	11.18
606	Grass and Oat Phosphate	Great Eastern Fertilizer Co., Rutland, Vt.	Silas Finch, Greenwich	**24.00**	12.55
			Elmer Keeler, Danbury	25.00	
601	Grass and Grain Fertilizer	Pacific Guano Co., Boston	James A. Nichols, Danielson	25.00	12.06
			Carlos Bradley, Ellington	24.00	
				24.50	
723	Grass and Oats Fertilizer	M. E. Wheeler & Co., Rutland, Vt.	G. F. Wagner, Deep River	**24.00**	11.19
653	Essex Odorless Lawn Dressing	Russia Cement Co., Gloucester, Mass.	W. J. Cox, East Hartford	----	29.40

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. Found.	Total Nitrogen. Guaranteed.	Soluble.	Reverted.	Insoluble.	Total. Found.	Total. Guaranteed.	Available. Found.	Available. Guaranteed.	Found. As Muriate.	Found. Total.	Guaranteed.
558	73.2	0.17	----	1.95	2.12	*2.0*	6.59	2.57	1.83	10.99	*10.0*	9.16	*8.0*	1.78	1.78	*1.5*
581	74.5	0.58	----	1.42	2.00	*2.0*	6.48	2.36	1.71	10.55	*9.0*	8.84	*8.0*	3.32	3.32	*2.0*
688	75.1	0.46	----	1.79	2.25	*2.0*	6.80	2.65	1.27	10.72	*10.0*	9.45	*8.0*	3.22	3.22	*3.0*
565	75.1	----	----	1.92	1.92	*1.6*	5.78	3.12	2.03	10.93	*8.0*	8.90	*6.0*	2.47	2.47	*2.0*
672	76.0	0.31	----	1.81	2.12	*2.0*	6.77	2.79	1.71	11.27	*9.0*	9.56	*6.0*	3.21	3.21	*3.0*
619	77.2	0.26	----	1.54	1.80	*1.5*	7.41	2.42	1.72	11.55	*10.0*	9.83	*8.0*	2.54	2.54	*2.0*
514	81.0	----	----	1.14	1.14	*0.8*	3.10	2.10	1.13	6.33	*5.0*	5.20	*4.0*	8.26	8.26	*8.0*
497	82.2	0.50	----	1.23	1.73	*1.5*	5.65	3.37	1.42	10.44	*10.0*	9.02	*8.0*	2.18	2.18	*2.0*
722	87.8	----	----	----	----	----	7.01	3.21	1.46	11.68	----	10.22	*11.0*	2.02	2.02	*2.0*
606	91.2	----	----	----	----	----	5.12	6.86	0.96	12.94	----	11.98	*11.0*	2.44	2.44	*2.0*
601	103.1	----	----	1.10	1.10	*0.8*	4.37	3.14	2.24	9.75	*8.0*	7.51	*7.0*	1.54	1.54	*1.0*
723	114.5	----	----	----	----	----	7.54	2.84	1.01	11.39	----	10.38	*11.0*	2.04	2.04	*2.0*
653	----	----	3.82	0.20	4.02	*3.7*	1.79	5.79	3.41	10.99	*8.0*	7.58	----	0.38	8.25	*7.0*

HOME MIXTURES.

In the table below are given analyses of seventeen samples of Home Mixed Fertilizers which were for the most part sent to the Station by those who had made them. With the analyses are given the formulas by which the mixtures are stated to have been compounded.

The average cost of these mixtures is $25.20 per ton and the valuation $23.82. 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 the average cost of the goods, mixed, has been $28.20 and the percentage difference between cost and valuation 18.4, much lower than in the case of factory mixed goods.

Home Mixtures. Formulas,

Station No.	Made by	Formulas. Pounds per ton									
		Nitrate of Soda.	Sulphate of Ammonia.	Dried Blood.	Cotton Seed Meal.	Castor Pomace.	Tankage.	Blood, Bone and Meat.	Ground Bone.	Dry Ground Fish.	Acid Phosphate.
585	Andrew Ure, Highwood	100	---	---	---	---	800	---	---	---	800
439	A. C. Lake, Bethlehem	100	---	---	---	---	1000	---	---	---	500
647	Charles C. Zabriskie, Preston	100	100	300	---	---	---	---	---	---	1100
533	Wm. O. Burr, Fairfield	100	---	---	---	---	900	---	---	---	650
411	John E. Griffiths, Moosup Valley, R.I.	60	---	150	---	---	---	---	---	---	1590
587	Conn. School for Boys, Meriden	500	---	---	---	---	500	---	---	---	400
1811	S. D. Woodruff & Sons, Orange	---	---	---	---	---	---	---	---	---	---
724	S. S. Mills, Stratford	200	---	---	---	---	800	---	700	---	---
1810	S. D. Woodruff & Sons, Orange	---	---	---	---	---	---	---	---	---	---
461	Willard E. Treat, Silver Lane	---	---	---	---	1334	---	---	200	---	---
412	John E. Griffiths, Moosup Valley, R.I.	141	---	275	---	---	---	---	---	---	1292
446	N. D. Platt, Milford	167	---	---	---	---	---	667	167	---	---
136	E. P. Brewer, Silver Lane	---	---	---	467	667	---	---	---	200	---
586	Conn. School for Boys, Meriden	100	---	---	---	---	750	---	---	---	750
375	F. T. Bradley, Saybrook	250	---	---	---	---	1100	---	---	---	250
165	S. D. Woodruff & Sons, Orange	100	---	---	---	---	800	---	---	---	800
584	William Crane, Broad Brook	100	---	---	---	---	---	---	---	400	600‖

* Valuation exceeds cost. † 0.97 per cent. of nitrogen as ammonia.
‡ 0.70 per cent. of nitrogen as ammonia.

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.

A sample marked "Davis Mixture," **1808**, sent by Richard Davis, Middletown, stated to be made by The Rogers Manufacturing Co., had the following composition:

Organic nitrogen	3.41
Soluble phosphoric acid	4.26
Reverted phosphoric acid	4.34
Insoluble phosphoric acid	2.34
Potash, as muriate	10.94
Cost per ton	$27.00
Valuation per ton	$27.45

Analyses and Valuations.

Station No.	Of Mixture.						Analyses.								Cost (Unmixed) and Valuation.		Percentage Difference between Cost and Valuation.
	Dissolved Bone Black.	Ground Tobacco Stems.	Cotton Hull Ashes.	H.G. Sulphate of Potash.	Muriate of Potash.	Kainit.	Nitrogen as Nitrates.	Organic Nitrogen.	Total Nitrogen.	Soluble Phosphoric Acid.	Reverted Phosphoric Acid.	Insoluble Phosphoric Acid.	Total Phosphoric Acid.	Potash.	Cost per ton.	Valuation per ton.	
585	---	---	---	---	300	---	2.10	2.56	4.66	2.43	3.43	3.31	9.17	7.62	$24.00	$26.34	8.8*
439	---	---	---	230	170	---	0.62	3.78	4.40	2.88	5.01	2.65	10.54	9.92	27.64	29.95	7.7*
647	---	---	---	200	200	---	0.55	1.95	3.47†	5.38	2.88	1.30	9.56	9.04	25.48	26.54	4.0*
533	---	---	---	---	350	---	0.64	3.14	3.78	2.66	3.28	1.86	7.80	11.20	26.43	26.73	1.1*
411	---	---	---	---	200	---	0.44	1.41	1.85	6.27	4.59	0.74	11.60	5.63	20.06	19.96	0.5
587	---	---	---	---	250	350	3.92	1.44	5.36	2.21	1.77	0.80	4.78	11.49	29.70	28.93	2.7
1811	---	---	---	---	---	---	0.75	1.94	3.39‡	5.52	2.00	0.33	7.85	8.17	26.00	24.34	6.8
724	---	---	---	---	300	---	1.34	2.98	4.32	0.24	8.72	4.97	13.93	7.69	30.63	28.59	7.1
1810	---	---	---	---	---	---	0.87	2.29	4.16§	3.87	2.99	0.66	7.52	5.16	26.00	23.57	10.3
461	---	---	466	---	---	---	---	4.42	4.42	0.56	4.10	0.92	5.58	6.18	27.00	24.03	12.4
412	---	---	---	191	101	---	1.10	2.15	3.25	5.82	3.22	0.53	9.57	4.90	24.82	22.02	12.7
446	666	---	---	---	333	---	0.91	2.29	3.20	5.09	7.18	0.89	13.16	5.76	28.50	25.14	13.4
136	---	333	333	---	---	---	---	4.74	4.74	0.38	2.71	0.39	3.48	6.92	28.03	24.28	15.4
586	---	---	---	200	200	---	0.70	2.11	2.81	3.70	2.96	1.48	8.14	7.97	25.00	21.62	15.6
375	---	---	---	---	400	---	1.77	3.49	5.26	0.58	3.28	4.66	8.52	10.06	34.00	29.15	16.6
165	---	---	---	---	300	---	0.67	3.33	4.00	3.58	3.93	3.16	10.67	7.85	------	26.42	-----
584	---	---	---	---	400	---	1.25	1.69	2.94	4.13	2.09	1.03	7.25	10.46	------	23.31	-----

§ 1.00 per cent. of nitrogen as ammonia.
‖ And 500 pounds of Brightman's Tobacco Special.

MISCELLANEOUS FERTILIZERS AND MANURES.

Cotton Hull Ashes.

In the table, pages 88 and 89, are given analyses of forty-one 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 have proved to be an invaluable fertilizer.

The analyses show the usual wide range of composition.

The highest percentage of water-soluble potash is 28.12 and the lowest 11.45. Excluding the latter—found in goods which were sold at a low price because of their inferior quality,—the lowest percentage was 13.29 and the average of forty samples was 19.89 per cent., nearly three per cent. lower 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 10.9 to 5.1 cents per pound and has averaged 7.5 cents, eight-tenths of a cent more per pound than last year.

In ten of the samples received, the total potash as well as the water-soluble potash was determined with the following results:

Percentage of Water-Soluble and of Total Potash in Samples of Cotton Hull Ashes.

Station No.	Water-Soluble Potash.	Total Potash.	Potash Insoluble in Water.
76	23.31	26.60	2.29
501	19.70	24.00	4.30
589	22.84	26.09	3.15
111	15.34	18.66	3.32
444	15.70	19.90	4.20
263	17.10	18.46	1.36
503	20.00	24.14	4.14
110	11.45	16.36	4.91
502	16.66	21.10	4 44
483	14.60	19.20	4.60

These figures show that from two to five per cent. of the potash contained in cotton hull ashes are not dissolved by a half hour's boiling with water. It cannot be assumed that potash which is so insoluble can be of any immediate benefit to the crop and, therefore, it is not taken into account in calculating

the cost of potash in the ashes. The amount of potash which becomes insoluble in water during the burning of the hulls depends on the temperature, the length of time that the ashes are exposed to a high heat and on the amount of sand or dirt present. "Ashes" may have their potash all converted into an insoluble glass by sufficient roasting with sand.

Wood Ashes.

In the table, on page 90, are given analyses of nineteen samples of wood ashes. Two of them represent ashes from brass mills, the others Canada unleached ashes. The percentages of potash soluble in water in the samples, ranged from 2.38 to 6.09, the average being 4.32 per cent. The percentage of total potash, as a rule, was about 0.60 per cent. higher than that of the water-soluble potash, the latter being, however, the only kind which has immediate agricultural value.

These wood ashes, as the analyses show, also contained on the average over 34 per cent. of lime, chiefly in the form of finely divided carbonate, and their value consists largely in this lime.

The cost, in car lots, ranged from $7.00 to $10.00 per ton, the average being $8.75.

The average ton of ashes, of the quality shown in these analyses, contains 86 pounds of potash, 28 pounds of phosphoric acid and 680 pounds of lime and costs $8.75. If the potash (as carbonate) is valued for what it costs in cotton hull ashes, 7½ cents per pound, and the phosphoric acid at 4 cents, and the amount is deducted from the cost, there remains $1.18 as the cost of 680 pounds of lime. At this price lime costs only 17 cents per hundred pounds. If potash is valued at only 4¼ cents, as in muriate, the lime in the ashes costs 59 cents per hundred pounds.

Lime.

Four samples of lime, for use on tobacco lands, were analyzed with the results given in the table on page 90. The percentages of magnesia in these samples were as follows:

108	0.51 per cent.
109	1.28 "
170	0.94 "
232	40.27 "

Cotton Hull Ashes.

Station No.	Dealer or Purchaser.	Supplied by
141	Arthur Sikes, Mapleton	Geo. A. Douglass, Thompsonville
134	" " "	Wm. H. Prout, Suffield
76	American Cotton Oil Co., N. York	C. D. Cannon, Windsor Locks
231	Arthur Sikes, Suffield	J. F. Brockett, Suffield
74	C. D. Cannon, Windsor Locks	H. S. Hatheway, Windsor Locks
142	Arthur Sikes, Suffield	E. S. Seymour, Windsor Locks
140	W. W. Cooper, Suffield	Oscar J. Hazard, Suffield
46	Olds & Whipple, Hartford	Wm. S. Pinney, Suffield
501	Arthur Sikes, Mapleton	Ralph Moody, Thompsonville
70	Olds & Whipple, Hartford	W. S. Pinney, Suffield
432	Elbert & Gardner, New York	J. C. Eddy, Simsbury
252	Arthur Sikes, Suffield	Chas. T. Remington, Thompsonville
71	Olds & Whipple, Hartford	T. P. Kinney, Windsor
589	J. E. Soper, Boston	H. K. Brainard, Thompsonville
251	J. C. Eddy, Simsbury	D. L. Brockett, Suffield
49	Arthur Sikes, Mapleton	Arthur Sikes
50	" " "	" "
230	" " Suffield	J. F. Brockett, Suffield
139	Olds & Whipple, Hartford	Clark Bros., Poquonock
242	" " "	R. A. Parker, Warehouse Point
265	R. A. Parker, Warehouse Point	E. F. Thompson, " "
111	Olds & Whipple, Hartford	Olds & Whipple
590	" " "	" "
133	W. F. Fletcher, Southwick, Mass.	Alfred H. Griffin, Granby
138	Loomis Bros., Granby	D. A. Merriam, Granby
444	Olds & Whipple, Hartford	R. W. Cowles, Tariffville
128	Arthur Sikes, Suffield	D. L. Brockett, Suffield
263	Edmund Halladay, Suffield	Edmund Halladay
503	S. D. Viets, Springfield, Mass.	Geo. S. Parsons, Enfield
47	Arthur Sikes, Mapleton	Arthur Sikes
397	Olds & Whipple, Hartford	John A. DuBon, Poquonock
393	Arthur Sikes, Mapleton	Wm. C. Vietts, Thompsonville
253	D. L. Brockett, Suffield	Chas. T. Remington, Thompsonville
110	Olds & Whipple, Hartford	Olds & Whipple
434	S. D. Viets, Springfield, Mass.	Frank H. Abbe, Enfield
233	Arthur Sikes, Suffield	T. C. Austin, Jr., Suffield
502	S. D. Viets, Springfield, Mass.	Geo. S. Parsons, Enfield
483	Arthur Sikes, Suffield	Ernest N. Austin, Suffield
410	" " Mapleton	Geo. N. Thompson, "
127	" " "	Howard W. Prout, "
235	" " "	E. B. Loomis, "

Analyses.

Station No.	Soluble Phosphoric Acid.	Reverted Phosphoric Acid.	Insoluble Phosphoric Acid.	Total Phosphoric Acid.	Potash Soluble in Water.	Cost per ton.	Valuation per ton.	Potash costs cents per pound.
141	2.00	8.75	0.61	11.36	24.48	$34.00	$33.52	5.1
134	1.79	8.56	0.75	11.10	21.94	34.00	30.70	5.8
76	0.56	7.51	0.85	8.92	23.31	34.00	30.16	5.8
231	1.46	8.13	1.05	10.64	21.76	34.00	29.99	5.9
74	0.58	7.51	0.98	9.07	22.94	34.00	29.86	5.9
142	1.18	6.12	0.62	7.92	22.02	34.00	28.23	6.3
140	0.66	6.75	0.96	8.37	24.76	38.00	31.13	6.4
46	2.18	7.33	1.89	11.40	21.07	36.00	29.65	6.5
501	0.90	8.94	0.64	10.48	19.70	34.00	27.92	6.5
70	0.45	5.73	0.18	6.36	28.12	43.00	33.18	6.7
432	0.32	6.92	0.82	8.06	22.06	36.00	28.22	6.8
252	0.43	5.92	1.44	7.79	20.80	34.00	26.51	6.8
71	0.83	9.87	0.51	11.21	25.05	43.00	33.90	6.8
589	0.38	7.59	0.45	8.42	22.84	38.00	29.43	6.9
251	0.74	8.66	1.17	10.57	22.88	40.00	30.95	7.0
49	0.51	4.75	1.07	6.33	20.56	34.00	25.25	7.1
50	0.74	8.03	0.97	9.74	18.70	34.00	26.17	7.1
230	0.53	6.92	1.43	8.88	18.94	34.00	25.53	7.2
139	0.74	9.61	0.32	10.67	23.82	43.00	32.31	7.2
242	0.74	7.03	1.85	9.62	24.98	43.00	32.01	7.2
265	1.34	6.89	2.07	10.30	24.26	43.00	31.81	7.3
111	0.32	8.16	1.69	10.17	15.34	30.00	22.84	7.3
590	1.10	7.33	0.96	9.39	15.50	30.00	22.73	7.3
133	0.32	7.00	0.80	8.12	19.69	36.00	25.90	7.5
138	0.29	8.28	1.28	9.85	19.09	36.00	26.48	7.5
444	0.86	5.72	2.64	9.22	15.70	30.00	22.11	7.5
128	0.38	7.09	1.38	8.85	17.99	34.00	24.55	7.6
263	0.56	4.96	1.00	6.52	17.10	31.00	21.97	7.6
503	1.10	7.84	0.64	9.58	20.00	38.00	27.52	7.6
47	0.27	6.21	1.21	7.69	18.31	34.00	24.00	7.7
397	0.53	5.14	1.28	6.95	17.15	32.00	22.25	7.8
393	1.25	6.39	1.14	8.78	17.21	34.00	23.91	7.9
253	0.74	7.83	1.38	9.95	20.32	40.00	27.80	8.0
110	0.32	8.35	2.18	10.85	11.45	27.00	19.29	8.4
434	0.61	6.32	1.17	8.10	18.64	38.00	24.72	8.6
233	0.26	5.69	1.18	7.13	16.14	34.00	21.39	8.9
502	1.71	5.57	0.88	8.16	16.66	38.00	23.01	9.5
483	0.77	4.63	0.96	6.36	14.60	34.00	19.37	10.0
410	0.54	5.22	1.14	6.90	14.36	34.00	19.49	10.0
127	0.70	4.58	1.70	6.98	13.67	34.00	18.64	10.6
235	0.34	5.04	1.53	6.91	13.29	34.00	28.24	10.9

Wood Ashes, Lime and Lime-Kiln Ashes.

Station No.	Dealer or Purchaser.	Sampled or sent by
	Wood Ashes.	
264	Bowker Fertilizer Co., Boston	A. T. Weldon, Simsbury
378	" " " Hartford	Ernest N. Austin, Suffield
535	" " " "	J. J. Hickey, East Hartford
712	" " " A. E. Hollister, Glastonbury	Station Agent.
	Bowker Fertilizer Co., H. K. Brainard, Thompsonville	
1812	Bowker Fertilizer Co., Boston	Chas. W. Scranton, New Haven
69	Geo. L. Munroe, Oswego, N. Y.	A. E. Plant, Branford
245	" " " "	C. V. Orchard Co., J. T. Molumphy, Berlin
258	" " "	C. V. Orchard Co., G. W. Spicer, Deep River
267	" " " "	Joseph Amsted, Windsor Locks
484	" " " "	
1832	" " " "	Elm City Nursery Co., New Haven
45	Coe Brass Manufacturing Co., Torrington	The Coe Brass Mfg. Co., Torrington
53	Brass Mill, Waterbury	J. H. Hale, South Glastonbury
1813	E. B. Clark, Milford	O. G. Beard, Shelton
1809	B. A. Jackson, South Norwalk	L. V. St. John, New Canaan
414	J. W. Miller, Bookton, Ontario	Geo. F. Platt & Son, Milford
429	Ernest N. Austin, Suffield	Ernest N. Austin, Suffield
366		George E. Pierce, Orton
246		L. B. Yale, Meriden
	Lime.	
108	E. D. Herrick, Holyoke, Mass.	Wm. K. Ackley, East Hartford
109	" " " "	" " "
170		J. T. Allen, Broad Brook
232	J. F. Merrell, Suffield	Arthur Sikes, Mapleton
	Lime-Kiln Ashes.	
77	Canaan Lime Co., Canaan	Wm. Crane, Broad Brook
1803	L. J. Follette & Sons, No. Adams, Mass.	R. A. Sikes, Ellington
1830		B. A. Jackson, South Norwalk

Analyses and Valuations.

Station No.	Potash Soluble in Acid.	Potash Soluble in Water.	Phosphoric Acid.	Lime, Calcium Oxide.	Carbonic Acid.	Sand and Soil.	Charcoal.	Cost per ton.
264	----	2.38	0.84	30.47	----	----	----	$10.00
378	----	4.88	1.33	31.11	----	----	----	10.00
535	5.19	4.52	1.07	30.06	----	----	----	9.50
712	6.33	5.80	1.16	38.03	----	----	----	10.50
1812	5.23	4.37	1.15	34.24	----	9.74	1.58	9.50
69	----	5.76	1.24	28.15	17.22	12.65	1.99	9.00
245	----	5.31	1.36	35.10	----	----	----	9.90
258	----	4.97	1.41	37.37	----	----	----	9.99
267	4.17	3.64	1.43	38.69	----	----	----	9.50
484	3.96	3.40	0.90	29.02	----	----	----	9.25
1832	4.16	3.60	1.13	30.64	20.20	7.18	0.97	----
45	----	6.09	3.40	47.42	25.05	2.00	0.16	----
53	----	4.94	3.16	40.25	24.83	8.08	0.28	----
1813	4.61	4.07	1.74	29.25	----	7.81	1.50	10.00
1809	3.02	2.65	0.99	40.00	----	1.79	0.50	7.00
414	----	5.32	1.28	30.95	----	----	----	9.00
429	----	3.42	2.05	35.25	----	----	----	8.00
366	----	2.79	0.83	40.50	----	----	----	----
246	----	4.20	1.24	29.47	----	----	----	9.00
108	----	----	----	56.90	4.26	0.02	----	----
109	----	----	----	95.26	3.00	0.02	----	12.50
170	----	----	----	70.52	----	----	----	----
232	----	----	0.04	56.83	----	0.14	----	6.00
77	----	0.46	0.35	32.10	17.48	1.25	1.62	6.00
1803	1.59	1.29	0.45	44.25	----	----	----	----
1830	2.00	----	0.78	49.98	26.51	2.44	1.15	----

Three of the samples contained only small percentages of magnesia, but No. **232** is a dolomitic or magnesian limestone, not well adapted to use on tobacco lands. The more complete analysis of this sample is as follows:

	232
Insoluble in acid	0.14
Lime	56.83
Magnesia	40.27
Phosphoric acid	0.04
Oxide of iron and alumina	0.56
Water and matters undetermined, by difference	2.16
	100.00

The cost of lime in sample **109** is 66 cents per 100 pounds, in **232**, 53 cents.

Lime-Kiln Ashes.

Three analyses of this material are given in the table on page 90. At $6.00 per ton, the cost of lime in sample **77** is 93 cents per 100 pounds.

Land Plaster.

12609. A sample of Nova Scotia Plaster, sent by Simeon Pease, Greenfield Hill, contained 75.86 per cent. of pure hydrated calcium sulphate (gypsum) and 4.34 per cent. of matters insoluble in acid. This is about the usual composition of Nova Scotia plaster.

Tobacco Stems.

52. Tobacco Stems from a carload of seventeen tons of Kentucky baled stems. Sample drawn from five bales by H. N. Griswold, Windsor. Sold by Olds & Whipple, Hartford.

467. Kentucky Tobacco Stems. Sampled from stock bought of J. A. Shepherd, Windsorville, by Jason Graham, Hartford.

573. Ground Tobacco Stems. Sampled by Clark Brothers, Poquonock, from stock of Olds & Whipple, Hartford.

709. Ground Tobacco Stems. Sampled by Olin Wheeler, Buckland, from stock of Olds & Whipple, Hartford.

Analyses and Valuations.

	52	**467**	**573**	**709**
Moisture	8.42	32.14	----	----
Nitrogen	2.31	2.43	2.10	2.81
Phosphoric acid	1.01	0.60	0.63	0.88
Potash	10.48	6.98	6.12	10.62
Cost per ton	$14.00	13.00	20.00	20.00
Potash costs cents per pound	3.0	3.8	10.	5.1

The analyses have the usual range of composition. The stems are sometimes baled when quite damp and, as **467** shows, may contain, when bought, nearly a third of their weight of water. If **52** represents the sample as sold, it was a very economical fertilizer to buy; for, allowing 15½ cents per pound for nitrogen and 2 cents per pound for phosphoric acid, the potash in it costs only 3 cents per pound.

Swamp Muck.

A sample of "Muck," No. **11**, sent by W. T. Williams, Yantic, contained—

Moisture	28.06 per cent.
Organic and volatile matters	5.42 "
Sand and soil	62.04 "
Other mineral matters	4.48 "
	100.00

The undried "muck" contained 0.11 per cent. of nitrogen. Nearly two-thirds of the weight of this material is a fine sand, with some grains of mica. It is of small value as an absorbent or amendment.

Crematory Ashes.

1806. This material, sent by R. S. Banks, Greenfield Hill, is stated to represent ashes from the Bridgeport Garbage Crematory. It contains:

Moisture	14.59 per cent.
Organic matter	26.89 "
Mineral matter	58.52 "
	100.00

Of the percentage of mineral matter 12.53 is sand and soil, 4.81 is phosphoric acid and 2.11 is potash. The material contained some organic matter and 0.97 per cent. of nitrogen.

The agricultural value of the material is small.

The nitrogen is probably in quite inert form and the phosphoric acid is mostly in form of bone ash, which is only very slowly available to plants.

Various Manurial Matters.

1801. Sheep Dung, sent by the Elm City Nursery Co., New Haven.

12546. Rotted Horse Manure, sent by P. P. Hickey, Burnside.

394. Sweepings from asphalt pavements in New Haven. Sampled by the Station.

12117. Waste from a silk mill, sent by J. H. Simonds, Warehouse Point.

Analyses.

	1801 Sheep Dung.	12546 Horse Manure.	394 Street Sweepings.	12117 Waste from Silk Mill
Moisture	12.78	45.59	36.21	96.12
Organic and volatile matters	57.42	9.46	20.77	3.41
Mineral matters	29.80	44.95	43.02	0.47
	100.00	100.00	100.00	100.00
The organic matter contains:				
Nitrogen	2.07	0.31	0.27	0.34
The mineral matter contains:				
Phosphoric acid	1.50	0.33	0.28	0.00
Potash	2.75	0.56	0.24	0.01
Sand and soil	----	36.32	37.96	0.00

The sheep dung is quite dry and pound for pound contains much more nitrogen, phosphoric acid and potash than moist fresh stable manure contains.

The "rotted horse manure" has much the same composition as street sweepings, and both have about the same manurial value as much of the "fine old rotted compost" sold at a high price in the spring for city lawns, flower beds and small gardens.

Residue from Acetylene Gas Manufacture.

12273. Sent by Noble Bennett, New Milford. The sample contained:

Sand	1.10
Organic matter	3.95
Oxide of iron and alumina	2.90
Lime	63.65
Water and carbonic acid, by difference	28.40
	100.00

The material has a disagreeable smell, but if applied to land in the late fall would, no doubt, prove a satisfactory form of lime.

THE SOLUBILITY OF ORGANIC FORMS OF NITROGEN IN PEPSIN-HYDROCHLORIC ACID.

In the Report of this Station for 1885, pp. 115–131, is an account of experiments on the solubility in acid pepsin solution of such organic nitrogenous matters as are commonly used in mixed fertilizers and also of certain materials which, though known to be very inferior as sources of nitrogen to crops, are yet put upon the market for use as fertilizers.

The conclusions from our experiments and those of Drs. Shepard and Chazal, our predecessors in this work, were given substantially as follows:

"1. The nitrogen of dried blood (red and black, 4 samples), cotton seed (4 samples), castor pomace and maize refuse (each 1 sample) was in every case soluble in pepsin-hydrochloric acid, by 24 hours digestion, to the extent of 75 per cent. or more.

2. The nitrogen of fish (10 samples), dried animal matter (tankage, horse meat, etc., 3 samples), and of bone (20 samples) was in every case soluble to the extent of over 52 per cent.

3. The nitrogen of leather, steamed or extracted by benzine, was in no case soluble to the extent of over 36 per cent. That of horn shavings, bone dust, ground horn and hoof, cave guano, felt waste and wool waste was considerably less soluble than the nitrogen of leather.

4. This method divides the organic nitrogenous matters used in fertilizers into two classes. In one, more than one-half of the nitrogen is soluble, in the other scarcely more than one-third is soluble. To the first class belong all the materials whose nitrogen is known to be readily 'available' in the usual sense. Of the second class, the most soluble are leathers

variously manipulated, which are comparatively valueless as ingredients of commercial fertilizers. To some extent this method is, therefore, a measure of the agricultural value of nitrogen. How far it is a measure must be determined by vegetation-experiments under accurately controlled conditions, in which nitrogen is supplied in the same materials which have been tested by digestion-experiments.

In the meantime the method has decided value, because in many cases it will distinguish in mixed fertilizers between such forms of nitrogen as the general sense of practical farmers accepts as available and such as the same tribunal condemns as inert."

During the present year most of the nitrogenous fertilizers have been tested by this method. The results are given in connection with the chemical analyses, and may be briefly summarized as follows:

		Percentage of the organic nitrogen which is soluble in pepsin solution.		
Fertilizer.	No. of samples tested.	Maximum.	Minimum.	Average.
Blood	1	----	----	84.0
Cotton Seed Meal	2	91.0	89.0	90.0
Castor Pomace	4	91.5	74.0	84.6
Bone	25	99.4	69.9	87.0
Tankage	5	82.8	73.1	76.3
Fish	5	87.6	61.5	73.5
Bone and Potash	6	88.2	58.1	77.6
Superphosphates	90	91.7	18.9*	74.8
Special Fertilizers	99	100.0	57.8	76.4

It is clear from these figures, as well as from other results previously published by this Station and by other observers, that the solubility of organic nitrogen in materials generally regarded as quickly acting fertilizers, such as blood, cotton seed, castor pomace, fish, tankage, bone and the like, may range from about 60 to nearly 100 per cent.

There is no reason to suppose that those with the lower solubility named are less effective fertilizers than those whose solubility in pepsin solution is relatively high.

It is evident, therefore, that it would be quite possible to mix inferior nitrogenous matter, like leather, hair, etc., with its own weight of some approved form of nitrogen, which had

*See pages 46 and 47.

exceptionally high solubility in pepsin solution and produce a mixture which would not be certainly detected by the test described above. It is only when the solubility is fifty per cent. or lower that it is reasonable to suspect the presence of inferior or inert forms of nitrogen.

But a single fertilizer has been found among those examined this year in which the solubility of the organic nitrogen was below 50 per cent. and in that case it was only 18.9 per cent. See pages 46 and 47.

In the work just described, the method is as follows:

Pepsin solution was made by dissolving 5 grams of Golden Scale Pepsin, made by the New York & Chicago Chemical Co., in 1000 c. c. of 0.2 per cent. hydrochloric acid and filtering the solution. A large amount of the dry, thoroughly mixed pepsin was kept on hand and the solution was made up only as required.

The Digestion.—Bring one gram of the material, which has been washed on a filter with cold water, into a 150^{cc} flask and add 100^{cc} of pepsin-hydrochloric acid solution. Place the flask, loosely corked, in a water-bath having a constant temperature of 40° C. Keep at this temperature for twenty-four hours, adding 2^{cc} of a ten-per cent. hydrochloric acid solution at the end of the 2d, 5th, 8th and 11th hours. Shake the mixture well on each addition of acid. At the end of the digestion transfer the contents of the flask to a filter, wash with 150 to 200^{cc} of cold water and determine nitrogen in the residue by the Kjeldahl method.

The determination of nitrogen was in all cases made by Kjeldahl's method and thus was avoided all necessity for cutting the filter paper fine. All materials experimented on were ground so as to pass a $\frac{1}{50}$ in. sieve.

REVIEW OF THE FERTILIZER MARKET,

For the Year Ending October 31, 1900.

By E. H. Jenkins.

Nitrogen.

Nitric Nitrogen.

The *wholesale* New York quotation of nitrogen in form of nitrate, which was 11.1 cents per pound in November, 1899, rose rapidly to 13.6 cents in March, 1900, fell to 13.3 cents in April, dropped sharply to 10.8 in June and rose again slightly to 11.5 in October of the present year.

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

Year	1900	1899	1898	1897	1896	1895	1894	1893
Average quotation, cents per pound for nitrogen, *wholesale*	11.8	10.5	11.0	11.4	11.1	11.4	13.0	12.7

Nitrate nitrogen has sold at *retail* in the State for from 14.2 to 15.1 cents per pound, or from $45 to $47 per ton for nitrate of soda.

Ammonic Nitrogen.

The *wholesale* New York quotation of nitrogen in this form was 13.8 cents per pound in November, 1899.

It rose to 15.0 cents—the highest quotation of the year—in March, and then declined, the quotation in October, 1900, being 13.4.

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

Year	1900	1899	1898	1897	1896	1895	1894	1893
Average quotation, cents per pound for nitrogen, *wholesale*	13.9	14.0	11.9	10.5	11.1	14.3	17.3	15.7

Scarcely any sulphate of ammonia is used by farmers for home mixture and the retail price has been merely nominal

at $75.00 per ton, making the cost of nitrogen 18.5 cents per pound, which is prohibitive for use as a fertilizer.

Organic Nitrogen.

The *wholesale* New York quotation of nitrogen in form of red blood, which was 11.0 cents per pound in November, 1899, rose sharply to 15.2 cents per pound in February, 1900, and since then has declined to 12.6 cents in July, rising again to 14.0 in October.

The quotations of low grade blood and concentrated tankage have shown corresponding fluctuations. In general, the quotations for this year have been higher than for last year.

Low grade tankage, bone, fish and, especially, cotton seed meal are the forms of nitrogenous matter most popular with those who buy fertilizer materials unmixed at retail.

The price of cotton seed meal advanced very sharply during the latter part of 1899 and in the present year, on account of increased European demand. At retail, nitrogen in this form cost one and a half cents more per pound in 1900 than in the previous year.

Dry Ground Fish has been one of the cheapest forms of fertilizer nitrogen during the last twelve months.

Phosphatic Materials.

The *wholesale* New York quotations of ground bone and bone meal have remained practically the same since November, 1899, with some slight fluctuations.

The wholesale quotation of available phosphoric acid in form of acid phosphate rose from 3.09 cents per pound in November, 1899, to 3.17 in March, April and May, 3.20 in July and 3.30 in October.

Available phosphoric acid in dissolved bone black has cost, at retail, from 6.4 to 6.6 cents per pound and in acid phosphate about 4.7 cents, though it has been bought in mixed car lots much more cheaply than this.

Potash.

The prices of potash salts, which are regulated by the German Kali Works, show little fluctuation.

Muriate of Potash.

Potash in this form cost, *at wholesale,* in New York, 3.58 cents per pound from October, 1899, to March, 1900, and since then has cost 3.66 cents.

At retail in this State, potash has cost from 4.0 to 4.8 cents. See page 32.

Double Sulphate of Potash and Magnesia.

At *wholesale,* in New York, potash in this form cost 3.91 cents per pound in November, 1899, and since March, 1900, the cost has been 4.04 cents.

At retail in this State, it has cost about 5½ cents per pound.

High Grade Sulphate of Potash.

The *wholesale* New York quotation of potash in this form, in November, 1899, was 4.10 cents per pound.

Since March, 1900, it has been uniformly 4.21 cents.

Potash in this form has sold, at retail in this State, for 4.9 to 5.5 cents per pound.

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 pound.
"	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 pound.
"	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, 1896. 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.

WHOLESALE PRICES OF FERTILIZING MATERIALS.

		Cost of Nitrogen at wholesale in					Cost of Potash at wholesale in			Available Phosphoric Acid in Dissolved South Carolina Rock. Cents per pound.
		Dried Blood.		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.	
		Red. Cents per pound.	Black or low grade. Cents per pound.							
1896.	November	11.0	10.1	9.4	11.6	10.8	3.59	3.94	4.10	2.73
	December	11.2	10.8	9.5	12.1	10.4	3.59	3.94	4.10	2.73
1897.	January	10.7	10.1	9.4	12.1	11.0	3.59	3.94	4.10	2.73
	February	10.6	10.0	9.4	11.9	11.0	3.59	3.94	4.10	2.73
	March	10.5	10.1	9.4	11.9	10.9	3.59	3.94	4.10	2.73
	April	10.5	9.9	9.4	12.3	10.8	3.60	3.97	4.10	2.68
	May	10.3	9.7	9.9	11.5	10.7	3.64	4.09	4.10	2.53
	June	10.1	9.7	9.9	11.0	10.3	3.64	4.09	4.10	2.53
	July	10.7	10.1	9.9	10.6	10.2	3.64	4.09	4.10	2.53
	August	11.1	10.5	10.1	10.5	9.7	3.64	4.09	4.10	2.53
	September	11.8	11.3	11.5	10.5	10.4	3.64	4.09	4.10	2.53
	October	12.0	11.8	11.7	10.5	10.5	3.64	4.09	4.10	2.53
	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

FIFTH
REPORT ON FOOD PRODUCTS.

To His Excellency, GEORGE E. LOUNSBURY, *Governor of Connecticut:*

As required by law, I herewith submit the Fifth Report of the Connecticut Agricultural Experiment Station on Food Products, for the year ending July 31st, 1900.

It may not be inappropriate in this connection to call attention to certain defects in the Food Law of Connecticut, which the experience of the last five years has made apparent, and to suggest some changes which would remedy these defects and thus better protect the public against frauds in food.

1. After "fully," in the second line from the end of section two, as it is printed on page 108 of this Report, insert the words *and conspicuously.* The manufacturers of "mixtures" and "compounds" quite commonly print on the package or label, in type so small as to be scarcely legible, or in a place not likely to catch the eye of the buyer, those words which the law requires, but which the venders do not wish to have seen.

2. The last five paragraphs of section three tend to favor the misbranding or adulteration of food products, being, in fact, contrary to other specifications in sections two and three. For instance, in regard to paragraph (a), there are a considerable number of articles of food on sale which are "mixtures or compounds," "now known" under their "own distinctive name and not included in definition fourth of this section, *i. e.,* not "in imitation of, or sold under the name of another article." Accordingly, they are exempt from all requirements of section three, whereas, they should not be exempt from paragraphs five, six and seven of that section. This fault would be corrected by inserting in the last line of (a) after the word "fourth" the words *fifth, sixth or seventh.*

Paragraph (b) of section 3 exempts from the requirements of section two any article that is *either* "plainly *or* correctly" (labeled) "to show that it is a mixture," etc. For the word "or" should, of course, be substituted *and*.

The intent is to permit the sale of mixtures of different materials, wholesome in themselves, which are so labeled as to show that they are mixtures and are not a single, unmixed food product. But the language of the law is not explicit enough. For example: A material consisting of coffee mixed with peas, chicory and roasted wheat may at present be legally sold as "French Mixed Coffee," under the provision of paragraph (b). Yet the label does not clearly indicate, as it ought, that the material contains other things than coffee. It is common to mix or blend various kinds of pure coffee and this label indicates nothing more than such a mixing. The word "compound" is less open to this objection than "mix" or "blend."

The paragraph might read, (b) *In the case of articles labeled, branded or tagged so as plainly and correctly to show that they are compounds of two or more different food products.*

(c) and (d) tend to favor the use of chemical preservatives, which, unlike the standard preservatives, salt, sugar, spices, vinegar and wood smoke, cannot be detected by the purchaser, (by taste or odor) and to nullify the fifth and sixth clauses of section three.

In my opinion chemical preservatives should only be allowed in food products when the fact of their presence is made known by a statement on the label, or, in case of milk, perhaps, by a written or oral statement to the purchaser. The reasons for this have been given in the Report on Food Products for 1899, pages 139 to 141. To make this change there should be inserted in section three, first line of paragraph (c), after the word "ingredient," the words—*excepting preservatives other than salt, sugar, spices, vinegar or wood smoke.*

Also insert in paragraph sixth of section 3, after the word preservative and in place of the rest of the paragraph, the words, *other than salt, sugar, spices, vinegar or wood smoke.*

Section eight prescribes no penalty for misbranding. It should be amended to read—

Any person who, either by himself, his agent or attorney, violates any of the provisions of this law shall be fined not more than five hundred dollars or imprisoned not more than one year.

The law provides for the printing and distribution of but seven thousand copies of this Report. As the facts given in it are important to every householder in the State, this number of copies seems extremely inadequate. To secure wider distribution of this Report and to meet the many calls for it from those not on our regular mailing list, the Station last year printed three thousand extra copies for distribution within the state. Less than twenty-five of these still remain in our possession. Fifteen thousand copies would no more than meet the demand.

Very respectfully,

E. H. JENKINS, *Director.*

New Haven, July 31st, 1900.

THE CONNECTICUT FOOD LAW.

CHAPTER CCXXXV.

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 case of articles labeled, branded, or tagged, so as plainly or 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:

THE CONNECTICUT LAW REGARDING COMMERCIAL FEEDING STUFFS.

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, cotton seed 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 beginning Aug. 1, 1899, authorized agents of the Station have visited eighteen 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	1
Hartford County	1
Windham County	1
Tolland County	0
New London County	3
Middlesex County	1
New Haven County	5
Fairfield County	6
	18

In all there have been bought by the Station, seven hundred and ninety-two samples of the following names or kinds:

	No. of Samples.
Buckwheat Flour	115
Coffee	60
Coffee Compounds	4
Milk from milk-wagons	246
Cream	8
Ice Cream	6
Olive Oil	77
Lard	160
Cream of Tartar	28
Baking Powder	76
Spring and Well Waters	32
Miscellaneous	12
	824

The State Dairy Commissioner is now charged by statute 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, 1900, the Station has received from the Commissioner and examined 420 samples, as follows:

	No. of Samples.
Butter and Imitation Butter	32
Molasses and Syrup	185
Vinegar	175
Olive Oil	28
	420

Other samples not collected either by the Station or the Dairy Commissioner have been examined, as followed:

	No. of Samples.
Milk and Skimmed Milk	41
Cream	7
Pickles and Preserves	4
Miscellaneous	7
	59

Forty-eight samples of cream tartar, collected in 1897, have also been analyzed during the last twelve months, making the total number of food examinations thirteen hundred and thirty-nine.

BUCKWHEAT FLOUR.

By A. L. Winton.

It is a not uncommon practice to sell various mixtures containing inferior wheat flour, corn flour or other cereal products, under the name of buckwheat flour. These mixtures are much cheaper to prepare than genuine buckwheat flour, but usually sell for the same price in the retail market.

While it is true, as is sometimes urged by way of excuse for this illegal practice, that some buyers prefer to use a mixture of buckwheat and other flour, it is likewise true that others prefer clear buckwheat, and that all buyers without exception wish and have the right to know exactly what they are paying for; a right which is denied them when mixtures containing various cereals are sold to them under the name of buckwheat flour. Such mixtures can only be legally sold in this State either under distinctive names, "not under the name of another article" or so "labeled, branded or tagged as plainly or correctly to show that they are mixtures, compounds, combinations or blends."

"Self-raising" or "Prepared Buckwheat Flour," put up in sealed and labeled packages, contains the requisite quantity of baking powder and salt so that it may be prepared for cooking,

by simply mixing with water or milk. The flour in these preparations is often a mixture containing wheat or corn flour, or both. Rice and barley flour are also occasoinally used.

The trade names under which self-raising flours are sold as well as the information given on the packages show that they are mixtures, and although it is not always stated that various kinds of flour are present, there is no evident intent of deception.

Examination of Samples.

The samples examined may be classified as follows:

1. *Buckwheat Flour not found adulterated*		63
2. *Buckwheat Flour adulterated*		44
Adulterated with Wheat Flour	26	
Adulterated with Corn Flour	9	
Adulterated with Wheat and Corn Flour	9	
3. *"Prepared" or "Self-Raising" Buckwheat Flour*		8
Total		115

Descriptions of the samples are given in Tables I, II and III, pages 116 to 119, to which the following explanations may be added:

Buckwheat flour not found adulterated. Under this head are included all samples in which no appreciable amount of matter foreign to the buckwheat kernel was detected. Minute quantities of wheat starch, such as might readily come from the dust of the mill or warehouse, were disregarded.

Adulterated buckwheat flour. The samples were bought in each case for buckwheat flour and the purchaser was not informed, either by word or label that they were mixtures. They contained in addition to buckwheat, either wheat flour or corn flour or both. In two samples rye flour appeared to be present, although probably through accident rather than design.

"Prepared" or "self-raising" buckwheat flour. These preparations were sold in sealed packages with full instructions for use on the label. In each case it was directed to mix with water or milk immediately before cooking, without addition of salt, baking powder, yeast or other leavening material.

Microscopic examination disclosed the presence of wheat flour in all of the preparations and of corn flour in all but three. Rice and barley flour in small amount may have been contained in some of the samples, but in the presence of buckwheat and wheat flour these are difficult of detection.

TABLE I.—BUCKWHEAT FLOUR NOT FOUND ADULTERATED.

Station No.	Dealer.	Price per pound, cents.
1227	*Bridgeport.* Geo. E. Cleveland, 200 State St.	4
1228	Coe & White, 560 Main St.	4
1229	Enterprise Market, 133 E. Main St.	4
1230	Village Store Co., 240 State St.	3
1231	R. T. Whiting, 345 Main St.	4
1232	*Greenwich.* Knapp & Studwell	5
1233*	John L. Mahoney	4
1234	S. A. Mosher	4
1235	173 Greenwich Ave.	4
1236	*Meriden.* C. N. Dutton & Co., 17 Colony St.	5
1237	F. H. Lewis, 98 W. Main St.	5
1238	*Middletown.* D. I. Chapman, 146 Main St.	5
1239	T. Walsh, 486 Main St.	3
1240	*New Britain.* Boston Branch Grocery Store, 238 Main St.	5
1241	H. A. Hall, 212 Main St.	4
1242	282 Main St.	4
1243	*New Haven.* S. S. Adams, 7 Shelton Ave.	4
1244	S. S. Adams, 745 Grand Ave.	4
1245	C. A. Bailey, 173 Dixwell Ave.	3
1246	H. E. Downes & Son, 1 Broadway	4
1247	Graff & McKay, 751 Grand Ave.	5
1248	P. Jente & Bro., 107 Broadway	4
1249	C. Kipp, 290 Dixwell Ave.	4
1250	H. E. Smith, 7 Broadway	4
1251	W. E. Waterbury, 774 State St.	4
1252	D. M. Welch & Son, 28 Congress Ave.	4
1253	*New London.* M. Wilson Dart, 486 Bank St.	4
1254	Wm. A. Holt, 50 Main St.	5
1255	Edward Keefe, 495 Bank St.	4
1256	Keefe & Davis, 125 Bank St.	4
1257	*Norwalk.* Wm. M. Betts, 15 Main St.	4
1258	Thos. Burns, Wall St.	4
1259	Finney & Benedict, 41 Wall St.	4
1260	E. Glover & Son, Wall St.	4
1261	P. J. Lynch Co., Main St.	4
1262	New York Grocery Co., 35 Main St.	4
1263	M. E. Osterbanks, 53 Main St.	4
1264	*Norwich.* A. H. Armington, Shetucket St.	4
1265	Fitch, The Grocer, 64 Broadway	5
1266	J. P. Holloway, 319 E. Main St.	4
1267	Henry Norman, 36 Franklin St.	5
1268	A. T. Otis & Sons, 261 E. Main St.	5
1269	Rallion, The Grocer, 45 Broadway	5
1270	Welcome E. Smith, 137 Main St.	5
1271	Wheeler Bros., 2 Cliff St.	4
1272	*South Norwalk.* Sam'l Comstock, Jr., 72 N. Main St.	4
1273	D. S. Davenport, 20 N. Main St.	4
1274	Lorenzo Dibble, 13 N. Main St.	3
1275	P. J. Lynch Co., 118 Washington St.	4
1276	New York Grocery Co., 132 Washington St.	3
1277	Sam'l H. Raymond, 44 S. Main St.	4
1278	Chas. E. Seymour, 33 Washington St.	4
1279	Edwin Wilcox, 72 Washington St.	4
1280	*Stamford.* J. M. Wassing, 131 Atlantic St.	4
1281	*Stonington.* Moses Pendleton	4
1282	James H. Stivers	4
1283	*Waterbury.* J. Cronan, 793 Bank St.	5
1284	Spencer & Pierpont, 352 E. Main St.	4
1285	Waterbury Grocery Co., 40 N. Main St.	4
1286	*Westport.* G. A. Darrow	4
1287	W. A. Osborne	3
1288	*Willimantic.* S. E. Amidon, 877 Main St.	5
1289	Perkins & Blish	5

* The H-O Company's Genuine Buckwheat Flour. In 5 pound package.

TABLE II.—ADULTERATED BUCKWHEAT FLOUR.

Station No.	Dealer.	Price per pound, cents.	Foreign Starch or Flour.
	Bridgeport.		
1332	T. Dundon, 410 E. Main St.	4	Corn.
1319	Foote's Market, 594 Main St.	4	Wheat.
1327	Lee & Ketcham, 20 Fairfield Ave.	4	Corn.
1338	National Cash Grocery, 342 Main St.	4	Wheat, corn.
1331	Robt. W. Parrott, 144 E Main St.	4	Corn.
1316	C. Russell & Co., 335 Main St.	4	Wheat.
1330	G. C. & A. L. Stewart. 136 Fairfield Ave.	5	Corn.
1317	John B. Sullivan, 588 E. Main St.	4	Wheat.
	Greenwich.		
1329	Amos W. Avery	4	Corn.
	Meriden.		
1323	L. C. Brown, 4 E. Main St.	5	Wheat.
1322	H. E. Bushnell, 79 W. Main St.	4	Wheat.
1325	Kapitzke & Quinlan, 80 E. Main St.	5	Corn.
1335	N. P. Lamontaigne & Co., 29 State St.	5	Corn, wheat.
1328	Rudolph & Co., 35 Pratt St.	5	Corn.
	Middletown.		
1306	A. M. Bidwell, 344 Main St.	4	Wheat.
1340	G. E. Burr, 136 Main St.	4	Wheat, corn.
1336	L. B. Chaffee & Co., 230 Main St.	4	Wheat, corn.
1321	Lawton & Wall, 468 Main St.	4	Wheat.
1303	J. B. Paterson, 110 Main St.	4	Wheat.
1304	W. K. Spencer, 98 Main St.	4	Wheat.
	New Britain.		
1299	A. B. Goodrich, 11 Franklin Sq.	3	Wheat.
1326	Chas. Nothnagle & Son, 363 Arch St.	4	Corn.
1314	Union Trading Co., 61 Arch St.	4	Wheat.
	New Haven.		
1302	A. A. Eisele, 287 Dixwell Ave.	5	Wheat.
1312	Geo. F. Gerner. 860 State St.	4	Wheat.
1324	F. J. Markle, 101 Dixwell Ave.	4	Corn.
1313	W. Tansey, 29 William St.	5	Wheat.
	New London.		
1311	Henry C. Hurlburt, Church St.	5	Wheat.
1310	W. M. Lucy, 193 Bank St.	4	Wheat.
1309	G. H. Thomas, 437 Bank St.	4	Wheat.
	Norwalk.		
1301	F. D. Lawton & Co., 47 Main St.	4	Wheat.
	Norwich. [Sts.		
1308	W. H. Cardwell, Commerce and Water	4	Wheat, possibly rye.
	South Norwalk.		
1300	F. D. Lawton & Co., 22 S. Main St.	4	Wheat.
	Waterbury.		
1334	Greater N.Y. Grocery Co., 128 E. Main St.	4	Wheat, corn.
1341	Hamilton's, 47 E. Main St.	4	Wheat, corn.
1333	The Hewitt Grocery Co., 74 N. Main St.	5	Wheat, corn.
1315	W. C. Nichols, 39 E. Main St.	3	Wheat.
	Westport.		
1318	Beers Bros.	3	Wheat.
1307	Taylor Bros.	3	Wheat.
	Willimantic.		
1339	Frank Larrabee, 20 Church St.	4	Wheat, corn.
1320	Lincoln, 144 Valley St.	5	Wheat,
1298	Purinton & Reade, 717 Main St.	4	Wheat, possibly rye.
1337	Burt. Thompson, 798 Main St.	4	Corn, wheat.
1305	Willimantic Cash Store, 17 Union St.	5	Wheat.

TABLE III.—"PREPARED" OR

Station No.	Brand.
1290	Davey's Atlas Buckwheat
1291	Cold Snap Prepared Buckwheat Flour
1292	S. H. Street & Co., New Haven, Perfection Prepared Buckwheat
1293	Puritan Self-raising Buckwheat Flour
1294	Port Jefferson Milling Co., Reliable Prepared Morning Glory Buckwheat Flour
1295	Mountain Mills, Prepared Buckwheat Flour
1296	Penn Mills, Best Prepared Buckwheat
1277	Burton & Davis, Best Prepared Buckwheat

COFFEE AND COFFEE COMPOUNDS.

By A. L. WINTON.

Coffee. The samples purchased during the year may be classified as follows:

	Unground coffee.	Ground coffee.
Samples not found adulterated	3	48
Samples found adulterated	2	7
Total	5	55

These figures convey no idea of the extent of adulteration of unground or bean coffee, because the different grades offered by each dealer were examined by the sampling agents on the premises and, as a rule, only those which appeared to be adulterated were purchased. Although only five samples were brought to the laboratory, several hundred lots were inspected.

Any careful observer with a little experience can readily detect adulterants in unground coffee at the stores where it is sold, but, as a rule, only a microscopist can judge as to the purity of ground coffee. For this reason samples of ground coffee were purchased in all the stores visited and were examined at the laboratory.

The ratio of the pure to the adulterated samples of ground coffee as given above doubtless represents fairly the condition of the market.

"SELF-RAISING BUCKWHEAT FLOUR."

Dealer.	Price per three pound package, cents.	Starchy matter other than from Buckwheat.
Bridgeport. Andrew Davey, 492 Main St.	12	Wheat, corn.
E. E. Wheeler, 471 Main St.	10	Wheat, corn.
New Haven. Paul L. Baer, 181 Dixwell Ave.	15	Wheat.
Oscar Boetiger, 209 Shelton Ave.	13	Wheat.
Everett & Everett, 33 Dixwell Ave.	12	Wheat.
South Norwalk. Gustav E. Friedrich, 11 Railroad Ave.	10	Wheat, corn.
P. J. Lynch Co., 118 Washington St.	10	Wheat, corn.
Westport. Our Red Letter Store	10	Wheat, corn.

Details regarding the pure and adulterated samples are given in Tables V and VI on pages 120 to 122.

In the report for 1899 attention was called to the fact that, since the passage of the pure food law, there has been a marked decrease in the number of adulterated "coffees" sold in this State. This decrease is no doubt largely due to the work of this Station in detecting and exposing this kind of fraud, although the fact that pure coffee has been cheaper during the last few years has also made adulteration less remunerative. The following statement shows for each year the percentage of adulterated samples in the whole number of samples examined:

TABLE IV.—PERCENTAGE OF ADULTERATED SAMPLES OF COFFEE IN WHOLE NUMBER EXAMINED.

Year.	Per cent. of samples adulterated. Unground coffee.	Ground coffee.	Both ground and unground.
1896	25.0	89.2	63
1897	7.1	86.6	57.7
1898	8.7	40.9	24.4
1899	1.5	18.8	10.4
1900	--	12.7	----

Coffee Compounds. Four samples have been examined as follows:

1562. "Perfection Brand Breakfast Blend. Sold only by The Union Pacific Tea Co." Bought of The Union Pacific Tea Co., 416 Main St., Bridgeport. 25 cents per pound. Consists of *coffee and chicory.*

TABLE V.—COFFEE NOT FOUND ADULTERATED.

Station No.	Brand.	Dealer.	Price per pound, cents.
	Unground Coffee.	*New Haven :*	
1504	Dixwell, Wright Co.'s Ja-vo-ka Coffee	C. Kipp, 290 Dixwell Ave.	15
1505	Sold in bulk	N. H. Provision Co., 382 Grand Ave.	20
1506	Sold in bulk	K. Ress, 135 Congress Ave.	25
	Ground Coffee.	*Bridgeport :*	
1507	O'Donohue Coffee Co., Santo Rico	George E. Cleaveland, 200 State St.	25
1508	Sold in bulk	George E. Cleaveland, 200 State St.	35
1509	Capital Mills, Hartford, Imperial Compound, Java and Mocha	*Derby :* Geo. E. May & Son, 260 Main St.	25
1510	John G. Turnbull & Co., National Coffee	Jas. McEnery, 75 Elizabeth St.	30
1511	Eugene Rosedale & Co., Empress Mocha and Java	D. M. Welch & Son, 312 Main St.	25
1512	Public Market, Special Mocha and Java	*Meriden :* Public Market, 45 W. Main St.	25
1513	Brownell & Field Co., Gold Brand Java	*Middletown :* G. E. Burr, 136 Main St.	25
1514	Old Reliable Coffee	J. B. Paterson, 110 Main St.	25
1515	Sold in bulk	Lawton & Wall, 468 Main St.	22
1516	Sold in bulk	*New Britain :* G. S. Vivian, 318 Main St.	20
1517	John P. Augur, Crescent Mills, Ceylon Java and Mocha	G. S. Vivian, 318 Main St.	30
1518	C. H. Russell, Old Government Java, Arabian Mocha	C. H. Russell	25
1519	Gold Eagle Coffee	Sovereign Trading Co.	25
1523	Stoddard, Gilbert & Co., Hermitage Coffee	*New Haven :* A. A. Eisele, 287 Dixwell Ave.	25
1524	Sold in bulk	A. Fehlberg, 116 Congress Ave.	20
1525	W. S. Quinly Co.'s King Philip Blended Coffee	Geo. F. Gerner, 860 State St.	25
1526	Sold in bulk	W. G. Graves, 341 Grand Ave.	25
1527	Sold in bulk	F. Hull, 399 Grand Ave.	25
1528	Paul Jente & Bro., Mocha and Java	P. Jente & Bro., 101 Broadway	25
1529	Bennett, Sloan & Co., Franklin Brand, Blended Coffee	C. Kipp, 290 Dixwell Ave.	25
1530	Sold in bulk	O. A. Rose, 27 E. Grand Ave.	25
1531	Sold in bulk	L. L. Rosenberg, 144 Congress Ave.	10
1532	Sold in bulk	H. E. Smith, 7 Broadway	25
1534	Yacht Club Coffee	D. M. Welch & Son, 30 Congress Ave.	20
1520	Brownell & Field Co., Autocrat Java	*New London :* M. Wilson Dart, 486 Bank St.	25
1521	Daniels, Cornell & Co., Corner Store Java	A. Gordon, Potter St.	25
1522	Wm. Boardman & Sons Co., Gold Star Coffee	Geo. R. Thomas, 437 Bank St.	25

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

Station No.	Brand.	Dealer.	Price per pound, cents.
	Ground Coffee.	*Norwich :*	
1535	Swain, Earle & Co., Silver Quarter Coffee	E. E. Beckwith, 88 Central Wharf	25
1536	Ross W. Weir & Co., Eureka Blend	J. P. Holloway, 319 E. Main St.	25
1537	L. J. Lehnermann & Co., Gold Label, Mocha and Java	Jas. Murphy, 3 Water St.	25
1538	O'Donohue Coffee Co., Princess Blended Java	*S. Norwalk :* Chas. E. Seymour, 33 Washington St.	25
1539	Sold in bulk	*Stamford :* Fitch A. Hoyt, 40 Atlantic St.	25
1541	Lincoln, Seyms & Co., Rex Java and Mocha	*Waterbury :* W. H. Fudge, 446 S. Main St.	30
1542	Lincoln, Seyms & Co., Union Club Coffee	W. H. Fudge, 446 S. Main St.	35
1543	Chase & Sanborn, Seal Brand Java and Mocha	The Hewitt Grocery Co., 14 N. Main St.	35
1544	Chas. E. Moody & Co., Morning Glory Coffee	The Hewitt Grocery Co., 14 N. Main St.	25
1545	The Heater Curtiss Co., Our Special Java and Mocha	N. W. Heater, 157 E. Main St.	25
1546	Dwinell Wright Co., White House Mocha and Java	The Hewitt Grocery Co., 14 N. Main St.	35
1549	Brownell & Field Co., Star Java	W. N. Ladd, 42 Center St.	25
1550	Sold in bulk	N. Y. & China Tea Co.	36
1551	International Coffee Co., Royal Arms	Rausch's Delicatessen, 3 Grand St.	25
1553	Wm. Boardman & Sons Co., Mocha and Java	Waterbury Cheap Grocery	25
1554	Potter & Payne, Columbia Blend Coffee	*Willimantic :* Frank Larrabee, 20 Church St.	30
1555	Purinton & Reade, Our Special 25 cent Coffee	Purinton & Reade, Main St.	25
1556	Upham Bros., Pure Gold Coffee	Purinton & Reade, Main St.	38
1557	Berry, Lohman & Rasch, Roasted Coffee	Purinton & Reade, Main St.	28
1558	Princeton Mocha and Java	Burt Thompson, Main St.	25
1559	W. H. Gilbert & Co., Old Homestead Mocha and Java	Burt Thompson, Main St.	25

1565. "French Mixture. C. H. Russell's Popular Hotel Coffee. Combination." Bought of The New York Butter Store, New Britain. 15 cents per pound can. Consists of *coffee, chicory, and imitation coffee made from a wheat product and other materials.*

1564. "Crown Jewel Java Coffee. Grand Central Tea Importing Co. Made of Pure Coffee and Cereals." Bought of

TABLE VI.—ADULTERATED COFFEE.

Station No.	Brand.	Dealer.	Price per Pound. cents.	Adulterants.
	Unground Coffee.	*New Haven :*		
1568	Sold in bulk	F. J. Markle, 85 Broadway	18	Chicory.
		Waterbury :		
1573	Sold in bulk	W. C. Nichols, 39 E. Main St.	10	Peas, Chicory, Imitation coffee.*
	Ground Coffee.	*Danbury :*		
1563	Sold in bulk	Village Store Co., 289 Main St.	25	Chicory, Pea hull pellets.†
		New Haven :		
1566	Sold in bulk	D. W. Allyn, 199 Exchange St.	25	Chicory.
1567	Bryan, Miner & Read, Welcome Coffee	M. L. Church, 173 Division St.	20	Peas, Chicory.
1569	Sold in bulk	Shelton Ave. Cash Store, 228 Shelton Ave.	25	Chicory, Imitation coffee.*
		Norwich :		
1570	Sold in bulk	A. H. Armington, Shetucket St.	10	Chicory, Peas.
		Stamford :		
1571	Sold in bulk	W. W. Edwards, 99 Main St.	20	Chicory
		Waterbury :		
1572	Sold in bulk	W. H. Fudge, 446 S. Main St.	25	Chicory.

Keriadar & Weck, Lafayette St., New Britain. 25 cents per pound package. Consists of *coffee, peas, chicory and pea-hull pellets.*

1561. "Red D Prepared Coffee. John G. Turnbull, New York." Bought of W. H. Fudge, 446 S. Main St., Waterbury. 25 cents per pound package. Contains *coffee, chicory, pea-hull pellets, and imitation coffee made of peas and a wheat product.*

MILK.

BY A. L. WINTON AND C. LANGLEY.

Milk is preëminently the food of infants and of invalids and often makes up the larger part, if not the whole, of their diet. To furnish inferior or adulterated milk is, therefore, likely to result much more seriously to the individual buyer and to the community than any other form of food adulteration which is now practiced.

* Brown lumps made from wheat middlings in imitation of coarsely crushed roasted coffee.

† Made from pea hulls and wheat middlings. Resemble ground roasted coffee.

The examination of milk to determine its wholesomeness is, unfortunately, a matter of great difficulty. Filth of certain kinds is the most dangerous matter in milk and has been the cause of devastating epidemics of typhoid and other diseases. But when it is required to examine a considerable number of samples within a short time, it is quite impracticable, by laboratory tests, to certainly identify those specific forms which make the milk dangerous or fatal. Protection against this danger can only be secured by suitable inspection of dairies.

Laboratory tests can, however, determine whether the milk is normal in composition, or of inferior nutritive value; whether it has been very extensively skimmed or watered and whether it contains preservatives, added to hinder its souring and as a substitute for strict cleanliness.

During the month of May, 1896, one hundred and five samples of milk were purchased by agents of the Station from grocers and bakers in all parts of the city of New Haven. Of these, twelve were pronounced adulterated, because of deficiency in total solids or fat. None, however, contained chemical preservatives.

In October and November of the same year, one hundred and forty-six samples were collected from milk wagons and groceries in various cities of the State. Of one hundred and thirteen samples taken from milk wagons, four were more or less skimmed, one was watered, one was suspected of being watered and two contained boric acid in the form of borax. The samples from groceries, thirty-three in number, were, with one exception, of fairly normal composition.

Up to the present year our knowledge of the chemical composition of the milk consumed in the State had been confined to the samples collected during the Spring and Autumn of 1896, and no knowledge had been gained of the extent to which adulteration, particularly the use of preservatives, is practiced during the Summer.

The need of further inspection appeared so great that, notwithstanding the pressure of other work, a large part of the month of August last was devoted to the collection and analysis of samples of milk.

The temptations to adulterate milk were unusually great during that month. Owing to the long continued drought, there was a great scarcity of milk and the addition of water and of skim milk from the creameries naturally suggested itself to the dishonest milkman. Furthermore, the weather was excessively hot, with several "record-breaking" days, and it is in such a season that the use of preservatives appears of special advantage to the milkman and is most dangerous to the public.

Collection of samples. The samples were all purchased by agents of the Station from milk wagons in the cities and larger villages of the State. The agent was provided with a bicycle 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.

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 a 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 illustrations opposite page 128.

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.

In this manner about eighteen samples were collected each day and brought without delay to the Station for examination.

Examination of samples. Determinations of specific gravity, fat and total solids, and tests for boric acid and formaldehyde were made on each sample immediately after its arrival. The results obtained are given in Tables VII and VIII, pages 126 to 133. 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 there is a very wide range of composition in genuine milk, 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.

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.

In the following is given a summary of the samples examined:

TABLE VII.—SUMMARY OF RESULTS OF EXAMINATIONS OF MILK.

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.	Containing boric acid (borax).	Containing formaldehyde.
Ansonia	5	0	3	0	2	0
Bridgeport	17	1	3	1	0	1
Danbury	7	0	4	0	0	0
Derby	8	0	2	0	0	0
Greenwich	4	0	2	0	0	0
Hartford	29	1	3	1	1	3
Meriden	12	0	0	0	0	0
Middletown	11	2	5	2	0	0
New Britain	12	1	1	1	0	0
New Haven	45	0	10	0	4	0
New London	11	1	2	1	0	0
Norwalk	8	1	2	1	0	1
Norwich	12	0	1	0	0	0
South Norwalk	11	0	0	0	0	4
Stamford	21	3	8	3	0	5
Waterbury	17	1	7	1	0	0
Willimantic	16	0	1	0	0	0
Total	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 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.

As appears from Table VIII, the following persons have sold milk containing borax or some other boron compound:

Ansonia ..... G. R. Wheeler.
Hartford ..... H. Rowland.
New Haven ..... L. G. Hemingway.
Martin Meyer.

The following have used formaldehyde:

Bridgeport ..... Ambrose Marsh, Acme Dairy.
Hartford ..... T. Cowles.
E. W. Parker.
Norwalk ..... R. Louden.
South Norwalk ..... J. S. Gainer.
R. D. Tryon.
Stamford ..... G. C. Chard.
Mt. Pleasant Dairy.
Sarr's Milk Wagon.

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

TABLE VIII.—MILK BOUGHT OF MILKMEN.

Station No.	Sampled Aug.	Dealer.	Specific gravity at 60° F.	Fat.	Total solids.	Preservative.
		Ansonia.				
1031	11	Baldwin*	29.8	4.2	12.75	None.
1032	"	A. Chatfield	30.9	4.0	13.04	"
1035	"	Judson*	28.2	3.1	**10.88**	"
1033	"	G. R. Wheeler	30.9	3.1	**11.51**	Boric acid.
1768	24	G. R. Wheeler	28.0	3.0	**11.49**	"
		Bridgeport.				
1724	18	B. S. Banks, Easton*	30.3	4.1	12.59	None.
1723	"	Samuel Beach*	27.7	3.4	**11.16**	"
1725	"	Craik & Sons	29.2	4.4	12.59	"
1711	"	W. E. Disbrow	29.1	3.9	12.29	"
1720	"	F. L. Downs	28.0	3.8	12.31	"
1713	"	George Gregory*	27.9	**2.8**	**10.63**	"
1722	"	S. J. Gregory*	27.0	5.0	13.04	"
1719	"	L. A. Jennings*	30.0	4.7	13.60	"
1714	"	Fred. Jennings*	28.9	4.2	12.55	"
1727	"	J. C. Lobdell, Greenfield Hill*	30.1	4.4	13.67	"
1718	"	Ambrose Marsh, Acme Dairy	29 0	4.1	12 64	Formaldehyde.
1726	"	Monhabie Farm, Jersey Milk	30.2	4.1	13.10	None.
1716	"	Park City Dairy	30.3	3.5	12.29	"
1717	"	The Rogers Farm Dairy	28.8	4.0	12.31	"
1715	"	E. B. Sherwood*	29.1	3.0	**10.93**	"
1721	"	M. A. Wakeley*	27.5	5.0	12 82	"
1712	"	Wellman, Nichols*	29.8	3.7	12.40	"
		Danbury.				
1052	9	Bailey's Pure Milk	29.8	3.5	**11.74**	"
1056	"	Buckholz*	28.2	3.5	**11.54**	"
1054	"	Danbury Milk Sterilizing Co.	29 6	3.8	12.00	"
1055	"	Andy Johnson, Home Dairy	26.0	4.4	12.00	"
1361	"	381 Main St. No. 4	29.2	3.5	**11.65**	"
1051	"	Morris*	30.0	4.0	12 67	"
1053	"	Peterson*	30.1	3.1	**11.46**	"
		Derby.				
1042	11	Baldwin*	30.3	5.0	13.89	"
1039	"	H. W. Bassett*	29.8	5.0	13.40	"
1040	"	F. E. Blakeman	29.5	3.1	**11.39**	"
1038	"	D. H. C.	30.1	3.7	12.34	"
1034	"	Myer*	30.2	3.3	**11.79**	"
1036	"	Riverdale Farm Dairy	29.0	4.9	13.27	"
1041	"	Walker (Huntington)*	30.0	4.6	13.61	"
1037	"	R. V. Werder	30.2	4.2	12.60	"
		Greenwich.				
1763	20	T. Brennan	30.2	3.2	**11.50**	"
1765	"	T. Brennan*	29.1	3.0	**10.98**	"
1764	"	Briarcliffe Farms Dairy	30.0	6.2	15.31	"
1766	"	Briarcliffe Farms Dairy	29.9	7.8	16.54	"

* Statement of the driver. Names not marked with * were given on the cart.

Bicycle with case for use in collecting samples of milk.

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

Station No.	Sampled Aug.	Dealer.	Specific gravity at 60° Fahr.	Fat.	Total solids.	Preservative.
		Hartford.				
1731	20	A. W. Butler	29.5	3.8	12.52	None.
1738	"	W. C. Cadwell	30.6	3.7	12.38	"
1131	16	O. A. Chapman	30.0	3.9	12.80	"
1744	20	O. A. Chapman	30.2	3.7	12.49	"
1743	"	T. Cowles	27.1	4.1	12.16	Formaldehyde.
1772	25	T. Cowles	----	----	----	"
1137	16	T. M. Daley	28.6	4.2	12.33	None.
1741	20	J. Dart & Son	29.7	3.8	12.45	"
1130	16	P. D'Sopo	26.5	5.0	13.05	"
1133	"	C. F. Goodwin, Bloomfield	30.2	3.6	12.88	"
1734	20	C. F. Goodwin, Bloomfield	30.0	4.5	13.23	"
1737	"	E. A. Isaacson	29.5	4.3	12.50	"
1728	"	Hans Jepson	31.4	3.5	12.46	"
1730	"	F. E. McKenney	30.5	4.4	13.25	"
1136	16	E. J. McNamara, Blue Hills	30.0	3.9	12.70	"
1129	"	A. Mekalit, Wapping	29.5	5.5	14.31	"
1732	20	L. C. Noyes	29.9	5.0	13.84	"
1739	"	E. W. Parker	29.6	4.2	12.96	Formaldehyde.
1736	"	H. Rowland, No. 1	27.5	3.3	11.12	Boric acid.
1773	25	H. Rowland	----	---	----	None.
1132	16	L. W. Seymour	25.5	3.7	11.45	"
1135	"	E. T. Slocum, Wethersfield	30.2	4.1	12.97	"
1134	"	Snyder & Root	30.2	3.8	12.53	"
1735	20	N. Swenson, Elmwood	29.7	4.0	12.70	"
1138	16	H. W. Talcott, West Hartford	25.0	2.9	10.14	"
1742	20	H. W. Talcott	30.7	4.6	13.34	"
1729	"	Terpsichorean Farm, West Hartford	29.0	4.2	12.88	"
1740	"	S. M. Wells, Ridgeside Farm Dairy, Wethersfield	29.7	3.7	12.18	"
1733	"	J. W. Wolley, Wethersfield	29.9	4.4	13.61	"
		Meriden.				
1090	16	Bartholomew	29.6	4.1	12.85	"
1093	"	Dickerman Bros.	30.5	4.0	12.61	"
1092	"	F. A. Disbrow	29.6	4.0	12.71	"
1094	"	D. Gonechia*	30.4	3.8	12.48	"
1086	"	D. Higgins	30.8	3.8	12.51	"
1095	"	D. Higgins	30.5	4.5	13.37	"
1088	"	C. L. Pomeroy	30.5	4.5	13.86	"
1097	"	C. L. Pomeroy	30.2	4.1	12.90	"
1089	"	J. Schieffer	30.8	4.1	13.04	"
1091	"	J. G. Schwink	30.4	3.7	12.30	"
1096	"	L. H. Smith	26.2	5.5	13.54	"
1087	"	L. B. Yale, Clover Hill	28.3	4.2	12.40	"
		Middletown.				
1008	8	C. E. Bacon	29.2	4.6	13.18	"
1014	"	T. Coleman	30.0	2.5	11.04	"
1006	"	F. A. Crook	27.0	3.4	11.42	"

* Statement of the driver. Names not marked with * were given on the cart.

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

Station No.	Sampled Aug.	Dealer.	Specific gravity at 60° Fahr.	Fat.	Total solids.	Preservative.
		Middletown.				
1009	8	R. Davis	29.0	3.9	12.34	None.
1005	"	T. A. De Mars	30.0	3.2	**11.70**	"
1012	"	William Ewald*	30.0	4.1	12.83	"
1013	"	Jones*	30.1	3.7	12.35	"
1007	"	W. G. Johnson & Sons	29.0	4.0	12.46	"
1010	"	Lee Brothers	28.0	3.1	**11.10**	"
1011	"	C. C. Plum	30.0	4.1	12.83	"
1004	"	F. S. Scoville	25.5	**2.6**	**9.89**	"
		New Britain.				
1753	18	Anderson & Smeburg	30.0	3.7	12.06	"
1761	"	Blair*	31.9	3.8	13.20	"
1762	"	F. J. Elton	29.2	4.7	13.27	"
1752	"	J. Flood & Sons	31.0	3.6	12.25	"
1757	"	M. A. Hunter*	30.9	4.2	13.22	"
1760	"	Johnson*	29.8	4.5	13.22	"
1758	"	A. S. Lyhne	29.0	4.1	12.68	"
1754	"	McMahon*	30.1	**2.3**	**10.63**	"
1751	"	Paul Meyer	30.6	3.8	12.37	"
1755	"	R. J. Newton*	28.0	6.0	14.32	"
1756	"	M. Shaughnessy	30.2	4.2	12.99	"
1759	"	Stanley*	29.5	4.2	13.04	"
		New Haven.				
1066	10	George G. Allen	30.0	3.6	12.11	"
1697	15	P. C. Allen	30.7	3.3	12.20	"
1698	"	M. M. Andrew	30.4	3.5	12.05	"
1700	16	J. J. Barry	30.0	3.3	12.00	"
1057	10	J. E. Brockett	31.0	3.9	12.86	"
1682	15	E. Casner	30.3	3.8	12.77	"
1060	10	Clover Dairy	31.4	3.5	12.43	"
1688	15	H. W. Coe	27.7	3.9	12.15	"
1696	"	H. L. Cooper	31.1	3.5	12.51	"
1783	30	Cooper & Hubbell	31.8	3.6	12.61	"
1064	10	W. H. Davis	29.6	3.8	12.11	"
1684	15	J. A. Downes	26.3	3.5	**11.12**	"
1069	10	Eagan*	30.3	4.2	12.95	"
1687	15	L. Gubersky	29.7	3.6	12.05	"
1073	13	L. G. Hemingway	29.8	3.7	12.25	Boric acid.
1774	27	L. G. Hemingway	----	----	----	"
1075	"	W. R. Hoggett	27.9	3.4	**11.18**	None.
1686	15	B. N. Hosley	30.3	3.7	12.41	"
1074	13	J. R. Huston	29.5	3.3	**11.35**	"
1072	13	J. Loveday	20.9	3.4	12.05	"
1070	10	H. A. Loveland	30.7	3.7	12.62	"
1691	15	D. W. Marks	27.0	3.0	**10.68**	"
1689	"	Martin Meyer	29.9	3.6	12.16	Boric acid.
1692	"	Martin Meyer	30.0	3.6	12.19	None.
1699	18	Martin Meyer	30.7	3.2	**11.62**	Boric acid.

* Statement of the driver. Names not marked with * were given on the cart.

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

Station No.	Sampled Aug.	Dealer.	Specific gravity at 60° Fahr.	Fat.	Total solids.	Preservative.
		New Haven.				
1065	10	New England Dairy Co.	30.0	4.0	12.22	None.
1063	"	R. N. Noble	29.6	3.5	12.05	"
1078	13	R. N. Noble	29.7	3.7	12.13	"
1061	10	J. A. Olson	30.8	3.4	12.09	"
1076	13	S. E. Riggs	29.7	4.0	12.63	"
1685	15	L. Saslafsky	29.0	3.2	**11.33**	"
1694	"	W. G. Schilf	29.7	3.9	12.37	"
1062	10	Serloc	30.1	4.1	12.60	"
1077	13	C. E. Thatcher	30.2	4.4	12.87	"
1071	10	C. E. Thatcher	30.4	3.6	12.23	"
1059	"	W. T. Thompson	29.0	3.9	12.65	"
1058	10	J. B. Turner	29.8	3.2	**11.59**	"
1079	13	Spring Glen Farm Dairy, J. H. Webb	29.2	5.0	13.66	"
1683	15	T. S. Weisenburg	30.5	3.1	**11.84**	"
1067	10	J. E. Wetmore	30.5	3.0	**11.20**	"
1784	30	The Whitneyville Creamery	31.5	3.7	12.93	"
1093	15	H. Woodcock	28.2	3.8	12.09	"
1690	"	R. W. 287	30.0	3.7	12.27	"
1068	10	215	30.3	3.1	**11.80**	"
1695	15	593	21.0	8.4	16.80	"
		New London.				
1145	17	F. E. Comstock	31.1	**2.9**	**11.44**	"
1142	"	Crawford*	30.5	3.8	12.35	"
1141	"	Dimmock*	29.9	3.5	12.27	"
1150	"	H. W. Hedden*	30.2	4.1	12.68	"
1147	"	E. Lewis*	30.1	5.2	14.42	"
1143	"	Maroney*	29.0	3.8	12.00	"
1139	"	McCaff*	30.7	3.2	**11.80**	"
1148	"	J. G. Newberry*	31.6	3.6	12.78	"
1149	"	W. F. Scott	29.3	4.0	12.75	"
1140	"	L. St. Germain	31.0	3.2	12.00	"
1144	"	Whitford*	29.1	4.6	13.17	"
		Norwalk.				
1124	14	William Godfrey	28.6	5.4	13.83	"
1122	"	Joseph T. Guyer	29.6	3.2	**11.39**	"
1125	"	David Jenks	31.4	**2.2**	**10.81**	"
1126	"	R. Louden, Sear Hill Dairy	30.3	4.6	13.15	Formaldehyde.
1769	25	R. Louden, Sear Hill Dairy	----	----	----	None.
1121	14	Thomas Mullard*	30.0	7.0	16.14	"
1127	"	F. R. Waters	30.3	4.4	13.10	"
1123	"	A. Wellnitz	28.7	5.7	14.37	"
		Norwich.				
1008	13	William Betham*	29.0	4.1	12.34	"
1111	"	H. F. Davis*	30.0	4.8	13.75	"
1106	"	James De Wolf*	29.6	5.6	14.46	"
1102	"	F. L Gardner*	30.5	4.2	13.19	"

* Statement of the driver. Names not marked with * were given on the cart.

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

Station No.	Sampled Aug.	Dealer.	Specific gravity at 60° Fahr.	Fat.	Total solids.	Preservative.
		Norwich.				
1107	13	Palmer Hewitt*	30.2	4.7	13.43	None.
1104	"	D. W. Lillibridge	29.6	4.6	13.02	"
1109	"	J. G. Lyman*	29.9	3.4	12.07	"
1110	"	Maple Farm*	30.2	4.4	13.39	"
1103	"	John Moore*	29.1	3.6	12.18	"
1105	"	J. O. Peckham*	26.6	3.7	**11.43**	"
1113	"	Charles Wheeler*	31.1	4.2	13.35	"
1112	"	N. W. Wheeler*	30.0	4.0	12.43	"
		South Norwalk.				
1118	14	William Barnes*	28.5	4.2	12.54	"
1128	"	J. S. Gainer	29.8	4.1	12.51	Formaldehyde.
1750	23	J. S. Gainer	29.5	3.9	12.43	"
1114	14	Charles H. Hawxhurst, No. 1	29.8	4.4	13.09	None.
1117	"	Charles H. Hawxhurst, No. 2	30.2	4.4	13.23	"
1116	"	Hilsdon & Hoyt, No. 1	31.2	3.5	12.42	"
1120	"	Hilsdon & Hoyt, No. 2	30.2	4.9	13.75	"
1115	"	R. D. Tryon	29.9	3.6	12.00	Formaldehyde.
1748	23	R. D. Tryon	29.0	3.5	12.13	None.
1770	25	R. D. Tryon	----	----	----	Formaldehyde.
1119	14	F. R. Waters	30.6	4.0	12.57	None.
		Stamford.				
1352	7	J. H. Bedell	30.6	4.1	12.98	"
1348	"	G. C. Chard, Riverbank Dairy	30.9	4.0	12.54	Formaldehyde.
1746	23	G. C. Chard, Riverbank Dairy	29.0	3.5	12.41	None.
1771	25	G. C. Chard, Riverbank Dairy	----	----	----	"
1356	7	M. R. Greer	29.0	3.4	**11.74**	"
1345	"	H. P. Howard	29.5	4.2	12.83	"
1358	"	P. Larkin, Glenbrook Dairy	28.1	4.8	12.86	"
1354	"	A. S. Lockwood	29.8	**2.9**	**10.75**	"
1360	"	E. B. Marrer	29.0	**2.9**	**10.94**	"
1350	"	W. Matthews & Sons	29.8	4.2	12.90	"
1346	"	McLean, Summer Street Dairy	21.2	3.1	**9.35**	"
1349	"	Mt. Pleasant Dairy	25.5	3.3	**10.36**	Formaldehyde.
1747	23	Mt. Pleasant Dairy	24.0	3.4	**10.64**	"
1355	7	W. F. Olmstead	29.8	3.5	12.06	None.
1351	"	Ponus Street Farm Dairy	30.0	4.3	13.07	"
1344	"	Sarr's Milk Wagon	30.1	4.0	12.33	Formaldehyde.
1745	23	Sarr's Milk Wagon	31.0	3.8	12.67	"
1347	7	G. Swenson	31.3	3.8	12.80	None.
1353	"	C. G. Waterbury, Springdale	29.6	4.4	13.09	"
1359	"	Emmet L. Weed	31.1	**2.9**	**11.75**	"
1357	"	James E. Wynn, North Stamford	28.3	3.6	**11.69**	"
		Waterbury.				
1049	17	G. S. Abbott	28.8	3.5	12.00	"
1703	"	C. C. Atwood	29.0	4.3	12.85	"
1709	"	C. C. Atwood	27.3	3.9	12.07	"

* Statement of the driver. Names not marked with * were given on the cart.

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

Station No.	Sampled Aug.	Dealer.	Specific gravity at 60° Fahr.	Fat.	Total solids.	Preservative.
		Waterbury.				
1704	17	H. E. Barnes	28.0	3.5	**11.48**	None.
1701	"	Buckingham Brothers	30.0	4.4	12.99	"
1050	"	Adolph Burnett*	29.0	4.0	12.37	"
1098	"	Charles Curnithan*	28.1	3.5	**11.44**	"
1707	"	W. A. Faber	30.0	3.2	**11.72**	"
1705	"	E. A. Ferrill	27.5	3.6	**11.81**	"
1099	"	E. H. L'Hommedieu	30.0	3.8	12.75	"
1706	"	Lockwood Brothers	29.8	4.2	12.81	"
1100	"	Frank McDonnell	30.1	3.5	12.19	"
1702	"	E. Moriarty	29.0	**2.6**	**10.51**	"
1710	"	E. H. Oviatt	29.0	4.0	12.41	"
1048	"	W. H. Platt	29.0	3.6	**11.70**	"
1047	"	Reed*	30.1	3.9	12.90	"
1708	"	G. Wheeler*	27.1	3.0	**10.65**	"
		West Winsted.				
1082	15	Highland Lake Farm	29.9	4.6	13.52	"
1083	"	Highland Lake Farm	30.0	4.4	13.81	"
1084	"	Mulcahy*	29.0	5.4	14.52	"
1085	"	Martin Tuttle	29.0	3.5	**11.63**	"
		Willimantic.				
1024	10	Andrews*	30.0	3.8	12.12	"
1028	"	Bowen*	26.3	3.8	**11.51**	"
1015	"	S. P. Brown, Homestead Farm	31.0	4.4	12.90	"
1023	"	O. Chappell & Son	30.2	4.0	12.75	"
1030	"	O. Chappell & Son*	30.0	5.0	13.51	"
1017	"	E. W. Ellison	30.5	3.8	12.47	"
1025	"	J. H. Griggs*	30.0	3.9	12.21	"
1021	"	C. H. Hoxie	29.0	4.1	12.56	"
1022	"	Grant A. Jacobs	30.0	4.2	12.39	"
1027	"	C. B. Pomeroy, Jr.	29.9	5.0	13.98	"
1019	"	A. Potter	30.0	4.0	12.30	"
1020	"	J. H. Stearns	30.2	3.4	12.00	"
1016	"	V. D. Stearns	30.0	3.6	12.00	"
1026	"	W. H. Terry	29.7	4.6	13.31	"
1029	"	G. A. Tracey	30.1	3.9	12.37	"
1018	"	D. L. Whitaker	29.5	4.4	12.59	"

The following samples were certainly adulterated:

Place.	Name of Dealer.	Sp. gr.	Fat.	Solids.	
Bridgeport	Geo. Gregory	27.9	2.8	10.63	----------
Hartford	H. W. Talcott	25.0	2.9	10.14	Watered
Middletown	F. S. Scovill	25.5	2.6	9.89	Watered
New Britain	McMahon	30.1	2.3	10.63	Skimmed
Norwalk	David Jenks	31.4	2.2	10.81	Skimmed
Stamford	McLean, Summer St. Dairy	21.2	3.1	9.35	Watered
Waterbury	E. Moriarty	29.0	2.6	10.51	Skimmed

* Statement of the driver. Names not marked with * were given on the cart.

MILK AND CREAM SAMPLED AND SENT BY INDIVIDUALS.

By A. L. Winton, A. W. Ogden and C. Langley.

MILK.

Thirty-three samples of milk have been brought to the Station by milkmen and others with request for determinations of fat. The extreme percentages found were 3.0 and 8.4. The latter percentage is never found in normal milk and indicates that the sample was not fairly taken. The analyses of samples improperly drawn do injustice either to buyers or sellers.

The Station will not hereafter analyze samples of milk, unless they are accompanied with particulars regarding the origin of each sample, stating whether it represents the milk of a single cow, or a number of cows, or of mixed milk offered for sale, nor unless assured that the samples were properly taken. If these particulars cannot be ascertained an analysis is not of sufficient value to justify the time and labor spent on it.

The whole amount of milk which the sample is to represent must be very thoroughly mixed, preferably by pouring several times from one vessel into another, and the sample for analysis, at least half a pint, must be taken *immediately* after this mixing and delivered at the Station for analysis before the milk has begun to sour.

In twelve samples brought by milkmen, solids, fat and specific gravity were determined. Three of these are worthy of notice.

A milk dealer submitted for analysis samples of milk sold to him by a number of persons. In these samples the following percentages of fat were found, 4.85, 3.00, 5.45, 4.60, 4.15 and 5.05. A determination of solids in the second sample of the series showed 9.99 per cent. The dealer, advised of these results, saved samples of this patron's milk from both morning and evening milkings, which were analyzed wtih the following results:

	Specific gravity.	Solids.	Fat.
Morning Milk	1.0225	9.82	3.35
Night "	1.022	9.27	3.05

It is clear that his milk, originally rich, has been extensively watered.

What action the dealer took we have not heard.

CREAM.

Seven samples of cream sent for determination of fat showed the usual range of composition, containing from 12.63 to 20.50 per cent. of butter fat.

TESTS FOR CHEMICAL PRESERVATIVES IN CREAM.

Eight samples of bottled cream bought by the Station agent, were tested for borax and formaldehyde, "formalin."

No trace of either chemical was found in the following:

No.		
1781	Pasteurized Cream, Maple Hill Farm.	Bought of Allen & Williams, 7. Broadway, New Haven.
1782	Pasteurized Cream, New England Dairy Co., New Haven.	Bought from Delivery wagon of N. E. Dairy Co.
1779	Spring Glen Dairy Cream, J. H. Webb, Proprietor, New Haven.	Bought from delivery wagon of J. H. Webb.
1777	T. Pavis, New Haven.	Bought from delivery wagon of T. Pavis.

The following contained chemical preservatives:

1780	Valley Farm Creamery, 100 Park St., New Haven.	Bought of H. Strack, Dixwell Ave. and Munson St.
1775	Valley Farm Creamery, L. G. Hemingway, New Haven.	Bought from delivery wagon No. 44, of L. G. Hemingway.
1778	Litchfield Creamery, J. H. Lee, Proprietor, 10 Whitney Ave., New Haven.	Bought of the Litchfield Creamery, New Haven.
1776	The Whitneyville Creamery, 43 Grove St., New Haven.	Bought from delivery wagon No. 9.

The two samples from the Valley Farm Creamery, L. G. Hemingway, proprietor, contained borax.

The sample from J. H. Lee's Litchfield Creamery and the one from the Whitneyville Creamery contained formaldehyde.

A sample of milk from each of the two last mentioned dairies, taken at about the same date, did not contain formaldehyde.

A single sample of cream, No. 175, in a bottle labelled Spring Glen Farm, sent by a grocer, was examined for preservatives, but none was found.

TESTS FOR CHEMICAL PRESERVATIVES IN ICE CREAM.

Samples of the Ice Cream made or offered for sale by the following firms were tested for chemical preservatives, but none was found in any of them.

No.		
1043	W. F. Hasselbach	796 Chapel St., New Haven.
1044	Francis	825 " "
1045	Hauff Brothers	875 " "
1046	Conrad Scholl*	241 Dixwell Ave., New Haven.
1080	Charles P. Snow	906 Chapel St., "
1081	Henry Hillman	1084 " "

SEPARATOR SKIM MILK.

Four samples, representing the work of two different types of separators and sent by a creamery for analysis, contained 0.11, 0.10, 0.17 and 0.17 per cent. of fat, determined by extraction with ether of the milk residue dried on asbestos.

LARD.

By A. L. Winton and A. W. Ogden.

The endeavor to substitute cheaper fats for the more expensive has led in recent years to the invention of oleomargarine, filled cheese, olive oil substitutes and compound lard. A brief consideration of all of these imitation products is desirable for the thorough understanding of any one of them.

Of the fatty products commonly used as foods in civilized countries, butter and olive oil are the most expensive and the most highly esteemed. Oleo oil and neutral lard rank next in price, followed by lard, beef tallow and other animal fats, while cotton-seed oil is cheaper than any of the other fats or oils mentioned.

From oleo oil, neutral lard and cotton seed oil are made oleomargarine and butterine, products which closely resemble butter in appearance and sell for nearly as high a price.

Filled cheese is another product in which the expensive butter fat is replaced by oleo oil, lard, or some other cheap fat. Cotton seed oil is the chief constituent of compound lard and is extensively used as a substitute for, or an adulterant of olive oil. In all these instances inferior fatty products are made to replace others of greater value.

*Made by New England Dairy Co.

Hog fat has a commercial value between that of butter and cotton seed oil and is not only used as an adulterant of the former, but is itself adulterated with the latter.

Beef fat, before the invention of oleomargarine, was considered of little value as a food, but to-day enormous quantities are converted into a product which competes with butter, and the stearin, obtained as a by-product, is utilized in the preparation of imitation lard. The process employed to-day in the manufacture of oleomargarine is in essential details the same as that devised by Mège Mourier in 1870. Beef fat is rendered at about 150° F. and the clear liquid fat, after cooling in vats, is subjected to pressure which separates the semi-liquid oleo oil from the solid stearin. Artificial butter is prepared from the oleo oil by churning with milk and color and addition of salt. It may also contain neutral lard, a product obtained by rendering hog fat at about 150° F., and treating with very dilute alkali, and cotton seed oil.

Cotton seed, formerly a waste product, now yields oil for the manufacture of imitation lard, salad oil and soap, and both the cake left after expressing the oil, and also the hulls, are valuable as cattle foods and as fertilizers. Compound lard is a mixture of cotton seed oil with enough stearin to give it the requisite degree of solidity and a small amount of real lard. Lard stearin, the residue left after expressing lard oil, cotton seed stearin, obtained by a similar process in the manufacture of "Winter" cotton seed oil, or paraffine, may be used in place of beef stearin.

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

The sale of compound lard for lard is a fraud akin to the sale of oleomargarine for butter. Even if the product is designed merely as a substitute for lard and is sold at wholesale under its true name, when retailed as lard it is morally, as well as legally, an adulterated food product.

Over one-third of the samples purchased for lard in 1896 were found, on examination, to be compound lard. At that time the price of real lard was high and the incentive to dishonesty unusually great. During the two years following, the price of lard was much lower and, although no samples were examined, it was learned from other sources that the fraudulent sale of compound lard was largely discontinued. Owing to the advance in the price of lard during the year 1899, it was thought advisable in the spring of 1900 to resume the work of inspection.

The results obtained in the years 1896 and 1900 may be summarized as follows:

TABLE IX.—SUMMARY OF EXAMINATIONS OF LARD.

	1896	*1900*
Number of samples not found adulterated	75	150
Number of samples adulterated	43	10
Total	118	160
Percentage of samples adulterated	36.5	6.2

From this statement it appears that the fraudulent sale of imitation lard is still practiced, although not so commonly as at the time when the food law first went into operation.

Descriptions of the samples not found adulterated, with names of the dealers and prices, are given in Table X and of the adulterated samples in Table XI. The analytical data and descriptions of methods of analysis appear on pages 145 to 149 in Tables XIII and XIV.

Each of the samples classed as adulterated was a compound lard consisting chiefly of cotton seed oil and containing a certain percentage of beef stearin. Tests were made for paraffine, which has been found by Geisler in oleomargarine, but in none of the samples was this or any other petroleum product present.

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.*

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

*Chem. News, Vols. xxxiv, 254 and xxxviii, 267.

TABLE X.—LARD NOT FOUND ADULTERATED.

Station No.	Brand.	Dealer.	Price per half pound, cents.
1344	Sold in bulk	*Danbury.*—C. Beers, 101 White St.	5
1345	" " "	L. S. Benedict & Son, 193 Main St.	5
1346	" " "	James Doran, 150 Main St.	5
1347	" " "	W. W. Edwards, 147 Main St.	4
1348	" " "	Hoyt & Scott, 7 West St.	5
1349	" " "	D. E. Ketcham & Co., 33 Elm St.	5
1350	" " "	Kirkby & Co., 61 White St.	5
1351	" " "	J. Mc Phelemy, 42 White St.	5
1352	" " "	Smith & Burns, Elm St.	5
1353	" " "	Village Store Co., 289 Main St.	4
1354	Plumb & Winton Co., Palatine Brand, Kettle Rendered	*Bridgeport.*—Lee & Ketcham, 20 Fairfield Ave.	36*
1355	Sold in bulk	*Derby.*—G. W. Cogswell, 30 Elizabeth St.	5
1356	" " "	S. Z. D. Durand, 193 Main St.	5
1357	" " "	G. E. May & Son, 260 Main St.	5
1358	" " "	James McEnery, 75 Elizabeth St.	5
1359	" " "	Peoples Market, 47 Elizabeth St.	6
1360	" " "	D. M. Welch & Son, 312 Main St.	5
1361	" " "	*Meriden.*—Block & Behrens, 74 East Main St.	5
1362	" " "	L. C. Brown, 4 East Main St.	5
1363	" " "	City Meat Market, 21 East Main St.	5
1364	International Provision Co., Brooklyn, Leaf Lard	City Meat Market, 21 East Main St.	25†
1365	Sold in bulk	C. N. Dutton & Co., 17 Colony St.	5
1366	" " "	A. W. Gardner, 41 East Main St.	6
1367	" " "	Hall's Cash Market, East Main St.	5
1368	" " "	Kimball & Hugins, 31 East Main St.	5
1369	" " "	N. P. Lamontagne & Co., 29 State St.	5
1370	" " "	N. E. Butter House, 24 East Main St.	5
1371	" " "	Adam Orr, 8 Colony St.	5
1372	" " "	Pelton & Greene, 65 West Main St.	5
1373	" " "	Public Market, 45 West Main St.	5
1374	" " "	H. F. Rudolph & Co., 32 Pratt St.	5
1375	" " "	Russell Brothers, 2 Colony St.	5
1376	" " "	*Middletown.*—W. F. Ackley & Co., 510 Main St.	5
1377	" " "	C. A. Allison, 31 Main St.	5
1378	Sold in pail, no label	J. E. Bacon, 480 Main St.	35*
1379	Sold in bulk	A. M. Bidwell, 344 Main St.	5
1380	" " "	G. E. Burr, 136 Main St.	5
1381	" " "	S. T. Camp, 234 Main St.	6
1382	" " "	D. I. Chapman, 146 Main St.	5
1383	" " "	Lawton & Wall, 468 Main St.	5
1384	" " "	J. B. Paterson, 110 Main St.	5
1385	" " "	*New Britain.*— Boston Branch, 238 Main St.	5
1386	" " "	City Market, 318 Main St.	5
1387	Cudahy Packing Co., Rex Brand, Kettle Rendered Leaf	City Market, 318 Main St.	30*
1388	Sold in bulk	H. A. Hall, 212 Main St.	5
1389	" " "	Keriadar & Weck, 9 Lafayette St.	5
1390	" " "	C. Nothnagle & Son, 363 Arch St.	5
1391	" " "	W. H. Pierce & Son, 72 West Main St.	5
1392	" " "	Public Market, 373 Main St.	5
1393	" " "	Sovereigns Trading Co., 282 Main St.	6
1394	" " "	Union Trading Co., 61 Arch St.	5

* Per 3 pound pail. † Per 2½ pound pail.

TABLE X.—LARD NOT FOUND ADULTERATED—*Continued.*

Station No.	Brand.	Dealer.	Price per half pound, cents.
1395	Sold in bulk	*New Haven.*—S. S. Adams, 7 Shelton Ave.	4
1396	" " "	D. W. Allyn, 199 Exchange St.	5
1397	" " "	P. L. Baer, 181 Dixwell Ave.	5
1398	" " "	C. L. Bailey, 175 Dixwell Ave.	5
1399	" " "	A. Basserman, 209 Grand Ave.	5
1493	" " "	Mrs. M. O'Connor, 391 Grand Ave.	5
1400	" " "	Oscar Boettger, 209 Shelton Ave.	5
1401	" " "	M. L. Church, 173 Division St.	5
1402	" " "	Mrs. P. E. Davis, 228 Shelton Ave.	5
1403	" " "	Enterprise Market, 316 Grand Ave.	5
1404	" " "	A. A. Eisele, 287 Dixwell Ave.	5
1405	" " "	Everett & Everett, 31 Dixwell Ave.	5
1406	" " "	J. W. Everett, 322 Crown St.	5
1407	" " "	Francis Brothers, 87 Grand Ave.	5
1408	" " "	W. G. Graves, 341 Grand Ave.	5
1409	" " "	F. Hull, 399 Grand Ave.	4
1410	" " "	P. Jente & Bro., 101 Broadway	5
1411	" " "	C. Kipp, 290 Dixwell Ave.	5
1412	Sperry & Barnes, Pure Lard	C. Kipp, 290 Dixwell Ave.	55†
1413	Sold in bulk	F. J. Markle, 85 Broadway	5
1414	" " "	N. H. Provision Co., 382 Grand Ave.	5
1415	Armour & Co., Shield Brand Pure Leaf Lard	N. H. Provision Co., 382 Grand Ave.	30*
1416	Merwin Provision Co., Pure Lard	J. G. Pohlman, 140 Dixwell Ave.	30*
1417	Sold in bulk	J. G. Pohlman, 140 Dixwell Ave.	5
1418	" " "	S. Sachs, 251 Grand Ave.	4
1419	" " "	J. T. Shea, 148 Newhall St.	5
1420	" " "	D. M. Smith, 1 East Grand Ave.	5
1421	" " "	H. E. Smith, 7 Broadway	5
1422	" " "	Voelker Brothers, 123 Shelton Ave.	5
1423	" " "	Mrs. M. Walz, 168 Newhall St.	5
1424	Springfield Provision Co., Pure Lard	D. M. Welch & Son, 28 Congress Ave.	28*
1425	Sold in bulk	D. M. Welch & Son, 28 Congress Ave.	5
1426	" " "	D. M. Welch & Son, 8 Grand Ave.	5
1427	" " "	*New London.*—M. W. Dart, 486 Bank St.	5
1428	" " "	A. Gordon, Potter St.	5
1429	Omaha Packing Co., Red Seal Brand, Kettle Rendered	Harrigan's Market, 175 Bank St.	30*
1430	Sold in bulk	W. A. Holt, 50 Main St.	5
1431	" " "	H. C. Hurlbut, 17 Church St.	5
1432	" " "	Edward Keefe, 495 Bank St.	5
1433	" " "	Keefe & Davis, 125 Bank St.	5
1434	" " "	C. H. Klink & Son, 137 Bank St.	5
1435	" " "	Harry Meadnis, 96 Bank St.	45†
1436	H. L. Handy, Choice Leaf Lard, Springfield	F. H. Smith, 100 State St.	30*
1437	Sold in bulk	George R. Thomas, 437 Bank St.	5
1438	" " "	N. Tinker & Son, 63 Main St.	5
1439	Swift & Co., Silver Leaf, Kettle Rendered Lard	*Norwich.*—J. A. Allyn, 3 Thames St.	30*
1440	Pure Leaf Lard from A. H. Armington, Danielson	A. H. Armington, Shetucket St.	28*
1441	Sold in bulk	Stephen A. Bailey, 40 Broadway	5
1442	" " "	E. E. Beckwith, 88 Central Wharf	5
1443	" " "	E. F. Burlingame, 128 West Main St.	4

* Per 3 pound pail. † Per 5 pound pail.

TABLE X.—LARD NOT FOUND ADULTERATED—*Continued.*

Station No.	Brand.	Dealer.	Price per half pound, cents.
1444	Pure Leaf Lard, C. H. Davis & Co., Packers, Norwich	*Norwich.*—W. H. Cardwell, 3 Market St.	50†
		W. H. Cardwell, 3 Market St.	5
		W. A. Church, 18 Market St.	5
1445	Sold in bulk	J. Connor & Sons, 68 Water St.	5
1446	" " "		
1447			
1448	Pure Leaf Lard, Gardner & Reynolds, Norwich	Gardner & Davis, 4 Commerce St.	36*
		C. W. Hill, 19 Franklin St.	5
1449	Sold in bulk	James Murphy, 3 Water St.	5
1450	" " "	Pease's Market, 86 Franklin St.	5
1451	" " "	*South Norwalk.*—C. Becker, 141 Washington St.	5
1452	" " "	D. S. Davenport, 20 North Main St.	5
1453	" " "	Lorenzo Dibble, 13 North Main St.	5
1454	" " "	G. E. Friedrich, 11 Railroad Ave.	5
1455	" " "	B. Hershfield, 19 Wood St.	5
1456	" " "	F. D. Lawton, 22 South Main St.	5
1457	" " "	P. J. Lynch Co., 118 Washington St.	5
1458	" " "	N. Y. Grocery Co., 132 Washington St.	5
1459	" " "	S. H. Raymond, 44 South Main St.	5
1460	" " "	C. E. Seymour, 33 Washington St.	5
1461	" " "	Edwin Wilcox, 72 Washington St.	5
1462	" " "	*Stamford.*—O. S. Brown, 10 Park Row	5
1463	" " "	H. S. Daskam, 59 Atlantic St.	5
1464	" " "	W. W. Edwards, 99 Main St.	5
1465	" " "	A. J. Finney, 202 Main St.	5
1466	" " "	Kirk & Dixon, 38 Atlantic St.	5
1467	" " "	J. M. Wassing, 131 Atlantic St.	5
1468	" " "	Samuel Price, 98 Main St.	5
1469	" " "	E. M. Purdy, Main St.	5
1470	" " "	C. M. Slater & Co., 88 Main St.	5
1471	" " "	West Park Market, 59 Main St.	5
1472	" " "		
1473	Navy Brand Pure Leaf Lard, Kettle Rendered	*Stonington,*—James H. Stivers	30*
1474	Sold in bulk	*Waterbury.*—M. Blanchette, 258 South Main St.	5
1475	" " "	Brownell's Butter Store, 147 South Main St.	5
1476	" " "	Greater N. Y. Grocery Co., 130 East Main St.	5
1477	" " "	N. W. Heater, 157 East Main St.	5
1478	" " "	Penn. Mdse. Co., 118 East Main St.	5
1479	" " "	William Riether, 12 Bank St.	6
1480	" " "	C. L. Rogers, 96 East Main St.	5
1481	Austin, Nichols & Co., Sunbeam Brand Pure Leaf Lard	Waterbury Grocery Co., 48 North Main St.	35*
1482	Eureka Lard. North Packing and Provision Co.	*Westport.*—Beers Brothers	30*
1483	Pure Kettle Rendered Lard. H. Howey	*Willimantic.*—H. Howey, 34 North St.	36*
1484	Sold in bulk	H. Howey, 34 North St.	6
1485	" " "	F. Larrabee, 20 Church St.	5
1486	Pure Lard. White, Pevey & Dexter Co., Worcester, Mass.	Perkins & Blish, 66 Church St.	30*
1487	Sold in bulk	Purington & Reade, 717 Main St.	5
1488	" " "	Burt Thompson, 796 Main St.	5
1489	" " "	C. M. Thompson & Co., 27 Church St.	5
1490	" " "	A. A. Trudeau, 949 Main St.	5
1491	" " "	Willimantic Cash Store, Main St.	5
1492	" " "	E. Winton, Main St.	6

* Per 3 pound pail. † Per 5 pound pail.

TABLE XI.—COMPOUND LARD SOLD FOR LARD.

Station No.	Brand.	Dealer.	Price per half pound, cents.
1494	Sold in bulk	*Danbury.*—N. Y. Cash Grocery, 307 Main St.	4
1495	" " "	*Derby.*—N. Y. Grocery Co., 215 Main St.	4
1496	" " "	D. Vaccaro, 176 Main St.	4
1497	" " "	*Meriden.*—E. T. Carter, East Main St.	4
1498	" " "	*New Haven.*—H. Strack, 13 Shelton Ave.	4
1499	" " "	*Stamford.*—G. A. Ferris, 184 Main St.	4
1500	" " "	Fitch A. Hoyt, 40 Atlantic St.	4
1501	" " "	M. W. Sherwood, 81 Main St.	4
1502	" " "	*Waterbury.*—W. C. Nichols, 39 East Main St.	5
1503	" " "	Waterbury Cheap Grocery, 171 S. Main St.	5

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.

Refractive Index. The instrument used is the butyro-refractometer made by Carl Zeiss, Jena. The readings are best made at 40° C., using the temperature regulator which accompanies the instrument. If the readings are made at other temperatures the results are reduced to 40° C. by adding 0.55 for each degree above, or substracting 0.55 for each degree below, that temperature. The instrument is graduated in scale divisions from 0 to 100, corresponding to refractive indices from 1.4220 to 1.4895. As readings on this arbitrary scale are not comparable with those made with other instruments, we prefer to reduce each result to the equivalent refractive index. For the purpose of facilitating the calculation of refractive index not only of lard, but of other edible fats, Table XII has been prepared from data given by the manufacturers of the instrument.

Hübl Iodine number. The method followed is essentially that described by the Association of Official Agricultural Chemists.*

The fat is weighed in flat-bottomed glass cylinders 10 mm. in diameter and 20 mm. high, weighing not far from 2 grams. About 0.5 gram of compound lard or 0.7 gram of genuine lard is used in each determination.

Dudley's Modification of the Bechi Test for Cotton Seed Oil.†—The reagent is a solution of 2 grams of silver nitrate in 200 cc. alcohol and 40 cc. ether. After exposure to sunlight, till reaction ceases, the solution is decanted or filtered into a dark bottle.

In testing, 10 grams of melted lard and 5 cc. of the reagent are well stirred together on the water-bath at 100° C. for 15 minutes, at the end of which time most of the alcohol will have passed off. With pure lard there should be no coloration, while in the presence of cotton seed oil the depth of color varies according to the amount and character

*U. S. Dept. Agr., Div. Chem., Bul. 46. Revised Edition, p. 50.

†Described by Wesson, Jour. Am. Chem. Soc. 17, 724.

TABLE XII.—READINGS OF THE ZEISS BUTYRO-REFRACTOMETER AND CORRESPONDING REFRACTIVE INDICES.

Reading.	Refractive Index.	Reading.	Refractive Index.	Reading.	Refractive Index.	Reading.	Refractive Index.
40.0	1.4524	50.0	1.4593	60.0	1.4659	70.0	1.4723
40.5	1.4527	50.5	1.4596	60.5	1.4662	70.5	1.4726
41.0	1.4531	51.0	1.4600	61.0	1.4665	71.0	1.4729
41.5	1.4534	51.5	1.4603	61.5	1.4669	71.5	1.4732
42.0	1.4538	52.0	1.4606	62.0	1.4672	72.0	1.4735
42.5	1.4541	52.5	1.4609	62.5	1.4675	72.5	1.4738
43.0	1.4545	53.0	1.4613	63.0	1.4678	73.0	1.4741
43.5	1.4548	53.5	1.4616	63.5	1.4681	73.5	1.4744
44.0	1.4552	54.0	1.4619	64.0	1.4685	74.0	1.4747
44.5	1.4555	54.5	1.4623	64.5	1.4688	74.5	1.4750
45.0	1.4558	55.0	1.4626	65.0	1.4691	75.0	1.4753
45.5	1.4562	55.5	1.4629	65.5	1.4694	75.5	1.4756
46.0	1.4565	56.0	1.4633	66.0	1.4697	76.0	1.4759
46.5	1.4569	56.5	1.4636	66.5	1.4700	76.5	1.4762
47.0	1.4572	57.0	1.4639	67.0	1.4704	77.0	1.4765
47.5	1.4576	57.5	1.4642	67.5	1.4707	77.5	1.4768
48.0	1.4579	58.0	1.4646	68.0	1.4710	78.0	1.4771
48.5	1.4583	58.5	1.4649	68.5	1.4713	78.5	1.4774
49.0	1.4586	59.0	1.4652	69.0	1.4717	79.0	1.4777
49.5	1.4590	59.5	1.4656	69.5	1.4720	79.5	1.4780

of the oil, and a metallic mirror is deposited on the surface of the liquid fat.

As steam lard treated directly often gives a slight coloration, Wesson recommends that doubtful samples should be first shaken with 2 per cent. solution of nitric acid (25 cc. to 50 grams of melted lard) and the mixture allowed to settle on the water-bath. After washing once with 50 cc. of hot distilled water the clear fat is tested in the manner described. Wesson also states that lards which have been heated at a high temperature for a long time sometimes contain, as a consequence, a slightly higher per cent. of free acid than the normal (normal is 0.4 to 1.0 per cent.) and certain decomposition products which have a strong reducing action. Such samples must be washed with dilute caustic soda solution and distilled water and finally with the 2 per cent. nitric acid.

*Halphen Test for Cotton Seed Oil.** Carbon disulphide containing about 1 per cent. of sulphur in solution is mixed with an equal volume of amyl alcohol. Three cc. of this reagent and 3 cc. of the sample are mixed and heated in a bath of boiling brine for 15 minutes. If olive, sesame, poppy, peanut, walnut or linseed oil, or lard is treated in this manner the color of the mixture usually remains entirely unchanged, but if cotton seed oil is present a red coloration is produced. In the presence of a very small amount of cotton seed oil, the color which

* Analyst., 1897, 326. Allen, Commercial Organic Analysis, 3d edit., Philadelphia, 1899, Vol. II. Part 1, 143. See also Raikow and Tscherweniwanow, Chem. Ztg., 1899, 23, [97] 1025.

appears may be pink or orange, according as the fat or oil tested is white or yellow.

This test is much more delicate than the Bechi test and is less liable to give slight reactions with pure samples.

If no color appears by the treatment described, the author states that 1 cc. of the reagent may be added and if, after 5 or 10 minutes more heating, no color is shown, a third addition of 1 cc. may be made. In our experience the second and third heating with fresh portions of the reagent appears to be unnecessary, as samples of pure lard and pure olive oil, which of themselves showed no color by this test, when mixed with as little as 0.6 per cent. of cotton seed oil, gave distinct reactions on heating for 15 minutes, and when the amount was as high as 5 per cent. a bright red color was obtained.

When operating on lard or olive oil mixed with a given sample of cotton seed oil in different proportions, we also find that the intensity of the color produced by the test is directly proportional to the percentage of admixture. While it is true that different lots of cotton seed oil react somewhat differently, still the intensity of the coloration serves as a rough indication of the amount of adulteration.

The color of the mixture remains unaltered for days and even weeks, unlike that obtained in the Baudouin test for sesame oil which changes in a few hours to black.

Raikow and Tscherweniwanow states that the sensitiveness of cotton seed oil toward Halphen's reagent is destroyed by heating the oil with superheated steam, or at a temperature of 220° C.

*Belfield Test for Beef Fat, Modified by Gladding.** Two and one-half grams of melted lard are dissolved with the aid of heat in 7.5 cc. of a mixture of one part of ether and two parts of absolute alcohol. The solution is cooled in ice water until a copious precipitate is obtained which is collected on a filter and washed once or twice with the alcohol-ether mixture. After drying on the filter at the room temperature, the solid fat is transferred to a test tube and dissolved in 15 cc. of ether. The test tube, loosely stopped with cotton, is placed in a vessel containing enough water to insure a uniform temperature and the ether is allowed to evaporate spontaneously. The abundant crystals which appear after some hours are examined under the microscope using ether as a medium. The needle shaped crystals of beef stearin, arranged in curved bundles, are readily distinguished from the broad truncated lard stearin crystals.

The specific gravity of the samples of lard not found adulterated ranged from 0.8655 to 0.8642, that of the adulterated samples ranged from 0.8605 to 0.8588.

The refractive index at 40° C. of the samples not found adulterated ranged from 1.4603 to 1.4582, and that of the adulterated samples from 1.4636 to 1.4623.

*J. Am. Chem. Soc. *18*, 189.

TABLE XIII.—ANALYSES OF LARD.

Station No.		Specific gravity at 98°C.	Refractive index at 40°C.	Bechi test.	Halphen test.
1344	Not found adulterated	----	1.4596	No color	No color
1345	" " "	----	1.4596	" "	" "
1346	" " "	----	1.4600	" "	" "
1347	" " "	----	1.4596	Faint gray	" "
1348	" " "	----	1.4596	No color	" "
1349	" " "	----	1.4600	" "	" "
1350	" " "	----	1.4596	" "	" "
1351	" " "	----	1.4600	" "	Faint pink
1352	" " "	----	1.4600	" "	No color
1353	" " "	----	1.4600	Faint gray	" "
1354	" " "	.8602	1.4600	No color	" "
1355	" " "	----	1.4600	" "	" "
1356	" " "	----	1.4600	" "	Faint pink
1357	" " "	----	1.4600	" "	No color
1358	" " "	----	1.4600	" "	" "
1359	" " "	----	1.4593	" "	" "
1360	" " "	----	1.4600	" "	" "
1361	" " "	----	1.4596	" "	" "
1362	" " "	----	1.4600	" "	" "
1363	" " "	.8600	1.4596	Faint gray	" "
1364	" " "	----	1.4596	No color	" "
1365	" " "	----	1.4596	" "	" "
1366	" " "	----	1.4593	" "	" "
1367	" " "	.8596	1.4596	Faint gray	" "
1368	" " "	----	1.4596	No color	" "
1369	" " "	----	1.4600	" "	" "
1370	" " "	----	1.4593	" "	" "
1371	" " "	----	1.4596	" "	" "
1372	" " "	.8590	1.4586	" "	" "
1373	" " "	----	1.4593	" "	" "
1374	" " "	----	1.4600	" "	" "
1375	" " "	----	1.4596	" "	" "
1376	" " "	----	1.4600	" "	" "
1377	" " "	----	1.4596	" "	" "
1378	" " "	----	1.4593	Faint gray	" "
1379	" " "	----	1.4600	No color	" "
1380	" " "	.8596	1.4600	" "	" "
1381	" " "	----	1.4600	" "	" "
1382	" " "	.8600	1.4600	" "	" "
1383	" " "	----	1.4596	" "	" "
1384	" " "	----	1.4596	" "	" "
1385	" " "	----	1.4600	" "	" "
1386	" " "	----	1.4596	" "	" "
1387	" " "	----	1.4600	Faint gray	Faint pink
1388	" " "	----	1.4596	No color	No color
1389	" " "	----	1.4596	" "	Faint pink
1390	" " "	----	1.4596	" "	No color
1391	" " "	----	1.4596	" "	" "
1392	" " "	----	1.4600	Faint gray	" "
1393	" " "	.8590	1.4593	" "	" "
1394	" " "	----	1.4596	No color	" "

TABLE XIII.—ANALYSES OF LARD—*Continued.*

Station No.		Specific gravity at 98°C.	Refractive index at 40°C.	Bechi test.	Halphen test.
1395	Not found adulterated	----	1.4596	No color	No color
1396	" " "	.8596	1.4593	" "	" "
1397	" " "	----	1.4593	" "	" "
1398	" " "	----	1.4600	" "	" "
1399	" " "	.8597	1.4596	" "	" "
1493	" " "	.8604	1.4600	" "	" "
1400	" " "	----	1.4596	Faint gray	" "
1401	" " "	----	1.4596	No color	" "
1402	" " "	----	1.4593	" "	" "
1403	" " "	.8593	1.4596	" "	" "
1404	" " "	.8590	1.4593	" "	" "
1405	" " "	----	1.4593	" "	" "
1406	" " "	----	1.4596	" "	" "
1407	" " "	.8590	1.4593	" "	" "
1408	" " "	.8600	1.4600	" "	" "
1409	" " "	.8595	1.4589	" "	" "
1410	" " "	----	1.4596	" "	" "
1411	" " "	----	1.4596	" "	" "
1412	" " "	.8600	1.4596	" "	" "
1413	" " "	----	1.4593	" "	" "
1414	" " "	.8600	1.4596	" "	Faint pink
1415	" " "	.8600	1.4600	" "	No color
1416	" " "	----	1.4596	" "	" "
1417	" " "	----	1.4593	" "	" "
1418	" " "	.8604	1.4600	" "	" "
1419	" " "	----	1.4600	" "	" "
1420	" " "	.8602	1.4600	" "	" "
1421	" " "	----	1.4593	" "	" "
1422	" " "	----	1.4596	" "	" "
1423	" " "	----	1.4596	" "	" "
1424	" " "	----	1.4600	" "	" "
1425	" " "	----	1.4596	" "	" "
1426	" " "	.8600	1.4596	" "	" "
1427	" " "	.8597	1.4600	" "	" "
1428	" " "	.8603	1.4600	" "	Pink
1429	" " "	----	1.4593	" "	No color
1430	" " "	.8599	1.4600	" "	" "
1431	" " "	.8602	1.4596	" "	" "
1432	" " "	.8598	1.4596	" "	" "
1433	" " "	.8602	1.4596	" "	Faint pink
1434	" " "	.8597	1.4600	" "	" "
1435	" " "	----	1.4596	" "	No color
1436	" " "	----	1.4596	" "	" "
1437	" " "	.8595	1.4593	" "	" "
1438	" " "	.8605	1.4600	Faint gray	Faint pink
1439	" " "	----	1.4600	No color	No color
1440	" " "	----	1.4600	" "	" "
1441	" " "	.8600	1.4596	" "	" "
1442	" " "	.8595	1.4596	" "	" "
1443	" " "	.8600	1.4596	" "	" "

TABLE XIII.—ANALYSES OF LARD—*Concluded.*

Station No		Specific gravity at 98°C.	Refractive index at 40°C.	Bechi test.	Halphen test.
1444	Not found adulterated	----	1.4600	No color	No color
1445	" " "	.8595	1.4596	" "	" "
1446	" " "	.8601	1.4596	" "	" "
1447	" " "	.8596	1.4593	" "	" "
1448	" " "	----	1.4593	Faint gray	" "
1449	" " "	.8602	1.4596	No color	" "
1450	" " "	.8599	1.4596	" "	" "
1451	" " "	.8597	1.4593	" "	" "
1452	" " "	----	1.4600	" "	Faint pink
1453	" " "	----	1.4603	Faint gray	No color
1454	" " "	----	1.4600	No color	" "
1455	" " "	----	1.4600	" "	Faint pink
1456	" " "	----	1.4596	" "	No color
1457	" " "	----	1.4593	" "	" "
1458	" " "	----	1.4596	" "	" "
1459	" " "	----	1.4596	" "	" "
1460	" " "	----	1.4596	" "	" "
1461	" " "	----	1.4600	" "	" "
1462	" " "	----	1.4600	Gray	Pink
1463	" " "	----	1.4600	No color	No color
1464	" " "	----	1.4593	" "	" "
1465	" " "	----	1.4596	" "	" "
1466	" " "	----	1.4600	" "	" "
1467	" " "	----	1.4596	" "	" "
1468	" " "	----	1.4600	Faint gray	" "
1469	" " "	----	1.4596	No color	" "
1470	" " "	----	1.4593	Faint gray	" "
1471	" " "	----	1.4596	No color	" "
1472	" " "	----	1.4593	Faint gray	" "
1473	" " "	----	1.4596	No color	" "
1474	" " "	----	1.4600	" "	" "
1475	" " "	----	1.4600	" "	Pink
1476	" " "	----	1.4600	" "	Faint pink
1477	" " "	----	1.4586	" "	No color
1478	" " "	----	1.4600	" "	" "
1479	" " "	----	1.4600	Faint gray	" "
1480	" " "	----	1.4600	No color	" "
1481	" " "	----	1.4596	" "	" "
1482	" " "	----	1.4600	" "	" "
1483	" " "	----	1.4593	Faint gray	" "
1484	" " "	.8600	1.4596	No color	" "
1485	" " "	.8600	1.4593	" "	Faint pink
1486	" " "	----	1.4600	" "	No color
1487	" " "	.8595	1.4593	" "	" "
1488	" " "	.8600	1.4596	" "	" "
1489	" " "	.8590	1.4582	Faint gray	" "
1490	" " "	----	1.4593	No color	" "
1491	" " "	.8594	1.4596	" "	" "
1492	" " "	.8588	1.4589	Gray	" "

TABLE XIV.—ANALYSES OF COMPOUND LARD.

Station No.		Specific gravity at 98°C.	Refractive index at 40°C.	Iodine number.	Bechi test.	Halphen test.	Belfield test.
1494	Compound lard	.8650	1.4629	89.36	Black	Deep red	Beef stearine
1495	" "	.8652	1.4633	90.91	"	" "	" "
1496	" "	.8645	1.4629	88.16	"	" "	" "
1497	" "	.8642	1.4629	92.52	"	" "	" "
1498	" "	.8650	1.4626	89.95	"	" "	" "
1499	" "	.8643	1.4626	88.07	"	" "	" "
1500	" "	.8653	1.4636	94.55	"	" "	" "
1501	" "	.8655	1.4636	94.46	"	" "	" "
1502	" "	.8644	1.4623	83.46	"	" "	" "
1503	" "	.8645	1.4626	85.27	"	" "	" "
2850	Cottolene	.8662	1.4633				

LARD OIL.

By A. L. WINTON.

It is stated that lard oil is used by bakers as a fat in which to cook doughnuts. A single sample sent for examination had a specific gravity at 15.5° C. of 0.8855, too low for genuine lard oil, and a refractive index at 15.5° C. of 1.4723, which is higher than that of genuine oil. It proved to be adulterated with about half its weight of coal oil.

OLIVE OIL.

By A. L. WINTON AND A. W. OGDEN.

Three years ago the purchasing agent of this Station bought in this state seventy-eight samples of "olive oil," partly of grocers and partly of druggists, which were duly examined with respect to adulteration.* During the present year one hundred and five samples have been examined. Those from grocers were, as a rule, sold in sealed bottles bearing the names of producers or wholesalers, whereas those from druggists were taken from shelf bottles and sold in common druggist's vial. Detailed descriptions of the samples examined in 1900 are given in Tables XVI, XVII, and XVIII.

Following is a statement of the results of these examinations of Market Samples.

*Report of this Station, *1897*, pp. 44-52.

TABLE XV.—RESULTS OF EXAMINATIONS OF OLIVE OIL IN 1897 AND 1900.

	1897			1900		
	From Grocers.	From Druggists.	Total.	From Grocers.	From Druggists.	Total
Not found adulterated	37	13	50	45	17	62
Adulterated with cotton seed oil	22	2	24	28	9	37
Adulterated with sesame oil	1	3	4	0	4	4
Variously adulterated	0	0	0	0	2	2
Total	60	18	78	73	32	105
Percent of samples adulterated	38.3	27.8	35.8	38.4	40.6	39.0

From these figures it appears that purchasers asking for olive oil often receive cheaper substitutes and that druggists sell adulterated oils quite as often as do grocers. Cotton seed oil is the most common adulterant, although sesame and other oils are used to some extent.

Of the samples consisting wholly or in part of cotton seed oil, 9 samples in 1897 and 17 samples in 1900 were in sealed bottles plainly labeled "Salad Oil".

They were, however, sold by the retailer, on request of the purchaser for "olive oil," which is illegal, as there was nothing on the label to show that the articles were not olive oil.

These samples are described by themselves in Table XVIII, page 153.

The purchaser who desires pure olive oil will do well to purchase in a sealed bottle or can bearing the name of a reputable house, which appears from the following tables to handle only pure oil.

The tables show which samples were not found adulterated but do not show anything as to the flavor or quality otherwise, since an oil though pure may yet be rancid and unappetizing. Different brands of olive oil differ quite as much in quality, flavor and price as wines.

METHODS OF ANALYSIS.

Specific gravity is determined by the Westphal balance at room temperature. The results are calculated to a temperature of 15.5° C. by the formula $G = G' + 0.00064\ (T—15.5)$ in which G is the specific gravity at 15.5° C, G' the reading of the balance at T, the temperature of the oil.

Refractive index. Readings by the Zeiss refractometer are taken at a temperature of 15.5°, or reduced to that temperature by the formula

TABLE XVI.—OLIVE OIL NOT FOUND ADULTERATED.

Station No.	Brand.	Dealer.	Price per bottle, cents.	Ounces of Oil in bottle.
1575	Beaumarchand Fils, Bordeaux, Huile d'Olive Vierge	*Bridgeport.*—Public Market, 46 State St	25	4½
1576	Pinto Aine & Cie, Bordeaux, Huile d'Olive	G. E. Cleaveland, 200 State St.	50	9
1577	Sold in druggist's vial	Congress Pharmacy, 589 Main St.	20	2
1578	Sold in druggist's vial	L. F. Curtiss, 481 Main St.	15	2
1579	P. M. Loubrie, Bordeaux, Huile d'Olive	Andrew Davey, 492 Main St.	20	4½
1580	Sold in druggist's vial	Dupee's Pharmacy, 59 Fairfield Ave.	10	2
1581	Clark, Chapin & Bushnell, Huile d'Olive Vierge, Bordeaux	E. R. Foote, 594 Main St.	45	9
1582	G. W. Smith, Sublime Olive Oil, bottled in France	G. W. Smith, 160 State St.	20	4½
1583	Barton & Guestier, Bordeaux, Huile d'Olive	G. W. Smith, 160 State St.	25	4½
1584	Alexis Godillot Jeune, Huile d'Olive Vierge	R. T. Whiting, 345 Main St.	25	5
1585	Sonnette & Cie, Bordeaux, Finest French Olive Oil	R. Wundrack, 575 Main St.	25	4
1586	Jules Chambon & Co., Bordeaux, Huile d'Olive	*Danbury.*—L. S. Benedict & Son, 193 Main St.	45	12
1587	Société Higiénique Alimentaire Tuscan Huile d'Olive	W. W. Edwards, 147 Main St.	40	12
1588	John M. Chapman & Co., N. Y., Cordon d'Argent Olive Oil	Hoyt & Scott, 7 West St.	25	4½
1589	F. Dupont, Bordeaux, Huile d'Olive Vierge	N. Y. Cash Grocery, 307 Main St.	10	2½
1590	Georges Leduc, Bordeaux, Huile d'Olive	*Derby.*—G. W. Cogswell, 30 Elizabeth St.	25	5
1591	Bryan, Miner & Read, Importers, bottled in Bordeaux	J. McEnerney, 75 Elizabeth St.	25	4
1592	A. Mordal & Cie, Nice (France), Huile d'olive Vierge	N. Y. Grocery Co., 215 Main St.	35	8
1593	F. Po Berio & Co., Lucca Toscana, Italy, Olio d'Oliva	D. Vaccaro, 176 Main St.	50	32*
1594	Naegely & Pasero, Marseilles (France), Huile d'Olive	D. M. Welch & Son, 312 Main St.	35	9
1595	Chateau Neuf. Pure Olive Oil	*Greenwich.*—H. C. Boswell	35	5
1596	A. Fontenelle Fils & Cie, Grasse (France), Huile d'Olive	*Hartford.*—H. Griswold, 547 Main St.	35	9
1597	James Plagniol, France, Huile d'Olive Vierge	Guilfoil Grocery Co., 193 Asylum St.	25	4½
1598	Cream Olive Oil, made in Leghorn	Public Market, 653 Main St.	25	4
1599	S. Rae & Co, Leghorn, Italy, Choicest Tuscan Olive Oil	Public Market, 653 Main St.	25	4
1600	Naegely & Pasero, Marseilles (France), Huile d'Olive	Russell's Butter Store, 909 Main St.	35	9
1601	S. Rae & Co, Leghorn, Italy, Sublime Lucca Oil	Union Grocery Co., 1028 Main St.	25	4
1602	Gobelin Fils & Cie, Bordeaux, Huile d'olive de Table	W. W. Walker, 745 Main St.	25	6
1603	Sold in druggist's vial	*Meriden.*—Albert Babb, 14 West Main St.	15	2
1604	Sold in druggist's vial	N. P. Forcier & Co., 37 West Main St.	15	2

* In tin can.

TABLE XVI.—OLIVE OIL NOT FOUND ADULTERATED—*Continued.*

Station No.	Brand.	Dealer.	Price per bottle, cents.	Ounces of Oil in bottle.
1605	Sold in druggist's vial	*Meriden.*—W. W. Mosher, 13 Colony St.	15	2
1606	C. Maspero's Lucca Olive Oil, Italy	*Middletown.*—C. P. Bonfoey, 181 Court St.	25	4
1607	Calve, Bordeaux (France), Huile d'Olive Vierge	G. E. Burr, 136 Main St.	45	9
1608	No label, bottle enclosed in wicker basket	S. T. Camp, 234 Main St.	30	7
1609	Sold in druggist's vial	*New Britain.*—C. Dickinson, 195 Main St.	20	3
1610	Sold in druggist's vial	*New Haven.*—J. J. Alling, 141 Dixwell Ave.	13	2
1611	Antonini & Co., Italian Salad Oil	J. W. Everett, 322 Crown St.	45	10
1612	Warrick Fréres, Grasse, France, Huile d'Olive	Everett & Everett, 31 Dixwell Ave.	20	4
1613	Henry Pasero & Co., France, Huile d'Olive Extra Vierge	E. E. Hall & Son, 381 State St.	59	16
1614	Brillat Fils, Bordeaux, Finest French Olive Oil	C. Kipp, 290 Dixwell Ave.	20	4½
1615	D. G. Rossette & Co., Leghorn, Italy, Cream Lucca Olive Oil	L. L. Rosenberg, 144 Congress Ave.	16	4½
1616	S. Rae & Co., Leghorn, Italy, Tuscan Lucca Olive Oil	*New London.*—Keefe & Davis, 125 Bank St.	25	4½
1617	J. B. & A. Artand Fréres, Marseilles, Huile d'Olive Vierge	C. H. Klink & Son, 137 Bank St.	45	9
1618	Sold in druggist's vial	Starr Bros., 108 State St.	15	2
1619	Sold in druggist's vial	*Norwalk.*—E. B. Weed, 38 Wall St.	15	2
1620	L. A. Price, Bordeaux (France), Huile d'Olive Vierge	*Norwich.*—A. H. Armitage, Shetucket St.	20	6
1621	Sold in druggist's vial	B. A. Herrick, Broadway	15	2
1622	Gabriel Triat & Co., Bordeaux, Huile d'Olive Vierge	J. P. Halloway, 319 East Main St.	25	4½
1623	Sold in druggist's vial	N. D. Sevin & Son, 118 Main St.	15	2
1624	A. Mordal & Cie. Nice (France), Huile d'Olive Vierge	*South Norwalk.*—N. Y. Grocery Co., 132 Washington St.	35	9
1625	Chapnelle & Cie, Aix, France, Huile d'Olive Laselle	C. E. Seymour, 33 Washington St.	25	4½
1626	Huile D'olive, bottled in Bordeaux, France	*Stamford.*—H. S. Daskam, 59 Atlantic St.	25	4½
1627	Finest Sublime Lucca Oil, Italy	G. A. Ferris, 184 Main St.	40	14½
1628	Sold in druggist's vial	C. S. Finch, 134 Atlantic St.	15	2
1629	Lanier Fréres, Bordeaux, Huile d'Olive Vierge	A. J. Finney, 202 Main St.	35	9
1630	Sold in druggist's vial	*Stonington.*—C. E. Brayton & Co., Main St.	10	2
1631	Sold in druggist's vial	*Waterbury.*—Apothecaries Hall Co.	20	3
1632	Sold in druggist's vial	Cannon & Webster, 105 Bank St.	15	3
1633	James Plagniol, Huile d'Olive Vierge, France	Hewitt Grocery Co., 14 North Main St.	25	4½
1634	La Roux & Fils, Bordeaux, Huile d'Olives	Rausch's Delicatessen, 3 Grand St.	25	4½
1635	Cream Olive Oil, made in Leghorn	*Willimantic.*—F. Larrabee, 20 Church St.	10	4
1636	Sold in druggist's vial	F. M. Wilson & Co., Main St.	15	2

TABLE XVII.—ADULTERATED OLIVE OIL.

Station No.	Brand.	Dealer.	Price per bottle, cents.	Ounces of Oil in bottle.
	Adulterated with Cotton Seed Oil.			
1637	E. Loubon, Nice, Huile d'Olive Vierge	*Bridgeport.*—A. E. Vincent, 21 Wall St.	7	2½
1638	Sold in druggist's vial	*Greenwich.*—P. B. Montells	15	2
1639	Sold in druggist's vial	*Middletown.*—Buell & Blatchley, 246 Main St.	10	2
1640	Sold in druggist's vial	*New Britain.*—Jas. R. Halloran, 365 Main St.	15	2
1641	Sold in druggist's vial	*New Haven.*—G. N. Alling, 95 Broadway	15	2
1642	Sold in bulk	A. Fehlberg, 116 Congress Ave	13	8
1643	Sold in bulk	A. Fehlberg, 116 Congress Ave	7	8
1644	Francesco Picinini, Lucca, Italy, Olio d'Oliva	S. Francesconi, 134 Congress Ave.	50	32*
1645	No label	G. Greenberg, 84 Congress Ave	25	6
1646	Italian Olive Oil (Vero Olio d'Oliva)	E. E. Hall & Son, 381 State St.	50	16
1647	No label	L. L. Rosenberg, 144 Congress Ave.	10	3
1648	Tisseraud & Fils, Huile d'Olive, Bordeaux	D. M. Welch & Son, 30 Congress Ave.	20	4
1649	Sold in druggist's vial	*New London.*—Nichols & Harris, 119 State St.	15	2
1650	Sold in druggist's vial	*Norwalk.*—W. C. Baur, 55 Wall St.	15	2
1651	C. Cartoux, Nice, Huile d'Olive Vierge	*South Norwalk.*—D. S. Davenport, 20 North Main St.	25	20
1652	Sold in druggist's vial	R. H. Plaisted, 43 Washington St.	10	2
1653	R. L. Dacosini, Bordeaux, Huile d'Olive	S. H. Raymond, 44 S. Main St.	12	6½
1654	Sold in druggist's vial	E. G. Tomlinson, 8 North Main St.	15	2
1655	Francois Ferrari, Port Maurice, Prés Nice, Italié	*Stamford.*—H. S. Daskam, 59 Atlantic St.	20	20
1656	Sold in druggist's vial	*Waterbury.*—Waterbury Drug Co., 134 East Main St.	15	3
	Adulterated with Sesame Oil.			
1657	Sold in druggist's vial	*New Britain.*—Lyceum Pharmacy	15	2
1658	Sold in druggist's vial	*New Haven.*—A. N. Dedrick, 245 Dixwell Ave.	30	4
1659	Sold in druggist's vial	S. H. Williams, 183 Shelton Ave.	20	4
1660	Sold in druggist's vial	*Willimantic.*—F. Rogers, 120 Main St.	13	2
	Otherwise adulterated.			
1661	Sold in druggist's vial	*South Norwalk.*—G. C. Stillson & Co.	25	2
1662	Sold in druggist's vial	*Willimantic.*—City Drug Store, 726 Main St.	15	2

* In tin can.

TABLE XVIII.—"SALAD OIL," CONSISTING WHOLLY OR IN PART OF COTTON SEED OIL.

Station No.	Brand.	Dealer.	Price per bottle, cents.	Ounces of Oil in bottle.
1663	Union Oil Co., Providence, R. I., Pure Salad Oil	*Bridgeport.*—G. E. Cleaveland, 200 State St.	10	5
1664	E. Loubon, Nice, Huile pour Salad	Coe & White, 560 Main St.	10	7
1665	Union Oil Co., Providence, R. I., Pure Salad Oil	Coe & White, 560 Main St.	15	10
1666	Los Angeles Extra Superfine Purest Salad Oil	Andrew Davey, 492 Main St.	10	5
1667	E. Loubon, Pure Salad Oil	E. R. Foote, 594 Main St.	10	7
1668	E. Loubon, Superfine Huile Salad Garantie	McKenzie Bros., 46 State St.	5	3
1669	E. Loubon, Pure Salad Oil	C. Russell & Co., 335 Main St.	15	7
1670	E. Loubon, Superfine Huile Salad Garantie	*Hartford.*—Dow & Hatch, Pratt St.	15	5
1671	E. Loubon, Nice, Huile pour Salad	P. S. Kennedy, 1046 Main St.	10	3
1672	E. Loubon, Superfine Huile Salad Garantie	P. S. Kennedy, 1046 Main St.	25	4
1673	Carlo Crispi, Nice, Superfine Huile Salad	W. C. Wade, 653 Main St.	10	4
1674	E. Loubon, Pure Salad Oil	Union Grocery Co., 1028 Main St.	8	2½
1675	Los Angeles Extra Superfine Purest Salad Oil	W. W. Walker, 745 Main St.	15	10
1676	Garnier Fréres, Bordeaux, Huile d'Salad	*Middletown.*—Winterich & Kirby, 218 Main St.	45	6
1677	L. Verona, Superfine Huile Salad	*New Haven.*—F. J. Markle, 85 Broadway	10	4½
1678	Midas Fréres Superfine Huile Salad	*South Norwalk.*—C. Becker, 141 Washington St.	25	20
1679	Lauren Fréres, Bordeaux, Huile d'Salad	P. J. Lynch Co., 118 Washington St.	6	3

$R = R' + 0.55\ (T - 15.5)$, in which R is the reading reduced to 15.5° and R′ is the reading taken at the temperature T.

Iodine number, Bechi test, and Halphen test. See pp. 142 and 143.

*Baudouin test for sesame oil.** Shake violently 20 cc. of the oil with 10 cc. of concentrated hydrochloric acid in which has been dissolved 0.1 to 0.2 grams of sugar. If the watery liquid remains nearly colorless, the oil may be judged free from sesame oil, but, if it acquires a deep red color, adulteration with this oil is indicated.

Domergue† states that pure African olive oil sometimes gives a pink coloration by this test when applied directly to the oil, but if the test is made on the fatty acids, this coloration does not appear; whereas the fatty acids from sesame oil react the same as the oil itself.

Tocher test for sesame oil.‡ Mix in a separatory funnel a solution of 2 grams of pyrogallic acid in 15 cc. of concentrated hydrochloric acid, with 15 grams of the oil. After the two liquids separate, draw off the acid solution and boil for about five minutes. In the presence of sesame oil the liquid becomes red, with a blue fluorescence.

* Ztschr. f. das. Chem. Grossgewerbe, 1878, 771.
† Chem. Ztg., 1891, 15 Rep., 15.
‡ Chem. Ztg., 1891, 15 Rep., 15 and 33.

TABLE XIX.—ANALYSES OF OLIVE OIL.

Station No.		Specific gravity at 15.5° C.	Refractive index at 15.5° C.	Iodine number.	Bechi test.	Halphen test.	Baudouin test.	Tocher test.
1575	Not found adult'd	.9166	1.4710	----	Faint gray	Yellow	Faint pink	----
1576	" " "	.9164	1.4707	----	Yellow	"	Yellow	----
1577	" " "	.9167	1.4707	----	"	"	"	----
1578	" " "	.9166	1.4710	----	"	"	"	----
1579	" " "	.9166	1.4707	----	Faint gray	"	"	----
1580	" " "	.9168	1.4704	----	Yellow	"	"	----
1581	" " "	.9157	1.4707	----	"	"	"	----
1582	" " "	.9166	1.4707	----	"	F'nt pink	"	----
1583	" " "	.9155	1.4707	----	"	Yellow	"	----
1584	" " "	.9156	1.4700	----	"	"	"	----
1585	" " "	.9165	1.4704	----	"	"	"	----
1586	" " "	.9168	1.4707	----	"	"	"	----
1587	" " "	.9169	1.4710	----	"	"	"	----
1588	" " "	.9165	1.4710	----	"	"	"	----
1589	" " "	.9163	1.4704	----	"	"	"	----
1590	" " "	.9168	1.4710	----	"	"	"	----
1591	" " "	.9163	1.4707	----	"	"	"	----
1592	" " "	.9170	1.4714	----	"	"	"	----
1593	" " "	.9168	1.4710	83.48	"	Pink	"	Faint test
1594	" " "	.9168	1.4707	----	"	Yellow	"	----
1595	" " "	.9168	1.4710	83.60	Sl'g't color	"	"	----
1596	" " "	.9166	1.4707	----	Yellow	"	"	----
1597	" " "	.9167	1.4707	----	"	"	"	----
1598	" " "	.9158	1.4707	----	"	"	"	----
1599	" " "	.9158	1.4707	----	"	"	"	----
1600	" " "	.9163	1.4710	----	"	"	"	----
1601	" " "	.9158	1.4704	----	"	"	"	----
1602	" " "	.9163	1.4707	----	"	"	"	----
1603	" " "	.9166	1.4707	----	Yellow	Yellow	Yellow	----
1604	" " "	.9168	1.4710	----	"	"	"	----
1605	" " "	.9168	1.4707	----	"	"	"	----
1606	" " "	.9175	1.4707	----	"	"	"	----
1607	" " "	.9175	1.4707	----	"	"	"	----
1608	" " "	.9163	1.4704	----	"	"	"	----
1609	" " "	.9166	1.4707	----	"	"	"	----
1610	" " "	.9167	1.4707	----	"	"	"	----
1611	" " "	.9168	1.4707	----	"	"	"	----
1612	" " "	.9169	1.4710	----	"	"	"	----
1613	" " "	.9166	1.4708	----	"	"	"	----
1614	" " "	.9167	1.4704	----	"	"	Faint pink	----
1615	" " "	.9164	1.4707	----	"	"	Yellow	----
1616	" " "	.9163	1.4707	----	"	"	"	----
1617	" " "	.9167	1.4710	----	Faint gray	Orange	"	----
1618	" " "	.9165	1.4710	----	Yellow	Yellow	"	----
1619	" " "	.9170	1.4704	----	"	"	"	----
1620	" " "	.9161	1.4707	----	"	"	"	----
1621	" " "	.9164	1.4707	----	"	"	"	----
1622	" " "	.9162	1.4707	----	"	"	"	----
1623	" " "	.9166	1.4707	----	"	"	"	----
1624	" " "	.9167	1.4714	----	"	"	"	----
1625	" " "	.9170	1.4710	----	"	"	"	----
1626	" " "	.9168	1.4707	----	"	"	"	----
1627	" " "	.9168	1.4707	----	"	"	"	----

TABLE XIX.—ANALYSES OF OLIVE OIL—*Continued.*

Station No.		Specific gravity at 15.5° C.	Refractive index at 15.5° C.	Iodine number.	Bechi test.	Halphen test.	Baudouin test.	Tocher test.
1628	Not found adult'd	.9167	1.4710	----	Yellow	Yellow	Yellow	----
1629	" " "	.9172	1.4707	----	"	"	"	----
1630	" " "	.9168	1.4710	----	"	"	"	----
1631	" " "	----	1.4707	----	----	----	----	----
1632	" " "	----	1.4707	----	----	----	----	----
1633	" " "	----	1.4704	----	----	----	----	----
1634	" " "	----	1.4710	----	----	----	----	----
1635	" " "	----	1.4707	----	----	----	----	----
1636	" " "	----	1.4704	----	----	----	----	----
1637	Adulterated with cotton seed oil	.9234	1.4744	----	Black	Deep red	----	----
1638	" " " "	.9230	1.4744	----	"	" "	----	----
1639	" " " "	.9241	1.4750	108.40	"	" "	----	----
1640	" " " "	.9221	1.4744	----	"	" "	----	----
1641	" " " "	.9234	1.4741	----	"	" "	----	----
1642	" " " "	.9225	1.4741	----	"	" "	----	----
1643	" " " "	.9230	1.4747	----	"	" "	----	----
1644	" " " "	.9203	1.4726	96.07	D'k brown	" "	----	----
1645	" " " "	.9168	1.4720	----	" "	" "	----	----
1646	" " " "	.9184	1.4721	----	Black	" "	----	----
1647	" " " "	.9221	1.4741	----	"	" "	----	----
1648	" " " "	.9200	1.4723	95.31	"	" "	----	----
1649	" " " "	.9204	1.4735	102.44	"	" "	----	----
1650	" " " "	.9232	1.4744	----	"	" "	----	----
1651	" " " "	.9229	1.4738	----	"	" "	----	----
1652	" " " "	.9232	1.4744	----	"	" "	----	----
1653	" " " "	.9223	1.4741	----	"	" "	----	----
1654	" " " "	.9234	1.4750	----	"	" "	----	----
1655	" " " "	.9235	1.4741	----	"	" "	----	----
1656	" " " "	.9231	1'4744	----	"	" "	----	----
1657	Adulterated with sesame oil	.9196	1.4722	86.72	"	"	Deep red	Red & blue
1658	" " "	.9174	1.4718	88.40	"	"	" "	" "
1659	" " "*	.9177	1.4717	87.34	"	"	" "	" "
1660	" " "	.9176	1.4717	89.63	"	"	" "	" "
1661	Otherwise adult'd	.9318	1.4723	73.26	Brown	----	Ora'ge red	----
1662	" "†	.9322	1.4723	67.32	"	----	" "	----
1663	Salad oil‡ -------	.9232	1.4744	----	Black	Deep red	----	----
1664	" " -------	.9220	1.4741	----	"	" "	----	----
1665	" " -------	.9220	1.4744	----	"	" "	----	----
1666	" " -------	.9221	1.4741	----	"	" "	----	----
1667	" " -------	.9223	1.4744	----	"	" "	----	----
1668	" " -------	.9227	1.4744	----	"	" "	----	----
1669	" " -------	.9226	1.4744	----	"	" "	----	----
1670	" " -------	.9223	1.4744	----	"	" "	----	----
1671	" " -------	.9219	1.4741	----	"	" "	----	----
1672	" " -------	.9221	1.4744	----	"	" "	----	----
1673	" " -------	.9224	1.4741	----	"	" "	----	----
1674	" " -------	.9223	1.4744	----	"	" "	----	----
1675	" " -------	.9221	1.4744	----	"	" "	----	----
1676	" " -------	.9224	1.4744	----	"	" "	----	----
1677	" " -------	.9222	1.4741	----	"	" "	----	----
1678	" " -------	.9235	1.4744	----	"	" "	----	----
1679	" " -------	.9223	1.4744	----	"	" "	----	----

* Saponification equivalent, 294.0. † Saponification equivalent, 285.0.
‡ Cotton seed oil.

SHREDDED ENTIRE WHEAT BISCUIT.

A sample of this material, bought of Gilbert & Thompson, of New Haven, had the following composition.

The average composition of whole wheat kernel is also given for comparison.

	Shredded Wheat Biscuit.	Wheat Kernel. Average.
Water	7.16	10.50
Ash	1.97	1.80
Protein	10.81	11.90
Fiber	1.61	1.80
Nitrogen-free Extract	76.99	71.90
Fat	1.46	2.10
	100.00	100.00

The shredded wheat biscuit had about one per cent. less of protein and five per cent. more of nitrogen-free extract (starch, sugar, gum, etc.) than entire wheat kernels of average composition.

PRESERVES.

By A. L. Winton.

Three samples of preserves in sealed bottles, sent for examination by a grocer, were as follows:

9852 and 9782. XX Brand Strawberries. These contained benzoic acid and glucose syrup and were colored with a coal-tar dye.

9851. "Extra Fine Quality Fruit Syrup. Blood Orange guaranteed absolutely pure," also contained benzoic acid and was colored with coal-tar dye.

The three samples bore the name of the Philip J. Ritter Conserve Co., Philadelphia.

ADULTERATION OF TRUE MACE WITH BOMBAY MACE.

By A. L. Winton.

In June, 1899, a sample of ground mace was received from Mr. John O'Brien, wholesale and retail baker of Waterbury, with Mr. O'Brien's statement that the article was sold to him for absolutely pure mace by J. E. Burns & Co., Philadelphia.

Microscopic examination of the sample revealed the presence of a large proportion of Bombay or false mace, which, although from a tree belonging to the same genus as that which produces true mace, is alsolutely worthless as a spice.

The material contained 39.47 per cent. of fixed oil and resin (non-volatile ether extract). Four samples of whole mace of undoubted purity examined in 1898 contained, on the average, but 22.48 per cent. of these ingredients, whereas a sample of Bombay mace contained 59.81 per cent. From these figures, it appears that the sample in question contained about half its weight of worthless adulterant.

Spice grinders who put spurious goods on the market are wont to claim that, since Bombay mace is a product of a tree botanically related to the one which yields true mace, it should not be classed as an adulterant. Food analysts, however, quite universally insist that the term mace should be applied only to the product from *Myristica fragrans* and that the inferior and tasteless kind should be sold under a distinctive name. Whatever their botanical relation, it is just as much a fraud for a spice merchant to mix Bombay mace with true mace as it would be for a seedsman to add to his carrot seed a certain proportion of the seed of that noxious weed known as wild carrot.

BAKING POWDERS.

By A. L. Winton, A. W. Ogden and C. Langley.

The leavening of bread products, whether by yeast or baking powder, is accomplished by an evolution throughout the whole mass of dough of carbonic acid gas, which in escaping makes the baking bread light and porous.

Yeast introduces into the dough microscopic plants which cause alcoholic fermentation and thus split up the sugars originally present, or formed during the process, into carbonic acid and alcohol, both of which escape, in large part, during the baking.

Baking powders, on the other hand, evolve carbonic acid in the dough, by the chemical reaction of bicarbonate of soda with cream of tartar, acid phosphate, alum or other chemicals, and leave, in the dough, the non-volatile products of the reaction, consisting partly or wholly of mineral matters.

The same chemical action results when bicarbonate of soda is used by the cook in conjunction with cream of tartar, sour milk or molasses.

Consumption of Baking Powder. In the memorial of the American Baking Powder Association, issued during the present year, it is stated that the sale of baking powder in the United States aggregates, approximately, 118,500,000 pounds per annum, or about one and one-half pounds *per capita.* These figures are conclusive proof of the national fondness for cake, griddle cakes, soda biscuit and other bread products made with baking powder, and justify a careful study of the brands on the market, both as to their efficiency and their wholesomeness.

Constituents of Baking Powders.

Two ingredients are essential in a baking powder: (1) a carbonate which contains the carbonic acid gas necessary to raise the dough, and (2) an acid constituent, or its equivalent, which, in the presence of moisture, liberates carbonic acid from the carbonate. Nearly every brand on the market also contains a "filling," consisting usually of starch or flour, which improves the keeping quality of the baking powder by hindering the reaction of the acid and alkali within the package.

Bicarbonate of Soda. The chief, and in nearly every case the only, source of carbonic acid gas in the baking powders of to-day is bicarbonate of soda, also known as baking soda. A few years ago a number of brands on the market contained in addition to bicarbonate of soda a small percentage of carbonate of ammonia, but it is stated that owing to popular, although perhaps unjust criticism, the use of this chemical has been largely discontinued. Pure bicarbonate of soda contains over 52 per cent. of carbonic acid.

Filling. The presence of a harmless material, such as starch or flour, in a baking powder of good leavening power is not regarded as an adulterant, but rather as an ingredient essential for the proper keeping of the product. The manufacturers of a brand put up in California which contains no "filling" claim, however, that starch is not necessary to insure the keeping qualities, provided the powder is properly prepared in a dry climate.

Sulphate of lime (gypsum or land plaster) which in small amount is unavoidably introduced into phosphate and alum-

phosphate powders, as an impurity of the acid phosphate, is separately added as a "filling." It is slightly soluble in water and, although it has no decided toxic properties, is a highly undesirable addition to food products.

Another mineral filling, more dangerous than gypsum, is the material known as argolite, which consists of a ground mixture of talc (soapstone), and asbestos-like tremolite. (See page 165.)

Acid Materials. The chemical used to liberate gas from the bicarbonate may be: (1) a true acid (tartaric acid), (2) an acid salt (cream of tartar, acid phosphate of lime, etc.), or (3) a neutral salt having the power of reacting with the bicarbonate (alums, aluminium sulphate, etc.). Baking powders are usually classified according to the kind of acid material which they contain.

A consideration of these acid materials and the residues left after their reaction with the bicarbonate is essential for a proper understanding of the wholesomeness of the powders in which they are contained.

The efficiency of a powder as a leavening agent depends on the amount of gas it evolves in the dough and must be considered apart from the wholesomeness of the residues.

Classes of Baking Powders.

Tartaric Acid Baking Powder. Tartaric acid is a colorless crystalline substance, readily soluble in water. It is the chief acid constituent of grapes and is contained in all grape wines. Like cream of tartar it is prepared from the settlings of the wine casks known as argols. The residue left in the dough by a tartaric acid powder consists of tartrate of soda which is a salt acting with a power equal to that of sulphate of magnesia (Epsom salts) in the dose of ten drachms (one and one-quarter ounces).* A dozen biscuits made with a quart of flour and 2 teaspoonfuls (0.18 ounce) of a good tartaric acid powder contain about one-fifteenth of an ounce of tartrate of soda, or less than one-nineteenth of a medicinal dose.†

* U. S. Dispensatory, p. 1744.

† The officinal teaspoon holds one fluid drachm, but when used to measure powders it is customary to heap the spoon so that it contains twice as much as when level full. Two teaspoonfuls (heaped in this way) of samples representing the different classes of baking powders were weighed in the laboratory and the weights thus obtained were used in the calculations of the amount of salts left after baking.

Cream of Tartar Baking Powder. Cream of tartar, the commercial name for bitartrate of potash, is a colorless crystalline salt, with an agreeable acid taste. Unlike tartaric acid it is difficultly soluble in water. It is the chief ingredient of argols from which it is prepared by recrystallization. The fixed product of its reaction with bicarbonate of soda is Rochelle salts (tartrate of soda and potash), which in doses of from half an ounce to an ounce is a well known purgative.* About one-sixth ounce of Rochelle salts, or less than one-quarter the average dose, is formed in a batch of twelve biscuits made from a quart of flour and two teaspoonfuls (0.22 ounce) of a tartrate baking powder.

Phosphate Baking Powders. The acid ingredients of these powders is a purified acid phosphate of lime commonly obtained by the action of sulphuric acid on bone ash or some other form of phosphate of lime. It usually contains a certain amount of sulphate of lime as an impurity incidental to the process of manufacture.

The residual products of a phosphate powder are phosphate of lime (chiefly dibasic phosphate), phosphate of soda, and sulphate of lime (gypsum or plaster).

Dibasic phosphate of lime is a white, crystalline solid, almost insoluble in water, but soluble in dilute mineral acid and probably in gastric juice. It is not mentioned in the Pharmacopoeia or Dispensatory.

Phosphate of soda is a colorless crystalline salt, readily soluble in water. "In doses of from 1 to 2 ounces it is a mild purgative, and, from its pure saline taste, it is well adapted to the cases of children and of persons of delicate stomachs." Administered with each meal in doses of from 3 to 10 grains, it is useful in infantile bilious disorders.†

Sulphate of lime is not used internally in medicine.

Twelve biscuits made from one quart of flour and two teaspoonfuls (0.25 ounce) of a good phosphate baking powder contain about one-sixth ounce crystallized phosphate of soda, together with a variable amount of phosphate and sulphate of lime.

* U. S. Dispensatory, p. 1095.
† Ibid, p. 1256.

The manufacturers of phosphate powder claim that "it restores the phosphates, so essential to health, which are removed from flour in bolting, and on this account is recommended by physicians." Phosphorus, it is true, is an essential ingredient of foods, but it is chiefly valuable in organic combination and the phosphorus of inorganic phosphates is believed by physiologists to play only a subordinate part in animal nutrition. While it is doubtful whether the residue left by phosphate baking powders adds to the nutritive value of bread products, it is probably as unobjectionable as the residues left in bread by tartaric acid and cream of tartar powders.

Alum and Alum-Phosphate Baking Powders. The acid material in brands known as alum or "straight" alum powders is entirely alum, whereas in alum-phosphate powders it is a mixture of alum and acid phosphate of lime.

Alum is a somewhat indefinite term applied to a number of double sulphates (usually of alumina and an alkali), all of which are much alike in chemical and physical properties. Three of these double salts, known as potash alum, ammonia alum and soda alum, have been used in the manufacture of baking powders. At present soda and ammonia alums are usually employed, although sulphate of alumina, a salt with the valuable, as well as the objectionable, properties of the alums, is said to be preferred by some manufacturers.

"Alum is a powerful astringent, with very decided irritant qualities, owing to which, when taken internally in sufficient quantity, it is emetic and purgative and may even cause fatal gastro-intestinal inflammation."*

But in a properly mixed baking powder the alum is largely, if not entirely decomposed, during the making of the bread.

By the reaction of soda alum or sulphate of alumina and bicarbonate of soda, hydrate of alumina and Glauber's salts (sulphate of soda), are produced. If ammonia alum is present, instead of soda alum, the residue contains, in addition to hydrate of alumina and Glauber's salts, a certain proportion of sulphate of ammonia.

The alumina in the residue from an alum-phosphate powder is partly at least in the form of phosphate, and in addition

*U. S. Dispensatory, p. 144.

all the salts contained in the residues of both phosphate and alum powders may be present, the exact composition of this residue being determined by the proportion of ingredients in the powder.

Hydrate and phosphate of alumina in a moist condition are white gelatinous substances, insoluble in water, but soluble in dilute hydrochloric acid and presumably in the gastric juice. The phosphate is not used in medicine, the hydrate but rarely and then only as an external application.

Glauber's salts, in doses of from one-half ounce to an ounce, is an efficient hydragogue cathartic; in smaller doses, an aperient and diuretic.*

A batch of twelve biscuits, made from a quart of flour and two teaspoonfuls (0.19 ounce) of a "straight" alum powder of good leavening power, contains about seven and one-half grains of hydrate of alumina and one-eighth ounce of Glauber's salts. Owing to the variable composition of alum-phosphate powders no satisfactory calculation can be made of the amount of salts in the residues.

Regarding the wholesomeness or unwholesomeness of the several kinds of baking powders the opinions of experts as well as of the public differ widely.

All baking powders, without exception, leave in the finished bread certain salts, named in preceding paragraphs, which are foreign to the flour and which are used in medicine as active cathartics. Common sense indicates that were it not for the great convenience and saving of time which is secured by using baking powders, the introduction into foods of these salts would be generally condemned, because of their physiological effects.

The use of alum or any alumina salt in baking powder is open to much more serious objection. Alum itself is a powerful astringent with irritant qualities, the use of which in any article of food is dangerous and should not be tolerated.

It is claimed, however, that alum is wholly decomposed in the processes of bread-making, so that no trace of it is left, but in its place only the hydrate and phosphate of alumina.

But it is not certain that the alum in a baking powder is wholly decomposed—if present in excess it cannot be—and under any circumstances it is very doubtful whether in the process of bread-making a complete reaction between the ingredients of baking powders can be secured.

*U. S. Dispensatory, p. 1260.

There is also good reason to believe that both the hydrate and the phosphate of alumina are soluble in the muriatic acid of the gastric juice and may have a physiological action similar to that of alum.

A careful study of the chemical nature and physiological action of the ingredients of baking powders leads to the conclusion that, while as a class they are not generally regarded as unwholesome, all of them are objectionable in that they introduce into bread salts having a decided medicinal action, but that alum in baking powders is much more likely to be injurious than any other active ingredient which is at present commonly used.

Examination of Baking Powders sold in Connecticut.

The sampling agent of this Station has purchased in the towns and villages of this State packages of seventy-five distinct brands of baking powder, which were all that he found on sale at the time of his inspection.

Each of the samples was purchased in a sealed tin can bearing on the label the name of the brand, the name of the manufacturer or retailer, together with instructions for use. In no case was there a statement on the label that alum was contained in the powder, although some of the brands were declared on the label to be cream of tartar or phosphate powders. These samples were carefully analyzed.

The following is a classified summary based on the analyses:

	Number of brands.
Tartaric acid powders	1
Cream of tartar powders	5
Cream of tartar-tartaric acid powders	8
Phosphate powders	3
Alum powders	15
Alum-phosphate powders	42
Alum-phosphate-tartaric acid powders	2
Total number of brands examined	76
Total containing alum	59
Percentage of brands containing alum	76.3
Brands adulterated with sulphate of lime	7
Brand adulterated with talc and tremolite	1

The results of the analyses are given in full in Tables XX, XXI and XXII, pages 166 to 173, together with the names of the dealers and particulars taken from the labels. The samples are classified according to the acid materials present and the leavening power. It should be understood that, on standing, baking powders gradually lose their leavening power. The longer a sample has been in store, other things being equal, the lower will be the available carbonic acid in it. Therefore, the following tables do not show the average relative value of the different brands—for that purpose it would be necessary to examine a large number of samples of known age of each brand. The tables are mainly designed to show of what materials the various powders are made and whether or not they are in any way adulterated. The results to the left of the double vertical rulings are expressed in the usual terms of a chemical analysis. To the right of the double ruling are given the probable percentages of actual salts contained in the powders. Owing to certain complications it is, however, impracticable to calculate the percentage of sulphates or phosphates of lime and some other ingredients.

The alumina was most commonly present as soda alum; in 22 of the samples, however, ammonia was detected, indicating the presence either of ammonia alum or (less probably) carbonate of ammonia. For the sake of uniformity, the equivalent percentage of anhydrous or "burnt" soda alum was calculated in each case, whatever the form in which the alumina existed in the powder.

Tartaric Acid and Cream of Tartar Powders. All of these have between 10½ and 13½ per cent. of available carbonic acid and are therefore of fair to good leavening power. Nearly all also have a slight excess of carbonate of soda in them.

With one exception (Schilling's Best, No. 1160), all contain starch, the percentages ranging from 38.30 to 11.34. The prices range from 45 to 30 cents per pound.

The Phosphate Powders. The percentages of available carbonic acid in the three samples examined were 12.62, 12.24 and 10.71, indicating fair to good leavening quality. There was no considerable amount of plaster in any of them. All contain starch, the percentages ranging from 40.68 to 25.67. The price of one sample is 45 cents, of the other two 30 cents per pound.

Alum Powders. Fifteen of this class were examined. The available carbonic acid range from 13.10 to 7.87, the average of all exclusive of No. 1175 being 9.33, or considerably less than the average of the tartrate and phosphate powders, which is 12.35 per cent. Whether this deficiency is due to carelessness in manufacture or to the unavoidable deterioration of the baking powder, the loss to the purchaser is the same.

The percentages of starch range (exclusive of No. 1175) from 51.51 to 23.36, and of anhydrous alum from 37.01 to 15.56.

The prices of the alum baking powders range from 50 cents to 15 cents per pound and average 24.3 cents.

These alum powders cost, on the average, ten cents less per pound than the tartrate powders. They contain, however, three per cent. less of available carbonic acid, the efficient principle of baking powder, than the tartrate powders, so that to do the same work as one pound of tartrate powder costing 34.3 cents would be needed one and one-third pounds of alum baking powder, costing 32.4 cents.

Adulterated Alum Baking Powder. Seven out of the fifteen samples contain twenty per cent. or more of sulphate of lime. This is clearly an adulterant. A list of the adulterated samples is given on page 168.

A particularly reprehensible adulteration, because very likely to prove injurious to health, is that practiced by the Southern Soda Works, Nashville, Tenn., manufacturers of No. 1175, Sweetheart, One Spoon, Baking Powder. This preparation contains more than twenty-five per cent. of a ground rock, insoluble in strong acids and consisting chiefly of silicates of magnesia. Prof. S. L. Penfield, of Yale University, kindly examined this material and found it to be a mixture of pulverized talc and tremolite, a species of hornblende, which is extensively mined in northern New York, perhaps elsewhere, and is much used as a filler in the paper manufacture. The tremolite appears under the microscope in sharp needle-like splinters which make it a dangerous admixture in food.

Alum-Phosphate Baking Powders. The larger number of brands collected by our agent, forty-four out of seventy-six, belong to this class.

The available carbonic acid in them ranges from 11.46 to 5.18 and is, on the average, 9.46 per cent. The percentage of starch

TABLE XX.—TARTARIC ACID, CREAM OF TARTAR, AND

Station No.	Brand.	Dealer.	Price per pound. cents.
	Tartaric Acid Powder.		
1187	Robertson's Pure. J. T. Robertson, Hartford, Conn.	*Hartford.*—Cowles & Howard, 156 Windsor Ave.	30
	Cream of Tartar Powders.		
1160	Schilling's Best. A. Schilling & Co., San Francisco, Cal.	*New Britain.*—Boston Branch Grocery, 236 Main St.	41
1195	Cleveland Superior. Cleveland Baking Powder Co., New York	*Hartford.*—H. Griswold, 547 Main St.	40
1191	Mrs. Lincoln. Mrs Lincoln's Baking Powder Co., Boston, Mass.	Boston Branch Grocery, 745 Main St.	40
1165	Solar Pure Cream Tartar. Fidelity Mfg. Co., 31 Rose St., New York	*Meriden.*—H. E. Bushnell, 79 W. Main St.	40
1154	Gold Seal. Hills & Co., Hartford, Conn.	*Hartford.*—Hills & Co., 372 Asylum St.	30
	Cream of Tartar–Tartaric Acid Powders.		
1155	Newton, Robertson & Co.'s Cream Tartar Baking Powder	*Hartford.*—Newton, Robertson & Co., 338 Asylum St.	30
1156	J. P. Guilfoil & Co.'s Cream Tartar Baking Powder	Guilfoil Co., 193 Asylum St.	30
1209	Royal. Royal Baking Powder Co., New York	*Bridgeport.*—C. Russell & Co., 335 Main St.	45
1164	Dutton's Cream Tartar Baking Powder	*Meriden.*—C. N. Dutton & Co., 17 Colony St.	30
1915	B. T. Babbit's Best. B. T. Babbit, 82 Washington St., New York	*New Haven.*—D. M. Welch & Son, 28–30 Congress Ave.	30
1192	Prairie. United Nine Co., New York	*Hartford.*—Boston Branch Grocery, 745 Main St.	30
1170	Williams' Cream of Tartar. R. C. Williams & Co., New York	*Stamford.*—C. M. Slater, 88 Main St.	30
1186	Cream. Price Baking Powder Co., New York and Chicago	*Hartford.*—Drake & Phillips Co., 344 Windsor Ave.	30

ranges from 46.76 to 10.78, of anhydrous soda alum from 25.29 to 14.29.

In seven of the samples, the large percentage of lime, over 11 per cent., may come either from the use of a low grade phosphate powder or from the addition of sulphate of lime.

The average cost of these samples of alum-phosphate powders was 28.6 cents per pound. To equal in leavening power, one

CREAM OF TARTAR–TARTARIC ACID BAKING POWDERS.

Station No.	Carbonic Acid. Available.	Carbonic Acid. Total.	Carbonic Acid. Residual.	Potash (K_2O).	Soda (Na_2O).	Lime (CaO).	Sulphuric acid (SO_3).	Total Tartaric Acid ($C_4H_4O_5$).	Starch.	Water free and combined by difference.	Bi-carbonate of soda.*	Cream of Tartar ($KHC_4H_4O_6$).†	Free Tartaric Acid ($H_2C_4H_4O_6$).‡
1187	12.44	14.90	2.46	0.10	12.46	....	0.05	21.36	38.30	12.83	28.46	.....	24.26
1160	13.15	13.96	0.81	17.38	12.45	....	0.02	48.63	0.00	7.56	26.66	69.37	.....
1195	12.23	12.89	0.66	13.60	9.64	....	0.05	38.33	16.20	9.29	24.62	54.29	.....
1191	12.09	12.44	0.35	15.08	10.47	....	0.01	42.24	11.34	8.42	23.76	60.20	.....
1165	11.68	13.93	2.25	13.32	11.02	....	0.06	37.26	15.40	9.01	26.61	53.17	.....
1154	10.62	12.00	1.38	12.67	9.84	....	0.05	35.14	20.95	9.35	22.92	50.58	.....
1155	13.55	13.58	0.03	12.35	11.03	....	0.09	40.16	14.07	8.72	25.93	49.30	6.33
1156	13.51	13.54	0.03	12.36	11.21	....	0.08	40.65	13.81	8.35	25.86	49.35	6.84
1209	13.20	13.74	0.54	12.19	9.75	....	0.02	36.66	19.33	8.31	26.24	48.66	2.85
1164	12.68	12.74	0.06	11.89	10.64	....	0.05	38.22	17.74	8.72	24.33	47.46	5.59
1915	12.10	12.34	0.24	11.45	9.41	....	0.05	35.89	22.49	8.37	23.57	45.71	4.34
1192	12.04	12.62	0.58	8.76	10.05	....	0.04	31.54	27.50	9.49	24.10	34.97	7.95
1170	11.75	12.65	0.90	8.79	10.07	....	0.06	31.42	27.36	9.65	24.16	35.09	7.72
1186	11.69	12.34	0.65	9.72	9.87	....	0.05	32.81	26.03	9.18	23.57	38.80	6.35

pound of the average tartrate powder, costing 34.3 cents, would be required 1.3 pounds of the average phosphate-alum baking powder, which would cost 37.1 cents.

Premiums. With the tartrate powders no "premiums" were offered, but with quite a number of the alum powders, various things were given to the sampling agent.

* Equivalent to the total carbonic acid. † Equivalent to the potash.
‡ Tartaric acid, not calculated as cream of tartar.

TABLE XXI.—PHOSPHATE

Station No.	Brand.	Dealer.	Price per pound. cents.
1214	Boston. Boston Baking Powder Co., Boston, Mass.	*Middletown.*—L. B. Chaffee & Co., 228 Main St.	30
1161	Prof. Horsford's Phosphatic. Rumford Chemical Works, Providence, R. I.	*New Britain.*—Sovereign Trading Co., 585 Main St.	45
1190	Rumford. Rumford Chemical Works, Providence, R. I.	*Hartford.*—Jason Graham, 125 Albany Ave.	30

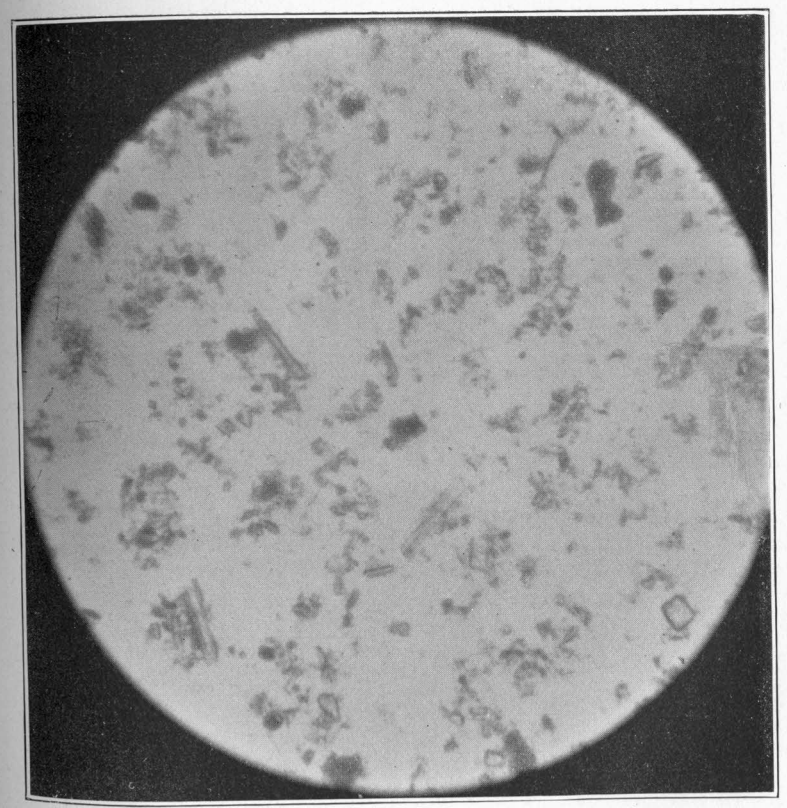
For example, with one pound of No. 1152, Snow Flake brand, were given 6 cakes soap, 1 of scourine, 1 package of soap powder, 1 bottle of ammonia and 1 bottle of blueing. Articles given with one pound of various brands were, one large plate, two small plates, a porcelain tea pot, six glass tumblers, a cup and saucer, granite ware articles, a wooden back thermometer, a picture, a wooden umbrella stand and a pair of ladies' stockings.

ADULTERATED BAKING POWDERS.

The following baking powders are adulterated and their sale in the State is illegal:

	Brand.	Adulterant.
1199	Daisy	Sulphate of lime.
1176	Reliable Baking Powder Co.'s	"
1203	Lenox	"
1201	Phelan's, Waterbury	"
1223	Eagle	"
1224	Sullivan's, New Haven	"
1216	Spencer's, Middletown	"
1175	Sweetheart, Southern Soda Works, Nashville, Tenn.	Talc and tremolite.

Can with label in which Sweetheart Baking Powder was sold.



Photomicrograph of the ground rock (talc and tremolite) which constituted 25.53 per cent. of Sweetheart Baking Powder.

Baking Powders.

Station No.	Carbonic Acid. Available.	Carbonic Acid. Total.	Carbonic Acid. Residual.	Sand (Ash insoluble in HCl).	Soda (Na_2O).	Lime (CaO).	Phosphoric Acid (P_2O_5).	Sulphuric Acid (SO_3).	Starch.	Water by difference.	Bi-carbonate of Soda.*
1214	12.62	14.93	2.31	0.09	11.48	8.57	20.57	0.55	25.67	18.14	28.52
1161	12.24	12.50	0.26	0.23	9.86	7.20	19.28	0.21	34.81	15.91	23.87
1190	10.71	11.07	0.36	0.09	8.90	6.69	17.19	0.22	40.68	15.16	21.15

METHODS OF ANALYSIS.

Carbonic Acid.

Total Carbonic Acid. The absorption method described by Fresenius† and modified by Heidenhain‡ was employed. The gas was liberated by 10 per cent. hydrochloric acid, dried by calcium chloride and absorbed, by soda lime, in weighed U tubes. The details given by Heidenhain were carefully followed. Duplicate determinations on each baking powder were made by different analysts and with different sets of apparatus.

Residual carbonic acid. The process adopted, based on methods described by McGill§ and Catlin,‖ imitates as far as is practicable the conditions encountered in baking, and in such a manner that concordant results may be readily obtained on the same sample and comparable results on different samples.

Weigh 2 grams of baking powder into a flask suitable for the subsequent determination of carbonic acid, add 20 cc. of cold water and allow to stand 20 minutes. This treatment, which corresponds to the mixing of cake or biscuit, removes a considerable amount of the carbonic acid.

Place the flask in a metal drying cell, surrounded by boiling water and heat with occasional shaking for 20 minutes. The solution heats up gradually as in the process of baking and most of the carbonic acid escapes before the liquid becomes thick from coagulation of starch and precipitation of alumina.

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* Equivalent to the total carbonic acid.

† Quant. Anal. I, p. 449 and II, p. 308.

‡ Am. Chem. Soc., XVIII.

§ Lab. Inland Revenue Dept., Ottawa, Canada, Bul. 68, p. 31.

‖ Baking powders. A Treatise on the Character, Methods for Determination of the Values, etc., p. 20.

TABLE XXII.—ALUM AND ALUM-PHOSPHATE

Station No.	Brand.	Dealer.	Price per pound, cents.
	Alum Powders.		
1175	Sweetheart. One Spoon. Southern Soda Works, Nashville, Tenn.	*Norwalk.*—P. J. Lynch Co., 21 Main St.	20
1174	Lynch's Snow Flake	*South Norwalk.*—P, J. Lynch Co., 118 Washington St.	40
1222	A. & P. The Great Atlantic & Pacific Tea Co., New York	*New Haven.*—A. & P. Tea Co., 386 State St.	50
1172	Monarch	*South Norwalk.*—N. Y. Grocery Co., Washington St.	15
1211	Columbia Tea Co. Columbia Tea Co., 10 Chrystie St., N. Y.	*Bridgeport.*—Columbia Tea Co., 534 Main St.	30
1162	Rising Sun	*New Britain.*—H. Oldershaw Co., 226 Park St.	15
1210	J. C. Grant's Bon Bon. The J. C. Grant Chemical Co., Chicago	*Bridgeport.*—P. E. McCaffrey, 492 Main St.	15
1199	Daisy	*Waterbury.*—Pa. Merchandise Co., 116 East Main St.	20
1176	Reliable. Reliable Baking Powder Co.	*Norwalk.*—N. Y. Grocery Co., 35 Main St.	10
1220	Absolutely Pure. Osborn Chemical Co., New York	*Norwich.*—Hong Kong Tea Co., 210 Main St.	50
1203	Lenox. The Lenox Baking Powder Co., New York	*Waterbury.*—Cash Tea Store, 97 Scoville St.	25
1201	Phelan's	J. F. Phelan, 41 East Main St.	20
1223	Eagle	*New Haven.*—John Franklin, 92 Nicoll St.	15
1224	Sullivan's	J. J. Sullivan, 114 Nash St.	20
1216	Spencer's Pure	*Middletown.*—W. K. Spencer, 96 Main St.	20
	Alum-Phosphate Powders.		
1151	Crystal. Crystal Baking Powder Co., Boston, Mass.	*Meriden.*—H. F. Rudolph & Co., 48 East Main St.	15*
1189	Davis' O. K. R. B. Davis, 90 West Broadway, New York	*Hartford.*—A. R. Barrows, 150 Windsor Ave.	20
1157	Higgins'. W. A. Higgins, New York	Buckley & Reardon, 559 Main St.	50
1342	Gold Medal	*New Haven.*—F. J. Markle, State and Olive Sts.	15
1168	Edwards'. W. W. Edwards, New York	*Stamford.*—W. W. Edwards, 99 Main St.	10
1182	S. S. Adams'	*New Haven.*—S. S. Adams, Court and State Sts.	15
1177	Osterbank's	*Norwalk.*—W. & E. Osterbank, 53 Main St.	30
1197	Snow Ball	*Derby.*—D. M. Welch & Son, 312 Main St.	20
1206	Baldwin's	*Danbury.*—W. D. Baldwin, 93 White St.	10
1180	Pure Sovereign. The Union Pacific Tea Co., 79 Water St., N. Y.	*Hartford.*—Union Pacific Tea Co., 8 Church St.	50
1153	Pilgrim. Pilgrim Baking Powder Co., Boston, Mass.	H. E. Hills & Co., 1143 Main St.	40
1159	Home Tea Co.'s	*New Britain.*—Home Tea Co., 460 Main St.	45
1204	Hatter's Brand	*Danbury.*—J. W. Smith, 62 Elm St.	20
1226	G. U. Tea Co. Grand Union Tea Co., Brooklyn, N. Y.	*New Haven.*—Grand Union Tea Co., 750 Chapel St.	50

* Quarter pound.

BAKING POWDERS.

Station No.	Carbonic Acid. Available.	Carbonic Acid. Total.	Carbonic Acid. Residual.	Sand (Ash insoluble in HCl).	Soda (Na_2O).	Lime (CaO).	Alumina (Al_2O_3).	Oxide of iron (Fe_2O_3).	Oxide of Ammonia ($(NH_4)_2O$).	Phosphoric Acid (P_2O_5).	Sulphuric Acid (SO_3).	Starch.	Water by difference.	Bi-carbonate of Soda.*	Anhydrous Soda Alum.†
1175	13.10	14.70	1.60	25.53	17.28	0.40	7.80	0.00	0.00	0.00	22.80	0.00	11.49	28.08	37.01
1174	11.47	12.74	1.27	0.04	12.09	0.83	4.44	0.25	0.00	0.78	15.02	44.13	9.68	24.33	21.07
1222	10.68	11.08	0.40	0.04	10.84	0.08	4.47	0.14	0.00	0.00	14.32	47.41	11.62	21.16	21.21
1172	10.49	11.31	0.82	0.04	12.67	0.07	5.48	0.00	0.00	0.00	15.83	41.11	13.49	21.60	26.00
1211	9.70	10.04	0.34	0.05	10.03	0.07	4.50	0.00	0.00	0.24	13.05	51.51	10.51	19.18	21.35
1162	9.65	9.90	0.25	0.11	9.83	0.00	4.71	0.00	0.00	0.00	13.19	50.62	11.64	18.91	22.35
1210	9.49	9.97	0.48	0.07	11.50	0.08	5.01	0.21	0.00	0.00	14.92	46.15	12.09	19.04	23.77
1199	9.24	9.92	0.68	0.19	8.37	9.00	3.69	0.14	1.52	0.42	24.41	30.35	11.99	18.95	17.51
1176	8.93	9.51	0.58	0.09	8.12	8.74	3.40	0.21	1.45	0.29	23.85	31.46	12.88	18.16	16.13
1220	8.70	9.14	0.44	0.08	10.04	0.00	4.47	0.00	0.00	0.00	13.19	51.01	12.07	17.46	21.21
1203	8.61	9.28	0.67	0.05	8.09	8.52	3.68	0.18	1.73	0.51	23.59	30.89	13.48	17.73	17.46
1201	8.44	9.11	0.67	0.08	8.19	11.22	3.57	0.11	1.47	0.47	27.49	24.34	13.95	17.40	16.94
1223	8.22	8.89	0.67	0.08	7.82	9.43	3.28	0.14	1.58	0.23	24.45	30.93	13.17	16.98	15.56
1224	8.13	8.92	0.79	0.07	8.35	11.80	3.74	0.11	1.30	0.31	27.82	23.36	14.22	17.04	17.75
1216	7.87	8.60	0.73	0.08	10.17	9.84	3.77	0.00	1.60	0.15	24.38	29.74	11.67	16.43	17.89
1151	11.46	12.06	0.60	0.10	10.31	6.06	3.83	0.32	1.86	5.40	18.80	28.66	12.60	23.03	18.18
1189	11.26	11.85	1.75	0.12	11.82	3.58	3.45	0.21	----	9.13	11.23	35.35	13.26	22.63	16.37
1157	11.25	12.47	1.22	0.08	11.77	1.81	3.91	0.29	----	5.60	12.63	38.01	13.43	23.82	18.55
1342	11.19	12.50	1.31	0.06	11.60	1.95	3.84	0.29	----	5.18	12.70	39.85	12.03	23.88	18.22
1168	10.98	11.88	0.90	0.11	10.67	1.62	4.43	0.14	----	1.96	13.57	47.05	8.57	22.69	21.02
1182	10.90	12.13	1.23	0.06	12.02	1.82	3.53	0.29	----	5.86	12.71	38.05	13.53	23.17	16.75
1177	10.89	11.36	0.47	0.07	8.91	3.81	3.56	0.21	1.69	4.76	14.57	36.43	14.63	21.70	16.90
1197	10.87	12.05	1.18	0.05	11.58	1.94	3.76	0.25	----	5.83	12.40	39.92	12.22	23.01	17.84
1206	10.85	12.20	1.35	0.03	11.76	1.87	3.86	0.29	----	5.76	12.63	39.31	12.29	23.30	18.32
1180	10.79	11.81	1.02	0.10	13.78	1.83	3.01	0.21	----	6.05	10.78	41.22	11.21‡	22.56	14.29
1153	10.75	11.35	0.60	0.09	10.44	6.39	4.34	0.25	1.73	5.51	18.79	28.44	12.67	21.68	20.60
1159	10.65	11.80	1.15	0.09	11.51	2.75	3.63	0.21	----	4.34	13.61	39.85	12.21	22.54	17.23
1204	10.50	11.75	1.25	0.03	12.01	1.66	3.79	0.25	----	6.06	12.62	38.30	13.53	22.44	17.99
1226	10.48	11.28	0.80	0.07	9.12	1.95	3.50	0.29	1.67	5.49	10.91	43.70	12.02	21.55	16.61

* Equivalent to the total carbonic acid. † Equivalent to the alumina.
‡ Includes some tartaric acid.

TABLE XXII.—ALUM AND ALUM-PHOSPHATE

Station No.	Brand.	Dealer.	Price per pound, cents.
1178	Favorite. F. D. Lawton & Co., 22 S. Main St., South Norwalk, Conn.	*Norwalk.*—F. D. Lawton, 47 Main St.	10
1152	Snow Flake	*Meriden.*—Sherwood & Son, 64 West Main St.	39
1213	New England Best	*Middletown.*—New England Tea Co., 442 Main St.	45
1198	Our Own	*Ansonia.*—Walsh Bros., 246 Main St.	45
1212	Sullivan's	*Bridgeport.*—J. B. Sullivan, 588 East Main St.	20
1181	Our Leader Brand	*New Haven.*—Mendel & Freedman, 770-774 Chapel St.	13
1183	American	Gilson Tea Co., 417 State St.	50
1163	White's Star	*Hartford.*—Centennial Am. Tea Co., 575 Main St.	25
1179	Hanlon's. Hanlon Bros., 8 and 9 Wall St., Norwalk	*Norwalk.*—Cash Grocery, 12 Wall St.	25
1194	Rival. Rival Baking Powder Co., New York and Boston	*Hartford.*—C. H. Russell, 711 Main St.	12
1184	Standard	Standard Tea Co., 1019 Main St.	50
1343	Gibbons'	*New Haven.*—Gibbons Bros., 824 State St.	25
1167	White Rose	*Stamford.*—Geo. A. Ferris, 154 Main St.	15
1188	I. C. Jaques Mfg. Co., Chicago	*Hartford.*—Cowles & Howard, 156 Windsor Ave.	16
1200	Monarch	*Waterbury.*—American Tea Co., 42 East Main St.	25
1219	Disco's	*Norwich.*—Disco Bros., 267 Main St.	25
1208	Wheeler's Corner	*Bridgeport.*—E. E. Wheeler, 475 Main St.	20
1173	The Model Grocery	*South Norwalk.*—Lorenzo Dibble, 13 North Main St.	25
1221	The Daisy	*New London.*—A. M. Stacey, 123 State St.	30
1193	Our Own. B. Fischer & Co., New York	*Hartford.*—P. S. Kennedy, 1040 Main St.	20
1205	Apollinaris	*Danbury.*—Doran's Cash Grocery, 150 Main St.	15
1225	Centennial	*New Haven.*—Andrew Morehead, 363 State St.	50
1202	Our Best	*Waterbury.*—N. Y. and China Tea Co., 181 South Main St.	45
1215	Chapman's	*Middletown*—D.I.Chapman,146 Main St.	20
1166	Columbia, 12 South Main St. Port Chester, N. Y.	*Stamford.*—Columbia Tea Co., 196 Main St.	25
1207	Vermilyea's Gold Medal	*Danbury.*—G. H. Vermilyea, 3 Elm St.	20
1158	New Britain Tea Co.	*New Britain.*—Oriental Tea Co., 491 Main St.	45
1218	Washington. Washington Baking Powder Co.	*Norwich.*—H. I. Palmer, 231 Main St.	25
1171	Excelsior	*Stamford.*—W. W. Waterbury, 207 Main St.	15
1217	Bako Baking Powder Co.	*Middletown.*—W. F. Ackley, 510 Main St.	10*

* Quarter pound tin.

BAKING POWDERS—*Continued.*

Station No.	Carbonic Acid. Available.	Carbonic Acid. Total.	Carbonic Acid. Residual.	Sand (Ash insoluble in HCl).	Soda (Na_2O).	Lime (CaO).	Alumina (Al_2O_3).	Oxide of iron (Fe_2O_3).	Oxide of Ammonia ($(NH_4)_2O$).	Phosphoric Acid (P_2O_5).	Sulphuric Acid (SO_3).	Starch.	Water by difference.	Bi-carbonate of Soda.*	Anhydrous Soda Alum.†
1178	10.36	11.92	1.56	0.06	12.38	2.06	3.48	0.29	----	5.54	12.60	39.10	12.57	22.77	16.51
1152	10.29	11.18	0.89	0.10	8.91	11.60	3.84	0.18	1.82	3.24	25.94	19.83	13.36	21.35	18.22
1213	10.28	11.94	1.66	0.06	12.08	1.76	3.83	0.25	----	5.50	12.38	38.79	13.41	22.80	18.18
1198	10.10	11.85	1.75	0.05	12.42	1.84	3.66	0.25	----	3.37	12.62	39.13	12.81	22.63	17.37
1212	10.04	11.58	1.54	0.04	12.03	1.68	3.91	0.29	----	5.56	12.33	39.46	13.12	22.12	18.55
1181	9.99	12.07	2.08	0.05	12.22	4.64	3.79	0.25	----	4.50	16.56	34.74	11.18	23.05	17.99
1183	9.87	10.38	0.51	0.07	9.06	7.87	3.67	0.29	1.71	2.71	21.94	29.95	12.35	19.82	17.41
1163	9.83	10.86	1.03	0.07	9.37	11.35	3.48	0.29	1.58	2.81	26.68	21.27	12.24	20.74	16.51
1179	9.83	10.87	1.04	0.24	9.22	11.62	3.21	0.18	1.63	2.65	26.40	21.53	12.45	20.76	15.23
1194	9.82	10.38	0.56	0.08	8.60	7.16	3.61	0.18	1.75	2.65	21.28	31.57	12.74	19.82	17.13
1184	9.65	10.86	1.21	0.09	9.56	11.61	3.22	0.18	1.19	2.94	26.26	19.83	14.26	20.74	15.28
1343	9.52	11.30	1.78	0.06	11.55	2.58	3.91	0.25	----	3.77	14.21	39.93	12.44	21.58	18.55
1167	9.50	10.71	1.21	0.12	9.54	11.48	3.65	0.18	1.19	2.98	26.24	20.56	13.35	20.45	17.32
1188	9.45	10.08	0.63	0.07	9.04	1.55	3.91	0.14	1.82	2.69	13.29	44.78	12.63	19.25	18.55
1200	9.44	11.14	1.73	0.11	12.36	2.43	4.37	0.21	----	5.44	13.67	37.44	12.83	21.28	20.74
1219	9.33	10.46	1.13	0.02	10.09	11.61	3.66	0.14	1.69	2.62	26.82	21.85	11.04	19.98	17.37
1208	9.10	10.13	1.03	0.05	10.95	1.77	3.41	0.25	----	5.71	10.96	42.26	14.51	19.35	16.18
1173	8.64	10.45	1.81	0.12	13.21	3.33	4.26	0.54	----	7.51	14.01	33.95	12.62	19.96	20.22
1221	8.58	9.20	0.62	0.07	10.03	7.97	3.89	0.21	1.69	2.89	22.06	29.63	12.36	17.57	18.46
1193	8.50	10.47	1.97	0.06	11.03	1.91	3.26	0.21	----	5.16	10.96	43.81	13.13	20.00	15.47
1205	8.37	10.02	1.65	0.04	11.45	2.65	3.69	0.25	----	4.63	13.66	39.10	14.51	19.14	17.51
1225	8.27	9.51	1.24	0.04	9.08	11.62	3.76	0.21	1.63	2.90	26.20	21.49	13.56	18.16	17.84
1202	7.94	9.27	1.33	0.15	12.26	3.68	4.58	0.46	----	7.29	13.99	35.42	12.90	17.71	21.73
1215	7.82	9.45	1.63	0.37	13.17	3.82	4.59	0.29	----	7.57	14.29	32.83	13.62	18.05	21.78
1166	7.44	8.57	1.13	0.26	12.90	3.68	4.55	0.64	----	7.16	14.36	35.42	12.46	16.37	21.59
1207	7.42	9.08	1.66	0.20	13.67	3.80	4.86	0.39	----	8.10	14.28	33.12	12.50	17.34	23.06
1158	7.11	8.37	1.26	0.20	12.61	3.70	4.50	0.50	----	7.68	13.91	34.34	14.19	15.99	21.35
1218	5.95	7.11	1.16	0.16	9.85	2.69	3.38	0.25	----	3.16	12.63	46.76	14.01	13.58	16.04
1171	5.78	6.96	1.18	0.48	12.86	2.95	5.33	0.42	----	5.90	15.17	36.61	13.32	13.30	25.29
1217	5.18	6.22	1.04	0.14	9.72	2.70	3.50	0.25	----	3.66	12.29	45.79	15.73‡	11.88	16.61

* Equivalent to the total carbonic acid. † Equivalent to the alumina.
‡ Includes some tartaric acid.

To complete the reaction and drive off the last traces of gas from the semi-solid mass, heat quickly to boiling over a lamp and boil for one minute. Aspirate until the air in the flask is thoroughly changed and determine the residual carbonic acid by absorption under *total* carbonic acid.

Available carbonic acid. Substract the residual from the total carbonic acid.

STARCH.

Copper reduction method. Weigh out 5 grams of the baking powder into a graduated 500 cc. flask, add 200 cc. of 3 per cent. hydrochloric acid and allow the mixture to stand for one hour with frequent shaking.* Filter on a Schleicher and Schuell, No. 575, hardened filter, 11 cm. in diameter, taking care that a clear filtrate is obtained. Rinse the flask once, without attempting to remove all the starch and wash the paper twice with cold water.

This treatment, as is shown by the experiments described in subsequent paragraphs, removes the lime and the greater part of the other mineral matter, without dissolving the starch.

Carefully wash the starch from the paper back into the flask with 200 cc. of water, using a small wash bottle, add 20 cc. of 25 per cent. hydrochloric acid (Sp. gr. 1.125) and heat for 3 hours on a boiling water bath to convert starch into dextrose (Sachsse's method).†

In the case of cream of tartar powders and all others free from lime, heat the material directly with 200 cc. of water and 20 cc. of 25 per cent. hydrochloric acid, omitting the preliminary treatment with cold 3 per cent. acid.

Cool the solution, nearly, but not quite, neutralize with sodium hydrate solution, make up to 500 cc. and filter through a dry paper. Determine reducing matters by Allihn's method,‡ as follows:

Mix 30 cc. of a solution containing 173 grams of Rochelle salt and 125 grams of caustic potash in 500 cc. of water, and 30 cc. of a solution of 34.69 grams of pure crystallized copper sulphate in 500 cc. of water in a beaker of 200 cc. capacity and heat to boiling. To the boiling liquid, without delay, add 25 cc. of the solution to be examined, and continue the heating until boiling begins again. After the reduced copper suboxide has settled, collect on a Gooch crucible, dry at a moderate heat, and finally, heat for three to five minutes at dull redness, taking care to avoid a bright red heat and to allow access of sufficient air to complete the oxidation to copper oxide.§ After weighing, repeat the heating to make certain that the oxidation is complete.

From the weight of copper oxide calculate the weight of metallic copper, using the factor 0.7986, and find the corresponding amount of dextrose in Allihn's tables. To obtain the corresponding weight of starch, multiply the weight of dextrose by 0.9.

*The treatment with 3 per cent. hydrochloric acid was suggested by McGill's method, described on p. 177.

† Chem. centralbl. 1877, 732. This Station Rep., 1887, 132.

‡ Jour. Prakt. Chem., 22, 52. This Station Rep., 1877, 129.

§ Compare Bartlett, Maine Ag. Ex. Sta. Rep., 1888, 207. This Station Rep., 1898, 188.

To prepare asbestos pulp for use in the Gooch crucible, cut woolly asbestos (best quality) into small pieces, boil with hydrochloric acid and wash free from acid and fine particles on a sieve with 1/25 inch meshes. This asbestos, when packed in the crucibles with the aid of a blunt glass rod, retains completely the finely divided copper suboxide, which is not true of the variety usually employed in filtering coarser precipitates.

The method described was adopted after conducting the following experiments:

Errors of direct inversion. Five gram portions of a number of samples of alum, phosphate, and alum-phosphate powders, of widely differing composition, were freed from starch by burning at dull redness. The ashes thus obtained were treated according to Sachsse's and Allihn's methods. If the direct inversion method, without separation of any of the mineral ingredients, were applicable for the determination of starch in these powders, the alkaline copper solutions in these trials on the mineral matters alone should have remained perfectly clear, even on cooling, without separation of lime salt, or any other precipitate. While hot, the solutions in every case appeared clear, but on cooling, those to which solutions of ash containing a considerable amount of lime had been added, became turbid with separation of a gelatinous precipitate more or less abundant according to the precentage of lime. The precipitates after collecting on filters and washing repeatedly with hot water were found to be of a light purple color, which color was not discernable when the precipitates were suspended in the deep blue liquid. Although it was evident from this color as well as from special reactions that copper was present, further tests showed that the chief constituent was calcium tartrate, which, as is well known, is insoluble in caustic alkali. None of the precipitates contained alumina, phosphoric acid, sulphuric acid or carbonic acid.

In the tests on baking powder containing phosphates and alum with only a trace of lime, no precipitate appeared.

These experiments show that the gravimetric determination of starch by direct inversion without removal of lime is only applicable to baking powders containing but a trace of this element.. The error due to calcium tartrate alone might be avoided by determining the copper in the impure copper suboxide by an electrolytical method; but as the calcium tartrate is itself contaminated with copper, even this procedure would still give high results.

Experiments on methods of removing lime. An air dry sample of commercial corn starch was ground to pass a sieve with round holes 1/50 inch in diameter and carefully mixed. A mixture of salts was also prepared in the following proportions:

Di-calcium phosphate	1.5 parts.
Calcium sulphate	1.0 parts.
Anhydrous ammonia alum	0.8 parts.
Sodium bicarbonate	1.4 parts.
	4.7

Four and seventh-tenths grams of this mixture contained as much or more of each acid and basic radical as was present in 5 grams of any of the samples examined.

Determinations of pure starch were made in the commercial starch by inversion with acid and copper reduction, both with and without the addition of the mixture of salts, following various methods for removal of lime.

In each experiment the inversion was made by Sachsse's method and the determination of dextrose by Allihn's method. The quantity of the commercial starch weighed out was in all cases 2 grams, but as the solution after inversion was made up to 500 cc. and 25 cc. of this were added to the copper solution, the weights of copper oxide obtained represent only 0.1 gram of the material or, as the results of Experiment A show, 0.0847 gram of anhydrous starch.

Experiment A. Starch only. Direct inversion. No preliminary treatment and no addition of reagents other than necessary for the determination.

Experiment B. Same as Experiment A, except that the starch before inversion was treated in a flask for one hour with 200 cc. of water with frequent shaking. After filtering on a hardened paper and washing twice with water, the starch was washed back into the flask, with 200 cc. of water and inverted.

Experiment C. Same as Experiment B, except that the starch was shaken with 3 per cent. hydrochloric acid solution instead of water.

Experiment D. Starch, 2 grams, and mixture of salts, 4.7 grams, treated with 3 per cent. hydrochloric acid as in Experiment C.

Experiment E. Starch, 2 grams and mixture of salts, 4.7 grams. No treatment preliminary to inversion. Lime removed by precipitation with ammonia and ammonium oxalate after inversion and neutralization with sodium hydrate.

Experiment F. Same as Experiment E, except that lime was removed by precipitation with sodium phosphate and ammonia.

Experiment G. Same as Experiment E, except that ammonium carbonate was substituted for ammonium oxalate.

Following are the results obtained:

Expt.	Material.	Treatment.	CuO found, grams.	Starch equivalent to CuO. grams,	Error compared with Expt. A. grams.
A	Starch.	No treatment	0.2302	0.0848	
			0.2297	0.0846	----
			av.	0.0847	
B	"	Digested with water	0.2296	0.0845	— 0.0002
			0.2297	0.0846	— 0.0001
C	"	Digested with 3% HCl	0.2302	0.0848	+ 0.0001
			0.2294	0.0844	— 0.0003
D	Starch and salts.	" " "	0.2305	0.0849	+ 0.0002
			0.2296	0.0845	— 0.0002
E	" "	Precipitated with ammonia and am. oxalate	0.2250	0.0828	— 0.0019
F	" "	Precipitated with ammonia and sodium phosphate	0.2248	0.0827	— 0.0020
G	" "	Precipitated with ammonia and ammonium carbonate	0.2256	0.0830	— 0.0017

The results of Experiments E, F, G, are low and would be still lower if a correction were introduced for the volume occupied by the lime precipitates in the 500 cc. flask. The copper precipitate in all three of these tests was of a yellow red color, indicating that it was different in composition from the usual red precipitate.

From Experiments A, B and C, it is evident that 3 per cent. hydrochloric acid, as well as water, does not bring any of the starch into solution. The results in the three cases are practically identical and the filtrates from B and C were entirely free from carbohydrates. The results of Experiment D, which presented all the analytical difficulties that could be encountered in a baking powder analysis, also agree closely with those of A, B and C, showing that preliminary digestion with 3 per cent. acid removes effectually the lime salts without dissolving the starch and establishing the accuracy of the method employed in our analyses.

*McGill's Method.** In the analysis of cream of tartar and tartaric acid powders the author proceeds as follows:

"Ten grams are treated with 150 cc. cold water, containing about 5 per cent. of strong ammonia solution, and shaken—by machinery—for one hour. The starch is collected on a tared filter, and washed till neutral. The filter and contents are dried in warm air (40° to 50° C.), and then allowed to stand at the ordinary temperature of the laboratory, exposed to air, before weighing, to take up normal moisture. The purity of the starch is insured by examining it with the microscope. The results are accurate to within one (1) per cent., where a purified starch has been employed in manufacture; where flour has been used, an error from 3 to 5 per cent. is probable."

The method for alum and alum-phosphate powders is described as follows:

"Starch has been separated by shaking, in cold solution, with 3 per cent. hydrochloric acid. Separated starch has been examined with the microscope as to kind and purity. Mineral matter found as 'ash,' on burning the starch, has been deducted from the 'crude starch.' The ash is invariably found to be alumina, rendered insoluble by the process of burning the alum."

The following modification of McGill's method was used by us on all classes of powders, to check the results by the copper reduction method.

Digest one gram of the powder with 150 cc. of 3 per cent. hydrochloric acid, at the room temperature, for 24 hours, with occasional shaking. Filter on a Gooch crucible, wash thoroughly with cold water and finally once with alcohol and once with ether. Dry at 110° (4 hours is usually sufficient), cool and weigh. Burn off the starch and weigh again. To obtain the weight of starch, substract the weight after burning from that after drying at 110°.

The results by this modification on all the tartrate and tartaric acid powders agreed closely with those by the copper reduction method.

*Lab. Inland Revenue Dept., Ottawa, Canada, Bul. 68, pages 31 and 33.

On the phosphate, alum and alum-phosphate powders, the results were usually satisfactory, but in some instances they were over two per cent. too high. With a mechanical shaking apparatus, better results could doubtless be secured.

Alumina, Iron, Lime, Potash and Soda.

Preparation of solutions. Char 5 grams of the material in a platinum dish at a heat below redness. Boil the carbonaceous mass with dilute hydrochloric acid, filter into a graduated 500 cc. flask and wash with hot water. Return the residue, together with the paper, to the platinum dish and burn to a white ash. Boil again with hydrochloric acid, filter and wash.

Incinerate the residue after the last filtration, for the determination of *ash insoluble in acid.* Unite the two filtrates, makes up to 500 cc. and draw off two aliquot portions of 100 cc. each, one for the determination of alumina, iron and lime, the other for the determination of potash and soda.

Alumina. Separate silica if necessary. Mix the solution with sodium phosphate solution in excess of what is required to form normal aluminum phosphate. Add ammonia until a precipitate remains on stirring, then hydrochloric acid drop by drop until the precipitate dissolves. Heat the solution to about 50° C., mix with a considerable excess of 50 per cent. ammonium acetate solution and 4 cc. of 80 per cent. acetic acid.

As soon as the precipitate of aluminum phosphate, mixed with a little iron phosphate, has settled, collect on a filter, wash with hot water, ignite and weigh.

Fuse the mixed phosphates with ten parts of sodium carbonate, dissolve in dilute sulphuric acid, reduce with hydrogen sulphide and determine the iron by the permanganate method. In the same solution determine the phosphoric acid. To obtain the weight of Al_2O_3, subtract the sum of the weights of Fe_2O_3 and P_2O_5 from the weight of the mixed phosphates.

Lime. Heat the filtrate from the mixed phosphates, which is acid with acetic acid, to 50° C. and precipitate with ammonium oxalate. Filter, wash, ignite over a Bunsen burner and finally convert into oxide by heating over a blast lamp.

Potash and soda. Evaporate an aliquot portion of the solution, prepared as described, nearly to dryness to remove excess of hydrochloric acid, dilute and heat to boiling. While still boiling, add barium chloride solution as long as a precipitate forms and enough barium hydrate to make the liquid strongly alkaline. As soon as the precipitate has settled, filter and wash with hot water, heat the filtrate to boiling, add sufficient ammonium carbonate solution* to precipitate all the barium, filter and wash with hot water. Evaporate the filtrate to dryness, ignite below redness to remove ammonia salts. Add to the residue a little water

*Prepared by dissolving one part of ammonium carbonate in a mixture of four parts of water and one part of ten per cent. ammonia water.

and a few drops of ammonium carbonate solution. Filter into a tared platinum dish, evaporate and ignite below redness, and weigh the mixed potassium and sodium chlorides.

Determine the potash as potassium platinichloride, using the factors 0.1939 for K_2O and 0.3069 for KCl.

Phosphoric Acid.

The official method of the A. O. A. C. was employed as follows:*

Ignite 5 grams of the material with a little magnesium nitrate solution, dry, ignite and dissolve in hydrochloric acid. In an aliquot of the solution determine phosphoric acid as magnesium pyrophosphate by the molybdic method.

Sulphuric Acid.

The determinations were made without previous ignition of the powder by the method described by Crampton:† Weigh out 5 grams, boil gently for one and one-half hours with a mixture of 300 cc. of water and 15 cc. of concentrated hydrochloric acid. Make up to 500 cc., draw off an aliquot portion of 100 cc., dilute considerably, precipitate with barium sulphate, filter through a Gooch crucible, ignite and weigh. For the purpose of learning whether the dextrose, which is formed in this process from the starch, interferes with the accuracy of the method, determinations were made on some of the samples after fusion with pure sodium hydrate and oxidation with sodium peroxide. The following are the results:

Determinations of Sulphuric Acid.

No.	Without previous ignition.	After fusion.
1152	25.94	25.92
1157	12.63	12.63
1158	13.87	13.95
1176	23.85	23.89
1179	26.38	26.42
1201	27.50	27.47
1162	13.19	13.47
1166	14.03	14.36
1167	26.22	26.26

Ammonia.

Nitrogen in the form of ammonia salt was determined by distillation with caustic soda into standard acid and titration.

Tartaric Acid.

Goldenberg-Geromont-Heidenhain method. Into a shallow porcelain dish, 6 inches in diameter, weigh out 2 grams of baking powder and

* U. S. Dept. Agr. Chem., Bull. 46, Revised ed., 12.

† U. S. Dept. Agr. Div. Chem., Bul. 13, Part 5, p. 596.

sufficient potassium carbonate to combine with all tartaric acid not in the form of potassium bitartrate. Mix thoroughly with 15 cc. of cold water. Add 99 per cent. acetic acid from a graduated pipe until effervescence ceases and in addition twice as much more as was used for the neutralization. Mix by stirring for half a minute with a glass rod bent at the end. Add 100 cc. of 95 per cent. alcohol, stir violently for 5 minutes and allow to settle at least 30 minutes. Filter on a Gooch crucible with a thin layer of paper pulp, and wash with 95 per cent. alcohol until 2 cc. of the filtrate do not change the color of litmus tincture diluted with water. Place the precipitate in a small casserole, dissolve in 50 cc. of hot water and add standard N/5 potassium hydrate solution, leaving still strongly acid. Boil for one minute. Finish the titration, using phenolphthlein as an indicator, and correct the reading by adding 0.2 cc. The standard of the potassium hydrate solution should be fixed by pure dry potassium bitartrate.

The accuracy of this method is indicated by the agreement of the percentages of potassium bitartrate in cream of tartar powders, obtained by calculation from the tartaric acid, with those obtained by calculation from the potassium oxide, as shown in the following table:

PERCENTAGE OF POTASSIUM BITARTRATE.

No.	Calculated from total tartaric acid.	Calculated from potassium oxide.
1160	69.31	69.37
1195	54.62	54.29
1191	60.19	60.20
1165	53.10	53.17
1154	50.15	50.58

CREAM OF TARTAR.

BY A. W. OGDEN.

Cream of tartar is, chemically considered, an acid potassium tartrate, which is deposited in a crude state by wines during fermentation.

This crude salt, called argols, is refined, forming an almost chemically pure acid tartrate or bitartrate of potash, the basis of all tartrate baking powders and considerably used by bakers and housekeepers in conjunction with saleratus for raising bread.

In December, 1897, forty-eight samples of cream of tartar were collected, but owing to pressure of other work could not be examined until this year.

The results, tabulated in Tables XXIII to XXV, pages 182 and 183, may be summarized as follows:

	No. of Samples Examined.	No. found Adulterated.	Percentage Adulterated.
Cream of Tartar sold, in labeled packages	11	3	27.2
" " " " bulk	37	12	32.4
Total	48	15	31.2

In most of the adulterated samples starch was found, in two cases alum was present and acid phosphates were present in eleven out of the fifteen samples examined.

Each of the samples not found adulterated contained 98.5 per cent. or more of pure potassium bitartrate.

In January, 1900, twenty-eight samples of cream of tartar were purchased and examined.

The results, given in detail in Tables XXVI and XXVII, pages 184 and 185, may be summarized as follows:

	No. of Samples Examined.	No. of Samples found Adulterated.	Percentage Adulterated.
Cream of Tartar in labeled packages	15	5	33.3
" " " sold in bulk	13	4	30.8
Total	28	9	32.2

Each of the samples not found adulterated contains at least 98.7 of pure potassium bitartrate.

Each of the adulterated samples contains starch, four of them, Nos. 11318, 11311, 11315 and 11336, contain ammonia alum and all with exception of 11315 contain sulphate and phosphate of lime. No. 11315 contains no phosphate, but more than half its weight is plaster, added as a makeweight.

In these samples starch is nothing other than an adulterant. Unlike baking powder, cream of tartar is not subject to any deterioration, when properly stored. In the adulterated samples, the more expensive cream of tartar has been replaced in part with cheap substitutes and make-weights.

The anaytical results are given in Table XXVIII, page 185.

TABLE XXIII.—CREAM OF TARTAR, SOLD IN LABELED PACKAGES. NOT FOUND ADULTERATED. COLLECTED IN 1897.

Station No.	Label.	Dealer.	Price per ¼ lb. Package.	Per cent. of Potassium bi-tartrate.
9017	Tiger Mills Pure Cream Tartar, New York	*Bridgeport.*—Berwick & Walker, 195 E. Main St.	.10	99.0
9090	Lincoln, Seyms & Co., Pure Cream Tartar	*Hartford.*—L. C. Hart & Co., Albany Ave.	.15	99.0
9093	Boardman's Pure Cream Tartar	J. C. & Co., Hill Grocery, 558 Asylum St.	.10	99.1
9256	Slade's Pure Cream Tartar, D. & L. Slade Co., Boston	*Meriden.*—L. C. Browns, 4 W. Main St.	.15	99.1
9347	Lincoln, Seyms & Co., Pure Cream Tartar	*Middletown.*—C. A. Allison, 31 Main St.	.10	99.5
9353	Stickney & Poor's Warranted Pure Cream Tartar	G. E. Burr, 136 Main St.	.12	99.1
9306	Bennett, Simpson & Co., Genuine Cream Tartar, 5 Mincing Lane, London, E. C.	*Norwich.*—H. I. Palmer, Main St.	.15	99.1
9322	Bugbee & Brownell, Warranted 99% Pure Cream Tartar, Providence, R. I.	*Putnam.*—Edward Muller	.10	99.1

TABLE XXIV.—CREAM OF TARTAR SOLD IN BULK, NOT FOUND ADULTERATED. COLLECTED IN 1897.

Station No.	Dealer.	Price per ¼ lb, Package.	Per cent. of Potassium bi-tartrate.
9028	*Bridgeport.*—R. T. Whiting, 345 Main St.	.14	99.3
9027	Coe & White, 560 Main St.	.13	99.3
9012	John B. Sullivan, 222 East Main St.	.10	99.3
9011	Geo. E. Cleaveland, 200 State St.	.13	99.5
9034	E. L. Sullivan, 436 East Main St.	.08	99.0
9038	Enterprise Market, 133 East Main St.	.10	98.5
9381	*Canaan.*—Jackson & Eggleston	.10	98.8
9049	*Greenwich.*—Geo. Finch, Greenwich Ave.	.12	99.1
9065	Avery & Wilson	.13	99.0
9078	*Stamford.*—W. W. Waterbury, 207 Main St.	.12	99.3
9099	*Hartford.*—M. Rosenblatt, Village St.	.13	99.3
9094	Chas. A. Post, 709 Main St.	.15	99.3
9239	H. J. Case & Co., 433 Main St.	.13	98.5
9264	*Meriden.*—James J. Pagman, 35 West Main St.	.10	98.9
9337	*Middletown.*—W. F. Ackley & Co., Main St.	.10	99.6
9346	W. K. Spencer, Main St.	.12	98.9
9286	*New London.*—I. W. Potter, 72 State St.	.10	98.5
9276	Keefe & Davis, 125 Bank St.	.20	98.6
9296	*Norwich.*—W. A. Church, 18 Market St.	.10	98.5
9302	G. A. Ray, 47 Shetucket St.	.10	99.2
9305	J. A. Stoddard, 100 Franklin St.	.13	99.3
9331	*Putnam.*—The Union Pacific Tea Co.	.05	99.3
9332	A. C. Stetson	.10	99.0
9317	J. E. Sullivan	.10	99.4
9323	W. H. Mansfield	.10	99.5

TABLE XXV.—ADULTERATED CREAM OF TARTAR. COLLECTED IN 1897.

Station No.	Dealer.	Price per package in cents.	Adulterants.
	Sold in Labeled Packages.		
9261	*Meriden.*—F. W. Miner, 213 Pratt St.	10	Starch, lime, alumina.
9284	*Norwich.*—H. D. Avery, Franklin St.	10	Starch, lime, alumina, ammonia.
9304	George Lyman, 252 Franklin St.	10	Starch, lime, sulphates and phosphates.
	Sold in bulk.		
9382	*Canaan.*—G. L. Parsons & Son.	12	Starch, lime, sulphates and phosphates.
9052	*Greenwich.*—J. L. Mahoney	15*	Lime, sulphates and phosphates.
9242	*Hartford.*—Joseph Hagerty, 75 Front St.	15*	Starch, lime, sulphates and phosphates.
9098	H. D. Frost, 595 Main St.	20*	Starch, lime, sulphates and phosphates, ammonia.
9097	H. E. Hills & Co., 547 Main St.	20*	Lime, phosphates, sulphates and ammonia.
9265	*Meriden.*—New York Butter and Grocery House, 2 Colony St.	20*	Starch, phosphates.
9294	*Norwich.*—A. Wilson, 58 Franklin St.	13	Starch, lime, sulphates and ammonia.
9303	A. B. Peckham, 47 Franklin St.	10	Starch, lime, sulphates and phosphates.
9324	*Putnam.*—W. J. Bartlett	10	Starch, lime, sulphates and phosphates and ammonia.
9083	*Stamford.*—H. Sawyer Daskam, Atlantic St.	22†	Lime and sulphates.
9081	Fitch A. Hoyt, Atlantic Sq.	18*	Starch, lime, sulphates and phosphates.
9071	Geo. A. Ferris, 184 Main St.	20*	Starch, lime, sulphates and phosphates.

* Per half pound. † Per pound.

TABLE XXVI.—CREAM TARTAR NOT FOUND ADULTERATED. BOUGHT IN 1900.

Station No.	Label.	Dealer.	Price per ¼ lb. Package.	Per cent. of Potassium bi-tartrate.
	In Labeled Packages.			
11319	Stickney & Poor's Warranted Pure Cream Tartar 99 80/100 per cent. purity	*New Haven.*—Paul Baer, 181 Dixwell Ave.	.10	99.1
11332	Stickney & Poor's Warranted Pure Cream Tartar 99 80/100 per cent. purity	D. M. Smith, 1 East Grand Ave.	.10	99.1
11323	Reliable Pure Cream Tartar, Clark, Chapin & Bushnell, New York	C. T. Downes, 1 Broadway.	.12	98.9
11321	Absolutely Pure Cream Tartar, D. & L. Slade Co., Boston	Paul Jente & Bro., 107 Broadway	.09	99.1
11326	Absolutely Pure Cream Tartar, D. & L. Slade Co., Boston	New Haven Provision Co., 382 Grand Ave.	.10	99.0
11328	Pure Cream Tartar, Bennett, Sloan & Co., New York	Edgar A. Johnson, 86 Ferry St.	.12	99.3
11314	Genuine Cream Tartar, Bennett, Simpson & Co., London	Johnson & Bro., 411 State St.	.12	98.7
11329	Warranted 99% Cream Tartar, Bugbee & Brownell, Providence, R. I.	S. Sax, 251 Grand Ave.	.10	99.2
11310	Gauntlet Brand Cream of Tartar, Guaranteed 100% Pure Bi-Tartrate of Potash.	S. S. Adams, 412 State St.	.08	99.0
11317	Gauntlet Brand Cream of Tartar, Guaranteed 100% Pure Bi-Tartrate of Potash.	E. E. Nichols, 378 State St.	.15	98.9
	Sold in Bulk.			
11333	*New Haven, Conn.*—E. L. Dutcher, 99 Grand Ave.		.08	99.1
11316	N. A. Fullerton, Chapel St.		.10	99.2
11334	J. T. Hillhouse, 40 Grand Ave.		.15	99.0
11321	S. W. Hurlburt, 1074 Chapel St.		.15	98.7
11335	S. L. Salisbury, 6 Grand Ave.		.15	99.0
11624	W. A. Spalding, 89 Church St.		....	99.5
11312	C. B Storer, 15 Shelton Ave.		.12	99.2
11313	S. H. Williams, 183 Shelton Ave.		.15	99.1
11322	A. Davidson, 12 Lafayette St.		.15	99.0

TABLE XXVII.—ADULTERATED CREAM OF TARTAR. BOUGHT IN 1900.

Station No.	Label.	Dealer.	Price per ¼ lb. Package, cents.	Adulterants Found.
	In Labeled Packages.			
11325	Excelsior Mill Pure Cream Tartar, Coburn & Co., 109 State St., New Haven	*New Haven.*—W. G. Graves, 341 Grand Ave.	10	Acid phosphate of lime, starch.
11318	Crescent Mills, Select Cream Tartar, John P. Augur, New Haven	W. A. Eisele, 287 Dixwell Ave.	10	Acid phosphate of lime, starch, ammonia alum.
11311	Crescent Mills, Select Cream Tartar, John P. Augur, New Haven	Mrs. Walz, 170 Newhall St.	10	Acid phosphate of lime, starch, ammonia alum.
11327	Challenge Mills, XX Cream Tartar, New York	Philip Wayrand, 50 Chapel St.	10	Acid phosphate of lime, starch.
11315	Genuine Cream Tartar, Bennett, Sloan & Co., New York	Coe & Jenks, 422 State St.	13	Plaster, starch, ammonia alum.
	Sold in Bulk.			
11336		*Canaan.*—Jackson & Eggleston	--	Acid phosphate of lime, starch, ammonia alum.
11331		*New Haven.*—Orton A. Rose, 27 East Grand Ave.	12	Acid phosphate of lime, starch.
11320		D. M. Welch & Son, 28 Congress Ave.	10	Acid phosphate of lime, starch.
11330		D. M. Welch & Son, 8 Grand Ave.	10	Acid phosphate of lime, starch.

TABLE XXVIII.—CHEMICAL ANALYSES OF ADULTERATED CREAM OF TARTAR. BOUGHT IN 1900.

Station No.	Lime.	Soda.	Potash.	Alumina.	Sulphuric acid.	Phosphoric acid.	Nitrogen as ammonia.
11325	4.57	0.43	18.79	0.00	3.28	5.94	0.00
11318	14.13	0.50	7.55	2.78	18.58	10.20	0.60
11311	14.08	0.62	6.85	3.10	19.26	11.00	0.62
11327	19.14	0.74	6.67	0.00	16.09	18.94	0.00
11315	20.02	0.42	2.02	0.89	30.82	0.00	0.24
11336	16.28	1.01	1.62	3.73	30.36	12.67	1.00
11331	14.67	2.02	5.91	2.02	1.91	36.85	0.00
11320	7.34	.55	17.58	0.00	7.96	6.34	0.00
11330	3.83	1.02	21.26	0.00	3.96	3.15	0.00

THE ANATOMY OF MAIZE COB, WITH ESPECIAL REFERENCE TO THE DETECTION OF GROUND COBS IN WHEAT- OR RYE-BRAN.*

By A. L. Winton.

The material used in the study here described was cob from a twelve-rowed yellow flint maize grown near Graz, Austria.

Macroscopic Structure.

The kernels of a maize ear spring from the cob transversely in pairs and longitudinally in double rows. The arrangement is such that a plane perpendicular to the axis of the cob which passes through the bases of the pair in one double row will pass alternately between and through the bases of the pairs in the other double rows. Since the double rows of kernels are arranged in pairs, it follows that there are normally an even number of rows on a cob. In the early stages of ripening, the double rows are separated by marked grooves; but as the kernels

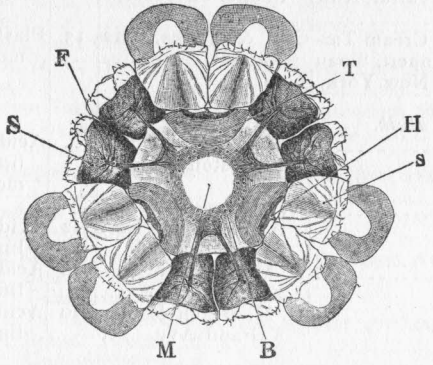

Fig. 1.—Section of maize ear looking toward the base. s inner surface of upper thick glume seen behind the thin glume and palets; S outer surface of lower thick glume; F axes; T denser portion of woody zone; H depression; B zone with fibro-vascular bundles; M pith. Natural size.

approach maturity they become so crowded that the arrangement in pairs and double rows may not be outwardly apparent, but is evident on cutting into the cob.

*The work described in this paper was done under the direction of Prof. Dr. Moeller at the Pharmacological Institute of Graz University, Austria, and the original paper in the German language was published in the Oesterreichische Chemiker-Zeitung, 1899, No. 14. As Mr. Winton was a member of the Station staff at the time and as the work is valuable in facilitating the detection of cobs in bran, it is here reproduced with appropriate emendations by Mr. Winton.—[E. H. J.]

Fig. 1 shows a cross section of an ear so cut as to leave three of the six pairs of kernels entire, alternating with three pairs of fruit cups in section. The core of pith (M) is surrounded by a zone (B) containing numerous fibro-vascular bundles running longitudinally through the cob and this in turn by an outer woody zone bearing the fruit cups. The woody regions beneath the double rows (T) are separated from each other by thin radial partitions of soft tissues extending from the central pith nearly to the surface. These partitions can be traced the whole length of the cob separating the woody matter into strips

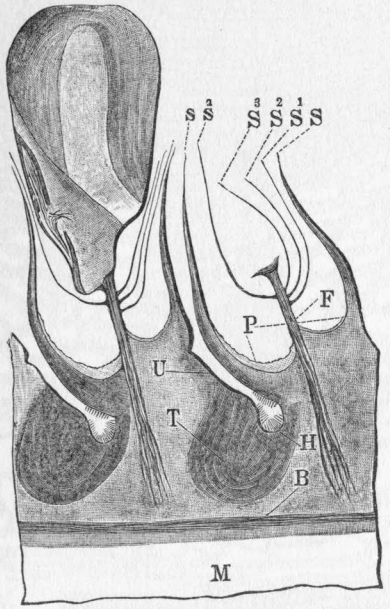

Fig. 2.—Radial section of maize ear through the centre of the kernels. s lower thick glume; S upper thick glume; S^1 thin glume; s^1 flowering glume; S^3 palet; S^2 palet of rudimentary flower; P spongy lining of thick glumes; U surface of woody zone beyond depression; H depression; T denser portion of woody zone; B fibro-vascular bundle; M pith. ×4.

which are arranged about the pith like the staves of a barrel. These strips of woody matter are pierced for the passage of the tissues connecting the kernels with the zone of vascular bundles.

On the surface of the woody zone between the pairs of fruit cups is a transverse depression clothed with hairs, which is more or less pronounced according to the dryness of the cob (Fig. 1 and 2 H). The woody matter (T) about these depressions is

of a darker color than in other parts, owing to its greater density. The cups in which the kernels rest are formed by six fruit envelopes, viz.; three glumes (Fig. 2, S, s, S^1), a flowering glume (s^1), a palet (S^3) and another palet (S^2) belonging originally to a rudimentary blossom. Two of the glumes (S, s)

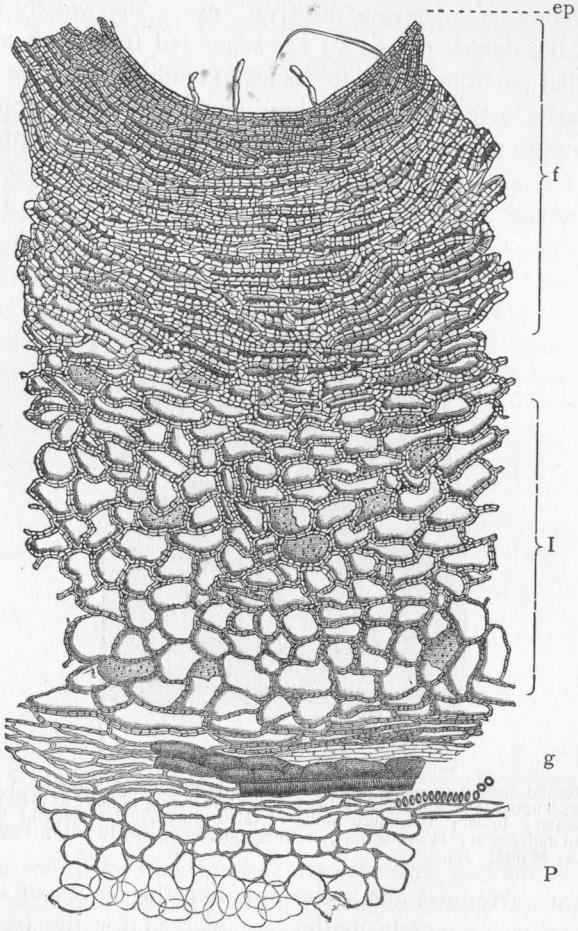

FIG. 3.—Radial section of maize cob through depression (H. figs. 1 and 2). ep epidermis with single-celled and jointed hairs; f elongated sclerenchyma; I isodiametric cells; g fibro-vascular bundle; P parenchyma of the pith. ×32.

are thick and horny with linings of spongy tissues (P) and thin ends resembling tissue paper. The other enveloping parts are entirely of this papery texture. The bases of the thick glumes, especially at their points of juncture, and also the thin ends, are clothed with hairs.

Microscopic Structure.

The epidermis overlying the woody zone in the depressions (Figs. 1 and 2, H) is made up of thin-walled cells of wavy outline arranged more or less distinctly in rows (Fig. 4, ep). The hairs which spring from this epidermis are like those on the base of the glumes and are described in a subsequent paragraph. The epidermal cells in the region between the depressions and the base of the upper thick glume (Fig. 2, U) are of two forms: one irregular in outline with thick walls

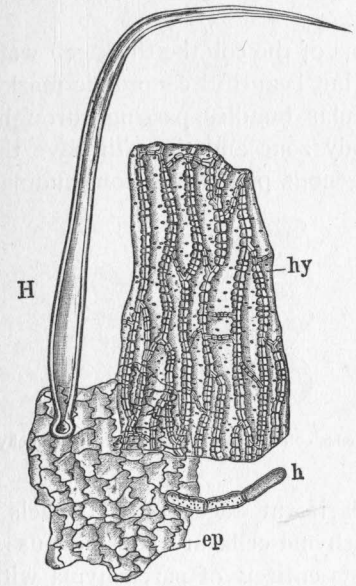

FIG. 4.—Surface view of epidermis (ep) and hypoderma (hy) of maize cob in the depression (H figs. 1 and 2). H single-celled pointed hair; h blunt three-celled hair. ×160.

pierced by numerous pores; the other smaller, more or less elliptical or moon-shaped, with thinner walls free from pores. The non-porous cells are often in pairs and occur at more or less regular intervals.

The sclerenchyma-cells of the woody zone (Fig. 3) vary greatly in form, size and in the thickness of the walls according to their location. The first layer beneath the epidermis in the depressions, as seen in a surface view (Fig. 4, hy), consists of elongated cells with porous walls usually narrower than the lumen. The side walls are much thicker than those at the ends.

The cells of several succeeding layers are long and fibrous with narrow lumen and extend in curves parallel to the surface of the depressions (Fig. 3).

Proceeding inward from these layers, the cells gradually diminish in length and increase in width until they are finally round or oval. At first this change in shape is accompanied by a thickening of the cell wall; but further inward the walls begin to diminish in thickness and continue to diminish until the cells lose the character of sclerenchyma. All the transitional forms from woody fibre to the thin parenchyma of the pith are noticeable in sections.

In cross-sections of the cob the thick cell walls show not only numerous pores, but beautiful concentric markings (Fig. 5).

The fibro-vascular bundles passing through the soft tissue between the woody zone and the pith have the characteristics peculiar to endogenous plants. In longitudinal sections spiral,

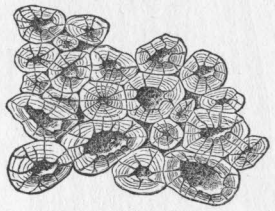

FIG. 5.—Transverse of maize cob through the elongated sclerenchyma of the woody zone. ×160.

annular, and scalariform ducts, pitted vessels and thin-walled elongated sclerenchyma-cells are conspicuous (Fig. 3).

The pith consists entirely of parenchyma with thin cell walls which, under high power, are seen to be pierced by pores.

Each of the thick glumes (Fig. 2 S, s) is composed of a horny lower portion and a thin papery tissue at the end.

The structure of the horny portion appears in cross sections (Fig. 6). The epidermis is of much the same character as that of the woody zone at the base of the upper thick glume (Fig. 2, U) although the cells of both forms are usually more rectangular and more regularly arranged (Fig. 7). Of the two forms of cells, those without pores are usually smaller than those with pores; but in some parts the difference in size is not so marked. The former occur singly, in pairs or in groups at more or less regular intervals between the porous cells. In

addition to these two forms of cells, hairs and well developed stomata also occur in parts.

The sclerenchyma of the glumes extends from the epidermis nearly to the inner surface (Fig. 6). The cells of the hypoderma are large, loosely arranged, more or less isodiametric and have walls of moderate thickness; but further inward the cells

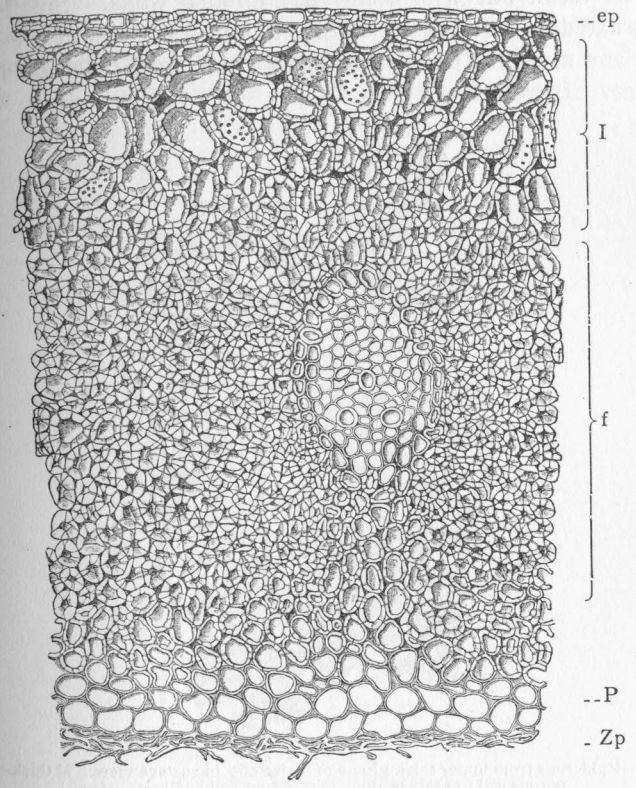

FIG. 6.—Transverse section of an upper thick glume of maize cob. ep epidermis with thick walled, porous cells and thin walled non-porous cells; I isodiametric cells; f longitudinally elongated sclerenchyma with fibro-vascular bundle; P parenchyma; Zp compressed parenchyma. ×160.

are smaller, thicker walled and are longitudinally much elongated. The fibro-vascular bundles run among these elongated cells and parallel to them. Toward the inner surface the cell walls diminish in thickness and the sclerenchyma passes finally into parenchyma. The parenchyma cells of the inner layers are indistinct and much compressed.

The structure of the thin ends of the thick glumes (S and s) is clearly shown in Fig. 8, reproduced from an illustration by Moeller.* There are two layers of cells; one, the epidermis (ep), made up of cells with wavy outline, the other parenchyma (p) with elongated cells. The epidermis, particularly at the margins, bears numerous hairs like those in other parts of the cob in form, but with somewhat thinner walls. Small cells designated by stars in the cut are found in corners of the wavy cells and mark the position of hairs which have fallen off in the process of growth.

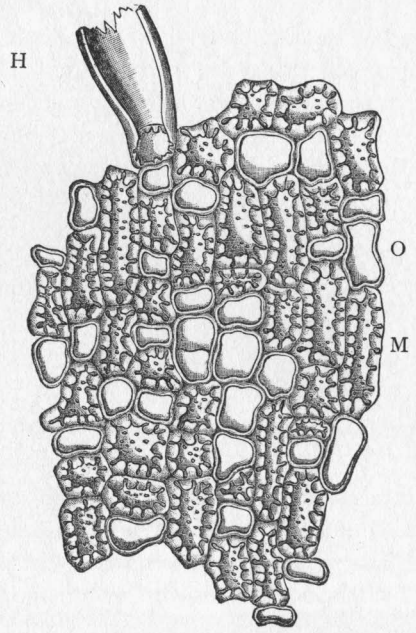

FIG. 7.—Epidermis from upper thick glume of maize cob in surface view. M thick-walled, porous cell; O thin-walled, non-porous cell; H hair. ×300.

The thin glume (Fig. 2, S^1), the following glume, the palets (S^3 and S^2) (s^1) are practically the same in structure as the thin ends of the thick glumes; hairs are found, however, only at the base (at least in the variety examined) and there only in small number. Toward their points of attachment there is frequently more than one layer of parenchyma.

* Moeller. Mikroskopie der Nahrungs und Genussmittel aus dem Pflanzenreiche. Berlin, 1886.

The hairs in different parts of the cob are of two forms; one, single-celled ending in sharp points; the other, two or more celled, blunt at the end. The single-celled hairs are often 1.5 mm. long and at their broadest part have walls from ⅓ to ⅙ the thickness of the lumen. In some, pores are evident. The compound hairs have thinner walls which, in the lower members at least, are pierced by numerous, although indistinct, pores.

Some of the hairs noted are shown in Fig. 9. The broadest hair at the left was from the group at the point where the bases of the thick glumes meet. Short single-celled hairs such as

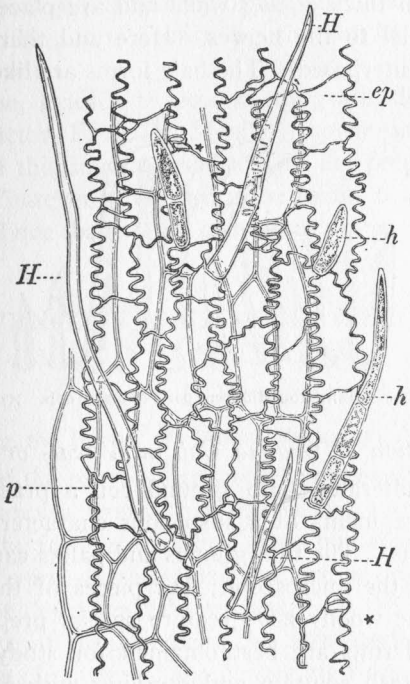

FIG. 8.—Membranous end of upper thick glume of maize cob in surface view. ep epidermis with pointed, single-celled hairs (H) and blunt, one to three-celled hairs (h); p parenchyma. ×160. (Moeller.)

the one shown at the right hand end are found on the surface of the thick glumes near the base and on the husk. The remaining forms in the cut occur in the parts already mentioned and also on the depressions in the woody zone and on the thin ends of the thick glumes.

The microscopist should also be familiar with the structure of the modified leaves which make up the husk, pieces of which often remain adhering to the base of the cob. The outer leaves of the husk are practically the same as the ordinary leaves; the inner leaves are however thinner and not being exposed to the light during growth, contain but little chlorophyl.

The nerves form prominent parallel veins on the outer surface, between which the tissues are thin and membranous.

The outer epidermis of the thin tissues has striking microscopic characters. The principal cells are porous, more or less elongated with thick zigzag walls and are placed end for end in rows parallel to the nerves. Here and there stomata and hair-cells are interposed. The hair forms are like those already described.

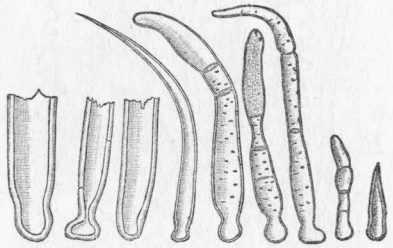

FIG. 9.—Hairs from different parts of maize cob. ×160.

The Detection of Ground Cob in Wheat- or Rye-Bran.

In bran adulterated with ground cob a practiced eye will usually find fragments of a suspicious character even without the aid of a lens. The thin glumes and palets can be examined directly under the microscope; but pieces of the thick horny glumes and the woody zone require special preparation. The hairs and epidermis are best obtained for study by warming with dilute potash solution and scraping with a scalpel. For the identification of other tissues, sections should be cut with a razor. In cases where the pieces are small the stone cells may be isolated by treatment with a macerating solution.

The hairs of maize cob, although exceedingly variable, are readily distinguished from those of wheat or rye bran. In a suspected sample of bran the presence of compound hairs with thin walls and of sharp pointed single-celled hairs with lumina five to six times the thickness of the walls is an indication of adulteration with maize cob.

The epidermal cells of the different parts of maize cob are characteristic and of much diagnostic value.

The cells of the hypoderma shown in Fig. 4 resemble somewhat those of the middle layer of wheat and rye, but are distinguished by their larger size and thicker walls.

Stone cells such as make up the woody zone of the maize cob and the interior of the thick glume will be at once recognized as foreign to bran; and the same may be said of fibro-vascular bundles and the parenchyma of the pith.

Where the percentage of adulteration is large, chemical analysis will disclose a deficiency of nitrogen, fat and starch and an excess of fibre, thus confirming the results of the microscopic examination.

In conclusion, I desire to express my gratitude to my distinguished instructor, Prof. Dr. Moeller, for continued aid in the prosecution of this investigation and in the preparation of the drawings. Whatever of merit may be found in the work is due more to his advice than to my own efforts.

A CONVENIENT MICRO-POLARISCOPE FOR FOOD EXAMINATION.

BY A. L. WINTON.

Reprinted from the *Journal of Applied Microscopy,* Vol. II, No. 10.

The value of the micro-polariscope as a means of distinguishing starch granules from other bodies and starch granules of different plants from each other, does not appear to be fully recognized by some of the leading authorities on the microscopy of foods, chief dependence being placed on the iodine test, the shape and size of the granules, the form and location of the hilum, and the character of the concentric rings.

While it is true that the skilled microscopist can distinguish the various starches when illumined by ordinary light, still if he is provided with a suitably arranged polariscope, he can often reach his conclusions with a saving of both time and eyesight.

Among the authors who advocate the use of this apparatus may be mentioned Tripe, Blythe, Richardson, and McGill.

The classification of starches adopted by Blythe* is based on

* Foods. Composition and Analysis. Fourth Edition, p. 170.

the appearance of the granules with polarized light and the selenite plate. Richardson* illustrates the application of the polariscope in the examination, with reference to adulteration, of ground spices and condiments. McGill† describes its use in the quantitative determination of wheat flour in ginger.

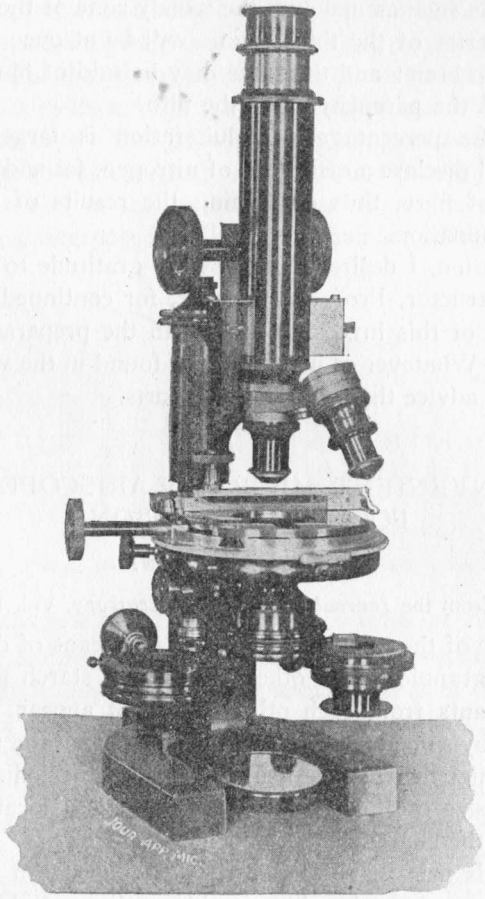

Figure 1.

The writer has found polarized light of special service in the examination of sausage for potato, wheat, and maize flour, which are frequently added to this food as carriers of water. If the fat is not removed before examination, the colorless starch

* U. S. Dept. of Agriculture, Div. Chem., Bull. 13, Part II.
† J. of Applied Micros., Vol. 1, p. 51.

granules are not readily distinguished from the fat globules, and the fat also interferes with the iodine test, but with crossed prisms the starch not only becomes evident, but the particular variety present may be readily determined.

One of the chief drawbacks to the use of this appliance is that biological microscopes are not usually arranged for changing quickly from plain to polarized light, and *vice versa.* Usually the polarizer is fitted to the sub-stage ring, which carries the Abbe condenser and cannot be attached until the sub-stage is lowered and the condenser is removed. For attaching the analyzer the microscope tube must be raised, the objective or nose-piece removed, and the analyzer screwed at the upper end to the tube, and at the lower end to the objective or nose-piece. Both the sub-stage and the tube must be readjusted before the object can be viewed. The change back again to plain illumination is equally laborious. These operations not only consume several minutes each time the polariscope is brought into service, but also, if often repeated, are ruinous to the screw threads and other parts of the apparatus.

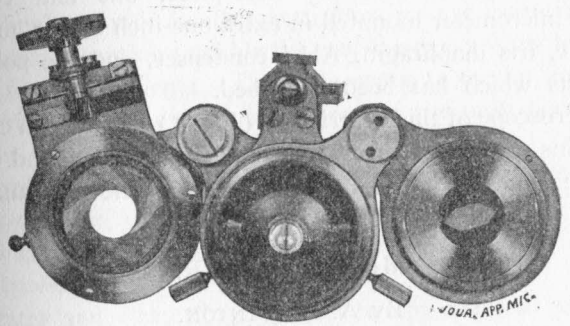

Figure 2.

In Fig. 1 is shown a Bausch & Lomb Continental microscope fitted with an arrangement devised by the writer, which obviates all the disadvantages which have been named. The polarizer (Fig. 2) is carried on an arm below the substage, and swings into position from the right, at the same time forcing the iris diaphragm out of position to the left. The analyzer is mounted in the same manner as in petrographical instruments, the prism being contained in a box which slides in the main tube, so that when pushed to the right the light passes

through the prism, but when pushed to the left, a round opening permits unobstructed vision.

When polarized light is desired, the polarizer is pushed to the left, and the analyzer box to the right, and the change to plain illumination is accomplished by the reverse operations. Either change can be made in less than a second, without disturbing the adjustment either of the tube or the sub-stage, and without damage to the instrument.

Another advantage is that the condenser may be used in conjunction with the polarizer, thus rendering the crosses on wheat, rye, barley, and some other feebly active starches much more distinct.

Selenite plates are mounted in a metal slip and are used on the stage.

Now that the microscopic examination of food products is coming into importance in the United States, the question arises as to the form of microscope best adapted for this work.

After experience with several types of instruments, the writer prefers a Continental stand, provided with two-thirds and one-sixth-inch objectives, double nose-piece, one and two-inch oculars, micrometer mounted in extra one-inch ocular, mechanical stage, iris diaphragm, Abbé condenser, and the polarizing apparatus which has been described.

A microscope of this description (Fig. 1) has been in constant use at this station for several years and has been found to fully meet the somewhat peculiar requirements of the food analyst.

MILK POWDER.

By A. L. Winton.

This preparation, said to be made from skim milk by the Ovine Co., 100 Maiden Lane, New York City, is used by bakers as a substitute for eggs. Following is the manufacturer's statement concerning it:

"OVINE.

EGGS FROM MILK

Is a product made of milk and sells for forty cents per pound. Each pound contains 160 eggs. As one ounce is equal to ten eggs, this makes eggs three cents per dozen.

Directions for use.

One ounce of OVINE is equal to ten eggs. To obtain the required amount of moisture, milk or water should be used.

One ounce of OVINE is equal to one pint of eggs, so one pint more milk should be used in your mixture, than called for when eggs are used.

First take sugar, shortening and OVINE and cream together, then add milk, and go ahead the same as if eggs were used.

THE OVINE COMPANY
100 Maiden Lane,
New York."

Two samples were submitted for analysis by a New Haven baker; one, a substitute for the white of eggs, the other, for yolks.

Analyses:	No. 1804. White milk powder.	No. 1805. Yellow milk powder.
Water	8.07	8.99
Casein (N x 6.37)*	73.25	73.64
Fat	1.53	2.03
Ash	6.68	6.33
Phosphorus	0.76	0.91

The yellow milk powder contains an ochre-yellow coal-tar dye.

The analyses indicate that both powders are essentially milk casein and, excepting possibly the coal-tar dye, are unobjectionable as food ingredients. The statements as to the number of eggs equivalent to different amounts of the milk powder are, however, misleading.

According to experiments recently conducted by Emery,† the weight of hens' eggs ranges from less than one and one-half to two and one-third ounces, the average weight being about two ounces.

Atwater and Bryant‡ give the average composition of raw eggs as follows:

Refuse	11.2 per cent.
Water	65.5 "
Protein (N x 6¼)	11.9 "
Fat	9.3 "

* This factor corresponds to 15.7 per cent. of nitrogen in pure casein. Hammarsten, A text-book of Phys. Chem., Trans. by Mandel. New York, 1900, p. 388.

† N. C. Agr. Expt. Sta., Bul. 167, p. 403.

‡ U. S. Dept. Agr. Office Expt. Sta., Bul. 28 (revised), p. 53.

Calculated from these data, the edible portion of ten eggs contains

4.66 ounces of dry matter,
2.38 ounces of protein,
1.86 ounces of fat.

Three and a quarter ounces of "Ovine"—not one ounce—would contain the same amount of protein as ten eggs of average size and weight, and there would be needed 121 ounces of "Ovine" to supply as much fat as ten eggs. The nature of the protein and fat of eggs is, of course, quite different from that of the protein and fat of milk.

ZANZIBAR CARBON.

By A. L. Winton.

A twenty-ounce tin can of this preparation was purchased directly from the manufacturers, B. Heller & Co., Chicago, Ill.

On the label of the can was a picture of "Natives at Work Boiling the Gum," and the following printed matter:

"Zanzibar Carbon produces a richer color than smoke, prevents mould on meat and sausage, prevents skippers on meat, imparts a fine aroma.

Directions.—For coloring Bolognas, Frankforts, etc., to a bright natural smoke color, and preventing them from getting slimy or mouldy, use one-half to one teaspoonful of Zanzibar Carbon to every thirty gallons of water, and boil the sausage in it.

Invented and put up only by B. Heller & Co., Chemists, Chicago, Ill., U. S. A.," etc.

Accompanying the material was a forty-seven page English and German edition of "A Treatise on Zanzibar Carbon or How to Color Smoked Sausages, Meats and Fish, published and dedicated to the Meat Packing, Sausage and Smoked Fish trades." This entertaining little work, illustrated with pictures of negro savages and wild beasts, was devoted to observations on the physical geography, ethnology and history of Zanzibar as well as to the coloring sausages and other meat products with "Zanzibar Carbon."

This material consists chiefly of a coal-tar color, probably Bismark brown, and common salt. Bismark brown is extensively employed in dyeing wool, cotton and leather, and also in staining wood. The commercial dye always contains more or less common salt as an impurity.

Although the material had a strong camphor odor the amount of this ingredient must have been small.

Following is the analysis:

Water and volatile matter	3.51
Non-volatile organic matter (chiefly coal tar dye)	29.96
Common salt	65.32
Mineral matter insoluble in water	.42
Other mineral matter	.79
	100.00

WATERS FOR TABLE USE SOLD IN BOTTLES OR JUGS.*

By H. E. Smith, M.D.

The sale of simple potable waters for table use has greatly increased during the past few years, and now amounts to a considerable industry. This increasing use of special drinking waters is doubtless largely due to greater diffusion of knowledge of the danger of drinking sewage-contaminated water, but is also to be attributed to a growing demand for a water with better physical characters than are found in the public supplies of many of our cities and villages. The extensive use of special table waters in a community having a public water supply is, therefore, to be regarded as an expression of distrust in the public supply, or at least of dissatisfaction with it. The distrust may be well founded in a suspicion or belief that the water is sewage-contaminated and therefore liable to produce serious diseases. Or there may be dissatisfaction with the water because of its physical characters, as its turbidity, high color and objectionable taste or odor. Much more attention is paid to the character of our reservoirs and to the protection

* As the Station laboratory is crowded with other work and is not fitted for making sanitary analyses of water, the services of Dr. Smith, Dean of the Yale Medical School and Chemist of the State Board of Health, were secured during the summer of 1900, to make chemical examinations and report on the waters for table use which are offered for sale in bottles and jugs throughout the State. The waters themselves were bought and delivered to Dr. Smith by the sampling agent of this Station.—[E. H. J.]

of the watersheds supplying them than formerly, especially in some of the larger cities. But there are still some supplies which are subject to dangerous contamination and there are inherent difficulties in protecting surface water supplies especially in the case of small reservoirs, which are sure to result in at least occasional bad tastes and odors. Until public water supplies are made practically safe and free from objectionable physical properties by some process of purification, as by filtration, it is reasonable to expect that there will be a demand for special table waters. These will be purchased by our citizens because they are believed to be pure and because they have desirable physical characters. What waters are clear, odorless and of agreeable taste, it is easy for the purchaser to ascertain, but he has in general no means of judging for himself whether a water either is or has been contaminated by sewage.

Some waters found in the market are put out in a large way over a considerable territory and after suitable precautions to ascertain the quality of the water, and to maintain its purity during the process of preparation for market. But other waters are handled only in a small way by dealers who present no evidence that they have used suitable precautions to ascertain the purity of the water or that they possess the means of properly sterilizing the bottles or jugs in which the water is sold.

It was with the object of ascertaining the quality of the table waters sold in Connecticut that the series of analyses about to be described was made. The plan included the examination of samples of all the simple potable waters, but not of the mineral waters. In order to secure as complete a set of samples as possible, personal inquiries were made throughout the State by an agent of the Station. Inquiry was also made by mail of the health officers of all the principal cities and villages. In these ways information was secured of thirty-one waters which were being sold in the State. Samples of all of these were purchased from regular dealers by an agent of the Station and by him sent at once to the Sanitary Laboratory of the Yale Medical School for analysis.

It was decided to limit the examination to the usual sanitary chemical analysis, since it was believed that bacteriological examinations would be misleading if made on samples obtained in the way described, and it was not practicable to obtain special samples suitable for bacteriological examination.

The Samples.

The samples were all purchased and sent to the laboratory in what purported to be original packages. The amount of water procured was one gallon, or more in cases where the smallest package placed on the market contained more than one gallon. The containers were jugs or glass bottles, ranging in size from one quart to five gallons. There were five jugs of from two to three gallons capacity, and twenty-six bottles, of which two had a capacity of one quart, four of two quarts, three of one gallon, and seventeen of five gallons.

The prices paid for the samples are shown in the following summary:

Price per Gallon	1½,	3,	5,	6,	7,	8,	10,	15,	20,	30,	40,	55 cts.
No. of Samples.	1,	1,	10,	1,	3,	2,	7,	1,	2,	1,	1,	1

The average price paid was 10.5 cents per gallon. The average price of the twenty-four Connecticut spring waters was 6.8 cents per gallon.

The collections were made during the months, July, August, and September, 1900. The samples were examined as promptly as could be after their receipt at the laboratory, the changeable constituents at least, being determined within twenty-four hours.

The Analytical Data and their Significance.

The methods of analysis used are in general the same as those employed in analyses made for the Connecticut State Board of Health, and described in the Annual Reports for 1891 and for 1895.

The Residue on Evaporation, and the Loss on Ignition.

200 cubic centimeters of the water are evaporated in a platinum dish containing a small weighed amount of sodium carbonate, and the residue dried to a constant weight in a water bath. After weighing, the dish and contents are ignited in a larger platinum dish at a temperature just below red heat, and again weighed to obtain the loss on ignition.

The residue on evaporation represents the total solid matter dissolved in the water. This material is derived from the soil and rock with which the water has come in contact, and varies both in kind and amount in different localities and in water

coming from different depths. The mineral constituents in Connecticut spring waters vary within comparatively narrow limits, for the most part not exceeding five or six grains per United States gallon in uncontaminated springs, and frequently being much less. The different compounds are also few in number, the residue consisting chiefly of calcium carbonate, magnesium carbonate and silica, with small amounts of chlorides and sulphates of sodium and potassium, sometimes of calcium sulphate and sodium carbonate, and traces of compounds of iron, manganese and aluminium. These substances, in the amounts usually present in our springs, do not impart medicinal properties to the water. With few exceptions Connecticut springs belong, therefore, to the class of simple potable waters, and have no medicinal value except in so far as pure water taken in large amounts may be considered to have medicinal effects.

The loss on ignition is small in most ground waters if the evaporation has been conducted in the presence of sodium carbonate, and is to be ascribed for the most part to the loss of water, not fully expelled on heating at the temperature of boiling water. In surface waters containing relatively less mineral matter and more organic matter than ground waters, the loss on ignition is of more importance as it is a close approximation to the amount of organic matter present.

Chlorine.

Chlorine is determined by adding to the water a standard solution of silver nitrate until all the chlorine is converted into silver chloride, a point easily told by the use of potassium chromate as an indicator. In most cases it was necessary to evaporate 250 cubic centimeters of the water to a volume of 50 for the determination. From the amount of silver nitrate solution used the amount of chlorine present is calculated.

All natural waters contain some chlorine, but it has been found that the amount normally present in uncontaminated waters in Connecticut varies in different parts of the State. A discussion of chlorine in water, with a map showing the normal distribution of chlorine in the waters of Connecticut, may be found in the Annual Report of the Connecticut State Board of Health for 1895, page 230. An examination of this map, and also of a similar one of Massachusetts published by the Massachusetts State Board of Health, shows that the amount of chlorine is greatest near the sea coast, and that it decreases as one leaves the coast. The explanation of this distribution is that the amount of chlorine normal to any place in the region covered by these two States is such as has been blown inland in the form of common salt from the salt water of the ocean to the south and east. Such being the origin of the chlorine, it would be expected that the amount at any one time or place would vary with the direction and force of the winds. That the amount is not perfectly constant in any one place is seen in series of analyses of samples taken at the same place from time to time over a considerable period. It has been found, however, that except in the region close to the coast the variation from the average is small, rarely exceeding one part per million under usual conditions. From the foregoing it is seen that it is possible to determine from the known distribution of chlorine in this State what amount should be present in a sample of normal water from any particular location. This is of special importance in considering the sanitary history and condition of a water, because chlorine in the form of sodium chloride is an important and constant constituent of all sewage, and consequently the addition of sewage to water increases its chlorine. Since chlorine is not altered by the processes of oxidation and filtration, which may remove other constituents of sewage more or less completely, it will remain in any sample which has been sewage-contaminated and the excess above the normal will serve as an index to the amount of this contamination. A water in which the chlorine is normal, therefore, cannot have received any considerable sewage contamination. A water containing an excess of chlorine above the normal may owe this excess to recent sewage contamination, in which case the chlorine is accompanied by the other constituents of sewage, and especially the organic constituents, or the excess may be due to past sewage contamination, by which is meant that the water has been subjected to the purifying influences of filtration and oxidation since the addition of the sewage, and that some of the constituents of the sewage have been removed more or less completely, especially the organic constituents.

Nitrogen in its Different Forms.

Nitrogen is recognized in water analysis in the form of free ammonia, albuminoid ammonia, nitrites and nitrates.

The *Free Ammonia* represents the nitrogen which exists in the water in the form of ammonium salts, or other compounds which readily yield ammonia on boiling the slightly alkaline water. The free ammonia is determined by distilling 500 cubic centimeters of the sample after the addition of a little sodium carbonate until there are obtained of the distillate three portions of 50 cubic centimeters each, in which the ammonia is determined by the use of Nessler's solution. In this process the portion of water remaining after the free ammonia has been distilled off is treated with a strong solution of potassium permanganate and potassium hydroxide, and the distillation continued. The ammonia which now passes off is called *Albuminoid Ammonia* and comes from the decomposition of organic bodies existing in the water as a result of the action of the permanganate.

The nitrogen in the form of *Nitrites* is determined by the Griess method in which the reagents, naphthylamine hydrochloride, sulphanilic acid and hydrochloric acid are added to 50 cubic centimeters of the water in long tubes. The presence of nitrites is indicated in this test by a pink color, and the amount is determined by comparison with standard tubes containing known amounts of nitrites.

The nitrogen of *Nitrates* is determined by the method of Grandval and Lajoux, in which a small amount of the sample, usually 10 cubic centimeters, is evaporated with a little sodium carbonate in a porcelain dish. This residue is treated with phenolsulphonic acid and after dilution is rendered alkaline with ammonia. A yellow color is thus produced which gives the means of determining the amount of the nitrates by comparing with standards.

The significance of nitrogen in its various forms may be best understood by considering the source of these compounds and the changes which take place in them as the result of the natural forces to which they are exposed in water. Organic compounds containing nitrogen are always found in surface waters and come chiefly from the various plants growing in the water, or on the land from which the water has been collected. They may, however, be due to sewage or to surface drainage from the vicinity of houses and barns, or from fertilized fields. The total amount of nitrogen in organic combinations in water may be most readily determined by the Kjeldahl process, and is designated in water analysis as *organic nitrogen*. This determination is not usually made except in the case of waters containing much organic matter, as sewage, or sewage polluted

river water, etc. Usually the organic matter is estimated by a determination of the albuminoid ammonia. Organic bodies do not yield all their nitrogen as ammonia when boiled with alkaline permanganate, and different compounds yield different proportions. Such bodies as are found in surface waters yield about one-half their organic nitrogen in this form, while sewage yields a considerably smaller proportion, hence the determination of albuminoid ammonia lacks the definiteness of that of organic nitrogen, but it has been very widely employed, and hence there are very abundant data in different classes of water. When comparisons of the results obtained from any given sample are made with those obtained from other waters of the same class, deductions of much value can be made, and this is especially true with regard to ground waters such as come from wells and springs. When nitrogenous organic matter undergoes decomposition, as many forms readily do under the action of putrefactive bacteria, ammonia is a constant product. The ammonia dissolves in water in the form of various salts, chiefly carbonate, and is estimated as free ammonia in the analysis. When the decomposition takes place in the presence of free oxygen, as in the open air or in water containing dissolved air, the conditions are favorable for the growth and activity of the nitrifying bacteria. These organisms convert the nitrogen into nitrous acid and then into nitric acid, and these acids readily unite with such alkalies as may be present to form salts. So that the result of bacterial action is to convert the nitrogen at first existing in organic combinations into nitrates of whatever alkali may be present. The form is usually calcium nitrate in this region. This nitrification takes place more readily in porous soils than in heavy soils or in large bodies of water. It is for this reason chiefly that nitrogen of albuminoid ammonia is commonly greater than the nitrogen of nitrates in surface waters, and less in good ground waters. In these bacterial changes the ammonia and nitrites are transitory products between the first stage, organic matter, and the final stage, nitrates.

From these statements it is seen that the albuminoid ammonia indicates the amount of organic nitrogenous matter present; that free ammonia and nitrites indicate the presence of the decomposition products of organic nitrogenous matter, and

usually may be considered to indicate recent contamination with such matter; and finally that the amount of nitrates show that a corresponding amount of nitrogenous organic matter has been present, but has been destroyed by the natural processes of oxidation. The albuminoid ammonia, the free ammonia, and the nitrites then indicate in general the amount of present or recent contamination, and the nitrates indicate the amount of past contamination. The nitrates, however, are not as good an index to the amount of past contamination as the excess of chlorine, since nitrogen in this form is a plant food and may be rapidly removed from water by growing plants.

The Oxygen Consumed.

200 cubic centimeters of water are acidulated with dilute sulphuric acid and heated for thirty minutes just under the boiling point with an excess of a standard solution of potassium permanganate. In this process the permanganate is decomposed by organic matter or other easily oxidized substances present in the water which absorb the oxygen from the permanganate. The amount decomposed is determined, after the heating, by a standard solution of oxalic acid and the result recorded as the amount of oxygen absorbed from the permanganate. This factor is, therefore, a measure of the easily oxidized substances in the water, chiefly organic matter. It may be large in surface waters, especially in highly colored swamp waters, and is low in ground waters of good quality.

Hardness.

Hardness is determined by adding to 100 cubic centimeters of the water in a bottle, a sufficient amount of a standard soap solution to produce a froth which persists for about a minute after shaking. In this test the soluble soap is converted into soluble calcium or magnesium soaps by the salts of these elements present in the water, and it is only after these salts have been acted upon and the soluble soap added in slight excess that a froth is produced. This test then indicates the amount of calcium and magnesium compounds present and is usually expressed in terms of calcium carbonate. The hardness is usually greater in ground waters than in surface waters from the same part of the State, because the water which percolates through the ground dissolves a greater amount of mineral matter, including salts of calcium and magnesium, than that which runs over the surface. The amount varies in different parts of the State, however, because the soil of some regions contains more calcium and magnesium than others. Waters coming from granites and shales are commonly soft, and those from limestones are hard, as are also deep waters from the red sandstone. The hardness may also be notably increased as the result of contamination with sewage or house drainage.

THE RESULTS OF THE ANALYSES.

These appear in detail in Tables XXIX to XXXII.

The samples submitted for examination were mostly waters from Connecticut springs, but included one well water from this State, two waters from springs located out of the State, three distilled waters and one filtered water. For the purpose of this report the miscellaneous samples are included in one table, and the Connecticut spring waters, including the single well water, are divided into three groups, according to the amount of chlorine which they contain as compared to the amount believed to be the average normal for the regions from which they come. The *first group* includes fifteen samples, or about half of those examined, and contains those in which the variation of the chlorine from the average normal does not exceed one part per million. The *second group* consists of four samples in which the excess of chlorine was from one to five parts per milliom; and the *third group* contains six samples having more than five parts of chlorine per million in excess of the normal.

In *the first group* the chlorine is above the average normal in seven samples, average + 0.30, and is below in seven samples, average — 0.24. The variations are within what may be considered the normal ranges and hence the samples in this group are to be regarded as practically free from sewage contamination. The nitrogen of nitrates, however, indicate some past contamination in some of the samples, especially Nos. 2662, 2636, 2641 and 2674. The average of the nitrogen of nitrates in these four samples is 0.67 as compared with an average of 0.15 for the other eleven. The relatively high nitrates associated with normal chlorine suggests that the water supplying these springs has come in part from fertilized fields. This suggestion was strengthened in the case of 2662 by an inspection of the spring, which was found to be situated at the base of a long ridge of which a considerable portion was highly cultivated. The amount of past contamination in these four samples is small, but they cannot be regarded as strictly normal. The figures indicating freedom from recent or present contamination in the samples of this group are noteworthy. Only one showed a trace of nitrites and the figures for free and

TABLE XXIX—CONNECTICUT SPRING WATERS.

NAMES AND LOCATIONS OF SPRINGS.	
Arethusa Spring	Seymour, Conn.
Cherry Hill Spring	Cherry Hill, Hamden, Conn.
Crystal Spring	Westville, Conn.
Highland Rock Spring	Manchester, Conn.
Highland Spring	Meriden, Conn.
Indian Rock Spring	New Milford, Conn
Live Oak Spring	Meriden, Conn.
Massacoe Spring	Canton, Conn.
Mica Spring	Torrington, Conn.
Mohegan Spring	Fairfield, Conn.
Newfield Spring	Torrington, Conn.
Pequabuck Spring	Bristol, Conn.
Quakanche Spring	Wethersfield, Conn.
Rock Ledge Spring	Montowese, Conn.
Shantok Spring	Norwich, Conn.

REMARKS.—The samples were all clear and were free from odor, except No. 2686, which was distinctly musty. The sediment was described as none, or very scanty, in all the samples except No. 2686, in which it was considerable, light flocculent.

TABLE XXX—CONNECTICUT SPRING WATERS.

NAMES AND LOCATIONS OF SPRINGS.	
Etna Spring	
Hollywood Spring	Southington, Conn.
Puritan Spring	Thamesville, south of Norwich, Conn.
Rockland Spring	Ansonia, Conn.

REMARKS.—The samples were all clear and free from color. The sediment was described as none or very scanty.

RESULTS OF ANALYSES.

Figures indicate Milligrams per Liter or Parts per Million.

GROUP I.—Excess of Chlorine not exceeding 1 part per Million.

No.	Color.	Residue on Evaporation. Total at 100° C.	Non-Volatile, Mineral.	Volatile.	Chlorine.	Nitrogen of Free Ammonia.	Albuminoid Ammonia.	Nitrites.	Nitrates.	Hardness as $CaCO_3$.	Oxygen Consumed.	Excess of Chlorine.
2719	.00	34.0	28.5	5.5	2.10	0.002	0.004	0.000	0.03	5.	.40	—.30
2662	.00	71.0	57.5	13.5	2.46	.004	.014	.000	1.20	26.	.20	—.04
2663	.02	89.5	83.0	6.5	2.68	.004	.012	.000	.18	37.	.15	—.02
2638	.02	35.0	33.0	2.0	1.82	.002	.012	.000	.15	30.	.25	+.02
2635	.03	94.0	86.0	8.0	3.00	.000	.016	.000	.30	51.	.65	+.80
2664	.00	59.0	51.0	8.0	1.86	.004	.016	.000	.11	27.	1.15	+.06
2636	.00	111.5	105.5	6.0	2.60	.002	.010	.000	.55	53.	.00	+.40
2639	.00	42.5	40.5	2.0	1.66	.000	.002	.000	.12	11.	.10	+.06
2679	.00	33.0	26.0	7.0	1.00	.000	.002	.000	.30	7.	.75	—.50
2642	.00	52.5	47.0	5.5	2.98	.006	.012	.001	.14	55.	.50	—.02
2680	.00	49.0	42.0	7.0	.92	.000	.000	.000	.10	17.	.65	—.60
2682	.00	35.5	28.0	7.5	1.40	.002	.002	.000	.14	7.	.70	—.20
2641	.00	106.5	100.5	6.0	2.30	.000	.004	.000	.50	73.	.15	+.40
2674	.02	111.5	100.5	11.0	3.10	.000	.006	.000	.45	39.	.50	+.35
2686	.00	54.5	40.5	14.0	3.00	.002	.018	.000	.12	23.	.35	.00
Average		65.3	58.0	7.3	2.19	.002	.009	.000	.29	30.8	.43	

GROUP II.—Excess of Chlorine between 1. and 5. parts per Million.

No.	Color.	Residue on Evaporation. Total at 100° C.	Non-Volatile, Mineral.	Volatile.	Chlorine.	Nitrogen of Free Ammonia.	Albuminoid Ammonia.	Nitrites.	Nitrates.	Hardness as $CaCO_3$.	Oxygen Consumed.	Excess of Chlorine.
2640	.04	115.0	108.5	6.5	2.86	0.002	0.010	0.000	2.00	78.	.10	+1.06
2634	.04	142.0	134.5	7.5	5.00	.002	.016	.000	2.22	72.	.20	+3.00
2645	.05	78.0	66.5	11.5	6.30	.000	.044	.002	2.50	40.	.45	+3.60
2648	.00	94.0	71.0	23.0	5.98	.004	.008	.010	2.00	43.	.00	+3.38

TABLE XXXI—CONNECTICUT SPRING WATERS.

NAMES AND LOCATIONS OF SPRINGS.	
Althea Spring	Two miles south Waterbury, Conn.
Crystal Spring	Meriden, Conn.
Park Spring	Willimantic Conn.
Spring Clear Lithia Water	East Haven, Conn.
Stillman Homestead Spring	East Bridgeport, Conn.
Bohan's Artesian Well	New Haven, Conn.

REMARKS.—The samples were all clear and free from odor, except No. 2637, which was slightly disagreeable. They were all free from sediment.

TABLE XXXII—MISCELLANEOUS SAMPLES.

NAMES AND LOCATIONS OF SPRINGS.	
Mt. Orient Spring	Amherst, Mass.
Poland Spring	Poland, Me.
Berkshire Distilled Water	City Water, Bridgeport, Conn.
Distilled and Aerated Water	Hygeia Ice Co., New Haven, Conn.
Hygeia Distilled Water	New York, N. Y.
Filtered Water	Boston Branch Grocery, Hartford, Conn.

REMARKS.—The samples were all clear and were odorless except No. 2651, in which the odor was slightly vegetable. The sediment was described as none, or scanty, in all the samples.

GROUP III.—Excess of Chlorine over 5. parts per Million.

No.	Color.	Residue on Evaporation. Total at 100° C.	Non-Volatile, Mineral.	Volatile.	Chlorine.	Nitrogen of Free Ammonia.	Albuminoid Ammonia.	Nitrites.	Nitrates.	Hardness as $CaCO_3$.	Oxygen Consumed.	Excess of Chlorine.
2649	.06	92.5	70.0	22.5	11.10	0.010	0.024	0.000	6.66	27.	.05	+ 9.10
2637	.03	117.0	110.0	7.0	8.60	.034	.054	.000	2.50	56.	.15	+ 6.40
2659	.00	80.5	72.5	8.0	17.90	.004	.018	.000	1.66	42.	.30	+16.10
2675	.00	136.0	121.0	15.0	12.40	.000	.008	.000	2.80	57.	.50	+ 8.90
2643	.00	106.5	99.0	7.5	8.70	.002	.016	.010	4.65	57.	.20	+ 5.20
2684	.02	397.5	353.5	44.0	51.90	.046	.024	.340	18.00	218.	.40	+48.90

RESULTS OF ANALYSES.

Figures indicate Milligrams per Liter or Parts per Million.

No.	Color.	Residue on Evaporation. Total at 100° C.	Non-Volatile, Mineral.	Volatile.	Chlorine.	Nitrogen of Free Ammonia.	Albuminoid Ammonia.	Nitrites.	Nitrates.	Hardness as $CaCO_3$.	Oxygen Consumed.
2683	.00	1614.0	1593.0	21.0	980.	0.000	0.016	0.000	0.10	28.	4.20
2647	.00	83.0	53.5	29.5	5.36	.000	.010	.000	1.40	41.	.15
2650	.07	58.5	43.5	15.0	.05	.020	.090	.160	.16	11.	.85
2661	.00	16.5	9.5	7.0	.21	.058	.046	.020	.09	7.	.60
2644	.02	9.5	6.0	3.5	.00	.246	.006	.002	.05	2.	.05
2651	.04	56.0	32.5	23.5	1.34	.000	.046	.001	.18	33.	1.55

albuminoid ammonia present the very low averages of 0.002 and 0.009 respectively.

In the samples of *the second group* there is a distinct excess of chlorine, which with the accompanying excess of nitrogen of nitrates indicate a distinct past contamination. No recent contamination is indicated except in No. 2645, in which the albuminoid ammonia is somewhat high.

In *the third group* the high figures for chlorine and nitrates indicates considerable past contamination with house drainage or similar material. This is conspicuously so in the case of the well water, No. 2684. This sample was similar in composition to the effluent from sewage filter beds, though the total dissolved matter, the chlorine and the nitrogen of nitrates, 397.5, 51.9 and 18. parts per million, respectively, are greater than are usually found in purified sewage. This well water is shown by the analysis to be sewage, fairly well purified at the time the sample was taken, but likely at any time to be as dangerous as unpurified sewage. No. 2683 was not a natural spring water and appeared to be an artificial product prepared by carbonating and salting a spring water. The analysis indicates that the water was free from drainage contamination, and that it had been salted to the extent of about ten grains per U. S. gallon. No. 2647 showed distinct evidence of a small past contamination in the figures for nitrates. Nos. 2650, 2661 and 2644 were distilled waters, the analyses of which are not to be interpreted in the same way as those of natural waters. The variations shown by these three samples in the amounts of the non-volatile constituents, especially the solids, chlorine and hardness, as also in the albuminoid ammonia and oxygen consumed, indicate a difference in the skill with which these waters were prepared, as well as a difference in the nature of the water used for distillation, and show that there is great variation in commercial distilled water. No. 2651 was stated to have been filtered through a porcelain filter, and the analysis indicates that it was prepared from the Hartford public supply and shows very well the good result of this form of purification.

Conclusions.

The series of analyses included twenty-five samples of Connecticut ground waters, twenty-four springs and one well. Of

the twenty-five samples eleven were normal waters, and fourteen showed some evidence of past contamination. All the contaminated samples, but two, appeared to have been very satisfactorily purified from the chemical standpoint in the natural process of filtration and oxidation to which the water had been subjected. It would not be safe to conclude, however, that samples taken under other conditions of rainfall and amount of polluting material would in all cases give as good results, for experience shows that an amount of filtration which is adequate at one time may fail at another under more unfavorable conditions. A water showing past contamination is to be regarded with suspicion, though it need not necessarily be condemned for use. Indeed many such waters derived from wells in country districts are properly enough in daily use. Whether a given water showing a moderate contamination is likely to be injurious to those using it, can only be decided from a consideration of the analysis in connection with the surroundings of the source from which it came. If this be such that the water is exposed to the least direct drainage from privy or cesspool, it is liable to become the means of infection with certain water-borne diseases. Whether it actually causes illness depends chiefly on whether the cesspool, privy or other source of contamination becomes infected with the specific causes of certain diseases, which may happen in several ways, some of which are frequently unsuspected, as for example, the chance visit of an unsuspected walking case of typhoid fever.

No claim is made that the spring waters examined and shown to be more or less contaminated, are subject to specific infection and are liable to cause typhoid fever, dysentery, or other specific disease, for the examinations which were made do not furnish sufficient data to justify an opinion as to the sources of the contamination. It is quite likely that many of the waters have been affected by drainage from very distant houses, barnyards, or cultivated fields, where manure or some other form of fertilizer had been used.

In the opinion of the writer the exact nature of the contamination which is shown to exist in a spring water offered for sale is immaterial, for no water should be purchased for table use if there is any suspicion of its purity. Fortunately the hills of Connecticut furnish many normal springs and there is no need or excuse for using any spring water which is not pure.

FOOD PRODUCTS EXAMINED FOR THE DAIRY COMMISSIONER IN THE TWELVE MONTHS ENDING JULY 31, 1900.

Suspected Butter.

Thirty-two samples were examined. Of these eight proved to be genuine butter free from any considerable admixture of oleomargarine.

Eighteen samples were oleomargarine.

Methods of Examination.

Refractive Index is determined with the butyro-refractometer of Zeiss.

Volatile Fatty Acid is measured by the modified method of Leffmann and Beam.

Specific Gravity of Butter Fat is determined at 100° C. by the Westphal balance.

Six of the samples were submitted by the Commissioner as "Process Butter," *i. e.,* butter which is made from damaged, rancid butter by any process which will remove its disagreeable smell and taste.

Neither in their refractive power, specific gravity or volatile fatty acid content did these butters differ from good creamery butter. The methods thus far proposed to distinguish between the two are quite unsatisfactory. The result of the examinations made are as follows:

Process Butter.

Sample.	Refractometer reading at 25° C.	Specific Gravity at 100° C.	Volatile Acids. Equivalent in cc. 1-10 N. KOH.
A	51.3	0.8659	26.0
B	50.5	0.8670	24.1
C	52.0	0.8669	27.5
D	50.7	0.8536	24.4
E	52.0	0.8666	26.2
F	51.0	0.8660	26.4

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 0.860 to 0.8624; the position of the critical line expressed in scale divisions of Zeiss' Refractometer ranged from 55.6 to 60.4 and the volatile fatty acids in five grams of the fat were equivalent to 5.1 — 0.40 cc. N/10 KOH.

Molasses.

One hundred and eighty-five samples of molasses, sent by the Dairy Commissioner, have been examined, and of these twenty-seven were adulterated with glucose syrup.

Methods 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 seventy-five samples of vinegar were examined so far as to determine acidity and total solids. Forty of these contained less than four per cent.—the legal standard—of acid calculated as acetic acid and fifty of the samples contained less than two per cent. of solids, the lowest observed being 1.21 per cent.

PEACH-FOLIAGE AND FUNGICIDES.

BY W. C. STURGIS.

Every attempt thus far made in this State to treat peach trees with Bordeaux mixture has resulted in loss, owing to the harmful action of the mixture upon the leaves. This was most strikingly illustrated a few years ago in the case of the orchard of Mr. J. H. Hale at South Glastonbury which, on my recommendation, was sprayed early in the summer with Bordeaux mixture consisting of six pounds of copper sulphate and four pounds of lime in fifty gallons of water. The result was that the leaves were badly corroded within a few days after the treatment, and most of them fell from the trees. At the Experiment Station the following year the same effect from the use of Bordeaux mixture was apparent on Peaches, Japanese Plums and Apricots, while Apples, Pears, Quinces and European Plums were uninjured. Up to that time (1898) the general impression among Experiment Station workers and others, was that peach-foliage was liable to injury in no greater degree than apple or pear-foliage.* So prevalent was this idea that an expert in spraying fruit trees, upon examining Mr. Hale's orchard after its treatment with Bordeaux mixture, expressed his surprise that such extensive injury should have been caused apparently by the "shot-hole" fungus on leaves thoroughly coated with the mixture. Moreover, although as noted above, the Delaware Station had, as early as 1892, called attention to the injurious effect on peach-foliage of Bordeaux mixture, it had been and was afterwards highly recommended not only by that Station, but by many other experimenters, as a practicable preventive of the rot (*Monilia*) and the scab (*Cladosporium* and *Helminthosporium*). Thus in the Eighth Report of the Delaware Station (1895-96) the successful use of Bordeaux mixture prepared by the formula 6-6-45† and applied six times between April 9th and June 28th,

* See, however, Del. Agr. Exp. Sta., Bull. 15, p. 10, 1892.

† In the formulas for Bordeaux mixture given in this paper, the first figure stands for pounds of copper sulphate, the second for pounds of lime and the third for gallons of water.

is reported. It is noted that a good many leaves dropped after each application and that by the end of June the difference between the sprayed and the unsprayed trees was visible; but the amount of rot was reduced, even in the case of the susceptible variety Early Rivers, from 80% to 36% and the foliage remained on the sprayed trees later in the fall than on those not sprayed. In the same report and as a result of the experience of three seasons, the 6-6-45 Bordeaux is especially recommended for peach-trees, as having only a "slight tendency to injure the foliage." In the Report for the next year it is finally recommended to use Bordeaux mixture (6-6-45 or 6-9-45) just before the blossoms open, again when the fruit has set, and for future applications, until the fruit ripens if necessary, a solution of copper acetate.

The Ohio Station, in Bull. 92 (1898), reports successful treatment for scab and leaf-curl (*Exoascus*) with Bordeaux mixture. The 4-4-50 formula is recommended for use before the leaves expand, and 2-2-50 thereafter. The following statement is made. "There is no need to fear injury from the mixtures recommended. Occasionally slight falling of the leaves may result when late applications are made, at shorter intervals than two weeks."

In Michigan, as we learn from Bull. 104 of that Station, two early treatments with 4-3-32 Bordeaux mixture, followed by a third treatment with Eau celeste (a solution consisting of copper sulphate neutralized with sodium carbonate and ammonia), and a fourth with 2-1½-32 Bordeaux, proved effective against the leaf-curl. "This last spray," we read, "caused considerable loss of the older foliage, leaving that near the extremities of the young shoots in all cases apparently unaffected." In the Eleventh Report of the same Station, p. 129, an experiment is reported in which Bordeaux mixture, containing four pounds of copper sulphate and ten pounds of lime to forty gallons of water was used on peach trees after the fruit had set. No injury to the foliage is reported in this case.

The Cornell University Experiment Station in Bull. 74 (1894) recommended 6-4-50 Bordeaux mixture for use on peach trees, though later (Bull. 180, 1900) this advice was modified. In the latter publication it is noted that normal Bordeaux mixture (6-4-50) has an injurious effect on the foliage if

applied as late as May 15th, and it is recommended for use only about the first of April, when the buds are beginning to swell, a 2-2-50 formula being used after the petals have fallen.

Finally the Year-Book of the United States Department of Agriculture for 1897 states that peach-trees are sprayed in California without any injury to the foliage, but the mixture used and the dates of application are not given.

From the above statements it is evident that, prior to 1898, there was little reason to suppose that peach-foliage was peculiarly susceptible to injury from Bordeaux mixture properly prepared. I was inclined to attribute the results attending its use in Mr. Hale's orchard, to some error in preparing the mixture, and I continued to recommend the use of a dilute formula for use in peach-orchards. Mr. Hale's experience, however, had made too deep an impression and, so far as I know, not a single peach-tree in the State has been sprayed during the past two seasons, except in a few cases where orchards have been sprayed, while dormant, with a dilute solution of copper sulphate.

The first well-authenticated instance of injury to peach-foliage resulting from the use of Bordeaux mixture is given in Bull. 164 of the Cornell University Experiment Station (1899). In this case a few trees each of peaches, apricots and plums of the native, *domestica* and Japan groups, were sprayed with a properly prepared Bordeaux mixture (formula not given, but presumably containing six pounds of copper sulphate to fifty gallons of water), with Bordeaux mixture containing an excess of copper, with Bordeaux mixture made with poor lime, and with a solution of one pound of copper sulphate in fifteen gallons of water. "The properly prepared Bordeaux produced no injury, except upon the Japan plum (Burbank)." The improperly made Bordeaux mixture produced marked "shot-hole" injury on the leaves of the peach and Japan plum, and also, to a lesser degree, on the apricot and native plum. The *domestica* plum was hardly injured at all. The copper sulphate solution caused serious injury in all cases, amounting to complete defoliation in the case of the peach. The conclusion is reached that the foliage of Japanese plums is much more susceptible to injury from properly prepared Bordeaux mixture than is that of the peach, but that nevertheless, where the fruit is liable to be seriously

attacked by plum-rot (*Monilia*), the slight injuries resulting from the mixture must be disregarded. It is evident from this that if the serious injury to plum-foliage following the use of Bordeaux mixture may be disregarded provided that the fruit can thereby be saved, this is still more true in the case of the peach. The Bulletin above referred to bears out this assumption, recommending a 4-4-50 formula for spraying peach trees and remarking that the properly prepared mixture produces no injury to the foliage.

Inasmuch as the peach-growers of Connecticut had arrived at a very different conclusion upon this matter, it was deemed advisable during the past season to experiment carefully upon the susceptibility of peach-foliage to fungicides, especially to Bordeaux mixtures of various degrees of concentration. For this purpose Mr. Geo. F. Platt of Milford and Mr. N. S. Platt of New Haven very kindly placed at the disposal of the Station a certain number of trees in their orchards at Orange and West Haven respectively. The experiment was planned to test as many fungicides as possible, all of them to be applied to several varieties of early, medium, and late peaches. Each of the fungicides used was to be applied to at least two trees. In case serious injury to the foliage resulted, the strong mixture used was to be changed for one less strong, this in turn to be superseded by a still weaker one if necessary, until at the close of the season a number of the trees would be undergoing treatment with the strongest mixture compatible with retention of the foliage, and this number would be sufficient to give trustworthy data upon the fungicidal effect of the mixture, while the earlier sprayings would have given data relative to the effect upon the foliage. It was found inexpedient for various reasons to carry out this plan in detail, but its main features were retained.

The following fungicides were used on one or both of the orchards.

Bordeaux Mixture, 5-5-50; 3-3-50; 2-4-50; 2-2-50; 1-2-50.

The copper sulphate used for these mixtures was purchased, in the granulated form, from the Nichols Chemical Co. of New York, and was presumably pure. No ill-effects attended its use on pear, apple and quince trees on the Station grounds. The stone-lime was fresh, and carefully selected; it was proved by chemical analysis to be pure, and free from magnesia. Only small quantities of the different mixtures

being needed at one time, they were made up in five-gallon lots, and fresh lots were prepared for each application. The materials were weighed out carefully on scales reading to one-tenth of a gramme, were dissolved separately in 2½ gallons of water, poured together quickly into a five-gallon pail, stirred thoroughly, and the mixture applied at once.

Soda-Bordeaux.—This mixture, in which soda is used in place of lime to precipitate the copper salt, was made according to the formula given by Halsted (Bull. Torrey Bot. Club, xxvi, p. 76. See also Rep. 18, N. J. Agr. Exp. Sta., p. 342). The proportions used were, Babbitt's lye (caustic soda), 1 lb.; copper sulphate, 3¼ lbs.; water, 30 galls. To this were added 5 oz. of lime, to precipitate any possible excess of copper sulphate. These proportions were reduced so as to make five gallons of the mixture, as in the case of the Lime-Bordeaux.

Ammonia Solution of Copper Carbonate.—This solution was made according to the method recommended in Bull. xxii, Del. Agr. Exp. Sta., p. 15. To one pint of strong ammonia were added eight pints of water. Four or five ounces of copper carbonate were placed in a coarse muslin bag, suspended in the ammonia and allowed to remain there over night. The dark-blue, concentrated solution thus obtained, was siphoned off and used in the proportion of one part of the solution to twenty parts of water.

Copper Acetate.—This was used in the proportion of eight ounces to forty-five gallons of water, or twenty-five grammes to five gallons. It forms a clear solution and was used only for the later sprayings. The normal acetate as well as the sub-acetate (verdegris) was tested.

Potassium Sulphide.—This dissolves readily in water and was used in the proportion of one ounce to three gallons, or 46.5 grammes to five gallons.

Experiments at West Haven.

This orchard presented exceptionally good opportunities for testing fungicides. It occupies an elevated tract of gravelly loam, having a slope toward the northeast. The orchard is four years old, and the trees are just coming into full bearing. The orchard contains a large number of standard varieties and the trees are of such a size as to permit of thorough spraying all over. For purposes of experiment the following varieties were selected: Walkers, Mt. Rose, Champion, and Early Rivers; the fungicides used were Bordeaux mixture 5–5–50, 3–3–50, 2–4–50, and 1–2–50; Soda-Bordeaux; Ammonia solution of Copper Carbonate, Potassium Sulphide and Copper Acetate. Each mixture, with the exception of the copper acetate, was at first applied to two trees of each variety. The mixture used for later applications was determined by the condition of the

foliage. The experiments having been planned primarily to test the susceptibility of the foliage, the first applications were not made until May 23rd, at which time the blossoms had fallen and the trees were in full leaf.

In an experiment involving so many factors as this, it is somewhat difficult to present the results clearly. The simplest method seems to be to give the following extracts from my field notes made on the spot, and then to summarize the results obtained and the conclusions deducible therefrom:

May 23. First Spraying.

Sprayed two trees of each of the four varieties mentioned above with each of the fungicides named, excepting the copper acetate.

Condition of foliage—Bordeaux, 5-5-50.

June 12. Second Spraying.

Walkers.—Leaves show a good deal of shot-hole injury caused by the fungicide. Falling somewhat, but injury not serious. Remaining foliage dark green and generally healthy. Repeated the same treatment.

Mt. Rose.—Leaves falling badly. All mature leaves much injured. Foliage thin, yellowish. Sprayed with Bordeaux, 3-3-50.

Champion.—Foliage rather more seriously injured than the Walkers. Not so badly as the Mt. Rose. Repeated the same treatment.

Early Rivers.—Leaves falling badly, (40-50 per cent.) yellow. Shot-hole injury not very apparent. Sprayed with Bordeaux, 3-3-50.

June 19. No Spraying.

Walkers.—Foliage no worse than on June 12. Leaves not falling badly. Fruit dropping considerably.

Mt. Rose.—Foliage thin, yellow. Fruit and leaves dropping badly. Fruit abnormally small.

Champion.—Foliage rather thin and pale, but showing little other injury. Fruit and leaves dropping considerably. Most of the fruit abnormally small.

Early Rivers.—Foliage fair in quantity, size and color. Not falling. Fruit abnormally small.

From this time until the close of the season, one of each pair of trees in this group was sprayed with potassium sulphide, while the other received no treatment. As a result, the young leaves which showed but little injury on June 19th, developed normally and by the end of the season, with one or two exceptions, no difference as regards foliage was observable between

these trees and those which had received no treatment. It was very noticeable, however, that the fruit of the sprayed trees had either entirely fallen or had become shrunken and worthless. That this was due partly to the direct action of the fungicide and not wholly to the loss of the foliage, is shown by the fact that the conditions were the same in the case of the trees which lost only a small percentage of their foliage, as in the case of those which were half defoliated and never fully recovered. It is of interest to note that the younger leaves were in most cases less seriously injured than the older ones, and that trees of the same variety, growing side by side and treated with the same mixture, showed astonishing differences in susceptibility to injury, even from strong Bordeaux mixture.

Conclusion. Bordeaux mixture of the 5-5-50 formula, applied twice before the middle of June to the varieties of peaches mentioned above, causes shot-hole and burning effects on the leaves, and defoliation to a more or less marked degree. A fairly good leafage may develop later, but the effect, both directly and indirectly, upon the development of the fruit is such as to preclude the use of this mixture.

The substitution of Bordeaux, 3–3–50, for the stronger mixture, at the time of the second spraying, does not lessen the injury appreciably.

Bordeaux, 3-3-50.

June 12. Second Spraying.

Walkers.—Injurious effects the same as with the 5-5-50 formula. Repeated the same treatment.

Mt. Rose.—Trees almost defoliated. Omitted any treatment on this date.

Champion.—Shot-hole effect on leaves not serious. Foliage dropping somewhat. Remainder green and generally healthy. Repeated the same treatment.

Early Rivers.—Injurious effects about the same as with the 5-5-50 formula. Foliage rather more yellow and dropping badly. Repeated the same treatment.

June 19. No Spraying.

Walkers.—Foliage and fruit dropping somewhat less; otherwise the same as with the 5-5-50 formula.

Mt. Rose.—Condition of one of the trees the same as those treated with the 5-5-50 formula. The other in very bad condition, retaining very few leaves (10%), and showing fruit very small and withered. (See Plate III, fig. 1, and Plate IV, fig. 2. Cf. Plate IV, fig. 1, and Plate V, fig. 2).

Champion.—In better condition than those sprayed with the 5-5-50 formula. Foliage falling somewhat. Fruit abnormally small.

Early Rivers.—Identical with those sprayed with the 5-5-50 formula.

Practically none of the fruit on these trees came to maturity.

Conclusion. The varieties of peach-trees mentioned above cannot profitably be sprayed with Bordeaux mixture, 3–3–50. Two treatments with this mixture before the middle of June causes practically as serious injury as the 5–5–50 formula, and checks the development of the fruit to the same degree.

Bordeaux, 2-4-50.

June 12. Second Spraying.

Walkers.—Foliage injured to about the same degree as by the 3-3-50 formula. Injury not serious. Repeated the same treatment.

Mt. Rose.—By an oversight these trees received no treatment on May 23. The treatment on the present date was therefore the first which they received.

Champion.—Very little injury apparent. A few leaves have fallen and show shot-hole injury and a burning of their tips. Repeated the same treatment.

Early Rivers.—Foliage fairly healthy. Very little apparent injury and only a slight dropping of the leaves. Repeated the same treatment.

June 19. No Spraying.

Walkers.—Injury about the same as with the stronger mixtures. Remaining leaves larger and greener. Fruit larger and dropping less.

Mt. Rose.—One of the trees is in very bad condition; almost defoliated; fruit very small and withered. The other shows hardly a trace of injury, though the mixture is still visible on the leaves; fruit almost normal.

Champion.—Injury about the same as with the stronger mixtures. Fruit somewhat larger.

Early Rivers.—Foliage not seriously injured; about 10 per cent. of the leaves fallen. Most of the fruit normal in size; very few fallen.

It is evident that in Bordeaux, 2–4–50, we have a mixture which has a somewhat less injurious effect upon peach-foliage than either of the stronger ones. It is, however, close to the danger line. With the stronger mixtures, not only was the foliage seriously burned in most cases, but the fruit was practically ruined by being stunted beyond recovery. With the

2–4–50 formula, while the foliage was in some instances injured to nearly the same extent, the fruit, in most cases, developed almost normally. The effect of any fungicide upon the fruit is naturally a surer criterion of its value than its effect upon the leaves, and in this case the fruit, except on one of the Mt. Rose trees due to some weakness in the tree itself, was almost normal after the second spraying. The partial loss of the foliage in all cases must have had an ill effect upon the trees, although they recovered and by the close of the season were hardly, if at all, distinguishable from the unsprayed trees. But the effect of this mixture was, in the case of the Early Rivers, quite as disastrous—in the end—as that of the stronger ones. Although at the time of the second spraying on June 12th, and even a week later, the fruit appeared perfectly normal, most of it made no further growth, but shrivelled and fell to the ground. At the close of the season the fruit on these two trees was scanty and deficient in quality. This was the more remarkable from the fact that, of all the four varieties sprayed with this mixture, the Early Rivers showed the least injury to the foliage.

All things considered, it was deemed inadvisable to continue or to extend the use of the 2–4–50 Bordeaux. As in the cases mentioned above, potassium sulphide was substituted for the Bordeaux mixture on one of the trees of each variety, while the other received no further treatment.

Conclusion. Bordeaux mixture of the 2–4–50 formula can not be unconditionally recommended for use upon peach-trees. Although somewhat less injurious to the foliage and decidedly less so to the fruit of certain varieties, than the stronger mixtures, it nevertheless causes in some cases a marked deterioration both in the quantity and the quality of the fruit. It can undoubtedly be used to good effect early in the season, and possibly under certain conditions its use can be continued throughout the season with advantage, notwithstanding its somewhat injurious effect upon the foliage.

Bordeaux, 1-2-50.

June 12. Second Spraying.

Walkers.—Foliage healthy; very few leaves fallen. Tips of the leaves somewhat burned. Shot-hole injury very slight. Repeated the same treatment.

Mt. Rose.—Foliage fairly healthy; not in as good condition as the Walkers. A good many leaves fallen. Repeated the same treatment.

Champion.—Leaves show considerable burning of the tips and shot-hole injury. Injury about the same as from the 2-4-50 mixture. Repeated the same treatment.

Early Rivers.—Very little injury apparent; a few leaves fallen. Repeated the same treatment.

June 19. No Spraying.

Walkers.—Foliage almost perfect in quantity and color. Fruit variable; partly normal, partly small and shrivelled.

Mt. Rose.—Foliage in rather poor condition, thin and yellowish; leaves dropping badly. Fruit in good condition.

Champion.—Foliage on one of the trees badly spotted and dropping considerably; on the other, small, but showing almost no injury. Fruit large and fine on both trees.

Early Rivers.—No serious injury on the leaves; about the same as from the use of the 2-4-50 mixture. Fruit fine and large.

The above record affords evidence that with the very weak mixture employed, the danger-point to both foliage and fruit has been passed. None of the varieties treated suffered any serious injury to their foliage and, more important still, all of the trees sprayed with this mixture matured a fair crop of fruit. One of each pair of trees received no further treatment after June 12th, while the other was sprayed with potassium sulphide after that date. In two cases, viz. the Walkers and the Early Rivers, the crop of fruit on the tree sprayed only with Bordeaux, 1–2–50, did not compare favorably in quantity with that on the tree sprayed later with potassium sulphide. This, however, may have been due to some individual peculiarity of the tree. Similar, quite inexplicable differences in the behavior of the trees, were constantly noted throughout the orchard.

Conclusion. Bordeaux mixture, 1–2–50, can be used with safety upon peach-foliage. It is questionable, however, whether so dilute a mixture possesses sufficient fungicidal value to warrant the expense of applying it. It has no injurious effect upon the fruit, and, if used late in the season, would possibly lessen the decay of the fruit.

Soda-Bordeaux.

The first treatment of the trees with this mixture, on May 23rd, produced such severe injury to the leaves, that it was

not repeated. The Walkers were more than half defoliated when examined on June 12th; the condition of the Mt. Rose trees was comparable with that of the trees of the same variety sprayed with Bordeaux, 3–3–50; the Champions had lost fully 50 per cent. of their leaves, and the effect of the mixture on the Early Rivers, where the injury was least pronounced, was decidedly worse than that caused by the strongest form of ordinary Bordeaux mixture.

Later the trees all recovered completely, but not one of them matured any fruit. The whole crop withered and fell to the ground.

Conclusion. A single treatment of peach trees, as late as May 23rd, with a Soda-Bordeaux mixture containing about five and one-half lbs. of Copper sulphate to fifty gallons of water, results in severe injury to the foliage and the practical destruction of the crop of fruit.

Ammonia-Solution of Copper Carbonate.

June 12. Second Spraying.

Walkers.—A considerable amount of injury to the foliage of one tree, the other practically uninjured. Repeated the treatment with the same solution diluted to half strength.

Mt. Rose.—Leaves of one tree show shot-hole injury and burning of the tips. No injury on the other. Repeated the treatment, half strength.

Champion.—Some injury on both trees. Injury not serious. Repeated the treatment, half strength.

Early Rivers.—About 10 per cent. of the leaves fallen. Injury not serious. Repeated the treatment, half strength.

June 19. No Spraying.

Walkers.—Foliage and fruit on the whole in good condition. Some of both falling, but injury not serious.

Mt. Rose.—Foliage showing some shot-hole injury. Fruit and leaves falling considerably. Remaining fruit fair.

Champion.—Foliage rather badly injured, falling considerably. Fruit abnormally small and dropping badly.

Early Rivers.—Foliage a good deal fallen (10%), but remaining leaves large, dark, and showing little injury. Fruit very small, with only an occasional normal one.

Considering the large amount of copper salt in the solution used, the above is rather a remarkable record. None of the varieties suffered severely as regards the foliage; the Early Rivers suffered least of all. But, as in the case of the Bordeaux mixture,

2–4–50, the promise of at least a fair crop of fruit was by no means fulfilled, and it was in this respect only that the solution proved disadvantageous. In the case of the Mt. Rose and the Champions, the trees which received no treatment after June 12th and those which were subsequently sprayed with potassium sulphide, both matured fruit, but in quantity decidedly below the average. The Walkers and Early Rivers matured practically no fruit whatever. These facts are the more noteworthy in that it was the two varieties whose foliage was most seriously injured which matured a partial crop, while the total failure occurred with the two varieties whose foliage was the least injured. Evidently we have, therefore, in this instance, additional proof that the stunting of the fruit is not caused entirely by the injury to the foliage, and that the fruit of peach-trees exhibits quite as marked differences in susceptibility to injury from fungicides as do the leaves, so that it is quite possible for a certain fungicide to be precluded by reason of its effect upon the fruit, although its effect upon the foliage is not seriously injurious.

Finally, it will be noticed that, in the case of the Walkers it was apparently not the first treatment which did the damage, but the second, although the latter consisted of the solution diluted to half strength. This would indicate that fruit partly grown is more susceptible to injury than fruit which has only just set. A similar fact was noted in connection with the Early Rivers fruit sprayed with Bordeaux mixture 2-4-50.

Conclusion. The Ammonia-Solution of Copper Carbonate cannot be safely used upon peach-trees. Although its injurious action upon the foliage may not be as pronounced as that of the stronger Bordeaux mixtures, its effect, even in a dilute form, upon the development of the fruit of some varieties, is such as to preclude its use.

Potassium Sulphide.

In considering the effect of this fungicide we may leave out of account those trees upon which it was used after June 12th only, as a substitute for some other fungicide which had proved injurious, and consider first the two trees of each variety on which it was used throughout the season. It became apparent very early that this was the only one of the fungicides thus far tested which caused no serious or permanent injury to the foliage.

On one of the Mt. Rose trees a good deal of shot-hole injury, burning of the tips of the leaves and dropping of the foliage, resulted from the first spraying on May 23rd. This injury, however, was merely temporary, was limited to this one tree and did not in any case have a bad effect on the quantity or the quality of the fruit. The treatment was repeated on June 12th, and July 2nd, 12th, 18th and 31st. No serious injury to the foliage resulted in any case, and all of the sprayed trees produced a normal crop of fruit. The results of this treatment in May and June appeared so favorable that a block of seven Early Rivers trees, which had not been sprayed heretofore, was selected, and sprayed with potassium sulphide four times during the month of July, with the special object of protecting the fruit from rot and scab. As in all the other cases the solution produced no appreciable injury to the foliage and did not diminish the yield of fruit. (See Plate III, fig. 3 and Plate V, fig. 2.) Whether its fungicidal value is sufficient to warrant its use, will be discussed later.

Conclusion. Potassium Sulphide dissolved in water at the rate of one pound to fifty gallons of water, may be used with safety in spraying peach-trees at any season of the year. It causes no appreciable injury to either the leaves or the fruit.

Copper Acetate.

This substance was used in the proportion of eight ounces to forty-five gallons of water. Its use was rather an afterthought, and the first application was not made until July 18th. Four trees of the Early Rivers variety were selected for the first treatment, since the fruit of this variety was known to be peculiarly susceptible to fungous attack, and the foliage had proved to be easily injured by strong fungicides. Traces of scab had begun to appear on the fruit of these trees as early as July 12th, six days before the first application was made. A solution of copper acetate had been so highly recommended in various quarters, notably by the Delaware Station, that no ill effects upon the foliage were anticipated. It was with some surprise, therefore, that, on visiting the orchard on July 31st in order to repeat the spray, it was found that the treatment given two weeks before had caused very serious injury to the foliage. The ground was fairly covered with yellow, spotted leaves, from 10 per cent. to 20 per cent. of the foliage having fallen, while the

remainder showed a good deal of shot-hole injury, evidently due to the spray. It had been noted, at the time of the first spraying, that the copper acetate did not wholly dissolve. A few crystals remained in the bottom of the pail, and gradually became blackish in color, a fact characteristic, not of normal copper acetate, but of the sub-acetate of copper, commonly called Verdegris. Several attempts were unsuccessfully made to procure the normal acetate for the second spraying, and it was finally prepared in solution by adding a solution containing 31 grammes of copper sulphate to one containing 47 grammes of lead acetate, fitering, and diluting the filtrate to five gallons. This gave a solution containing approximately the equivalent of 25 grammes of crystallized normal copper acetate in five gallons of water.

On July 31st, this solution was used on two of the trees sprayed before with verdegris, and on two adjoining trees not before sprayed. No ill effect upon the foliage followed the use of the normal copper acetate solution. The trees sprayed with both forms of the acetate yielded a full crop of fruit, the only difference being that on the trees partially defoliated by the verdegris, the fruit became much more highly colored owing to increased exposure to the sun.

Conclusion. Normal copper acetate, in the proportion of 8 oz. to 45 gallons of water, may safely be used on peach foliage, even late in the season. The subacetate, or verdegris, commonly sold as acetate of copper, when used in the above proportion, produces serious injury to the foliage and cannot at present be recommended.

Effect of the Fungicides upon the Quantity and Quality of the Fruit.

The main object of the present experiment having been to test the effect of various fungicides upon the foliage of different varieties of peach-trees, it was deemed sufficient to make an accurate record of the fruit from only one variety. For this purpose the Early Rivers were selected since this variety was known to be peculiarly susceptible to both scab and rot, and further because a larger number of the trees had been sprayed than of any other variety.

The harvesting was begun on August 8th, and continued every other day until August 17th, making five pickings in all.

At every picking the fruit from each of the sprayed trees and from five unsprayed trees, was gathered separately and sorted into perfect fruit, fruit showing scab, and fruit showing rot. The number of fruits in each class was then counted and recorded. The test was an unusually searching one, since many of the peaches, which would ordinarily have been marketed as first quality, showed some scab and were therefore placed in the second class, while many others which were placed in the third class would have been first-quality fruit had it not been for multitudes of wasps which fed upon the fruit and were thus indirectly the cause of much injury from the *Monilia,* which later attacked this injured fruit. Turning first to the effect of the fungicides on the quantity of fruit, the following table shows the average yield, per tree, of the sprayed and the unsprayed trees.

Table I.

Average Yield of Fruit.

Fungicide Used.	Average number of peaches per tree.
Bordeaux, 5-5-50*	6.
" 3-3-50†	16.
" 2-4-50†	82.
" 1-2-50†	50.
Soda-Bordeaux‡	0.
Ammoniacal Copper Carbonate§	23.5
Potassium Sulphide. (Six sprayings)	190.5
" " (Four sprayings)	258.3
Copper Acetate (Verdegris. One spraying)	613.5
" " (Verdegris, one spraying. Normal, one spraying)	206.
" " (Normal. One spraying)	275.
Unsprayed	210.6

These results afford a basis for comparison, only in a very general way. It is apparent at a glance that the trees sprayed with the first five fungicides produced a crop so far below the average in quantity as to preclude the use of those mixtures. That this diminished crop was due to the spraying, was manifest from the condition of the fruit on these trees at the time of harvesting. Plate IV shows the comparative condition on July 2nd, of the fruit on a tree of the Mt. Rose variety unsprayed, and of that on a tree of the same variety sprayed on May 23rd

* One spraying only, followed by one spraying with Bordeaux, 3-3-50.
† Two sprayings.
‡ One spraying.
§ One spraying, full strength; followed by one, half strength.

and June 12th with Bordeaux, 3–3–50. It will be noted that the fruit set on both of these trees, but the fungicide checked the development of the fruit and only an occasional one came to maturity. The same results were seen on the variety which we are discussing. It was further evident, as has been before stated, that the diminished crop was not entirely due to the partial defoliation caused by the fungicide, for it was occasionally observed that, of two adjacent trees sprayed with the same fungicide on the same date, one suffered very little injury to its foliage, while the other was half defoliated; yet the injury to the crop was practically the same in both cases. This is merely one illustration of a fact which was very noticeable throughout the experiment, viz.: the peculiar diversity of individual character exhibited by the trees. One would naturally suppose that a number of trees of one variety, planted together and growing under identical conditions, would show a practical uniformity with regard to their susceptibility to external conditions and to fruitage. Such, however, was far from being the case in the present instance. Not only did the foliage of adjoining trees exhibit the greatest diversity in its degree of resistance to the same fungicide, but the trees themselves showed a surprising lack of uniformity in fruitage. This is very plainly seen from the figures in Table I, or, better still, from those of Table II, in which the yield of every tree is given. The differences of yield therein observable, ranging from 31 in the case of one of the unsprayed trees, to 708 in the case of one tree sprayed with verdegris, are due, not to the dropping of the fruit in one case and its retention in the other, but to individual differences in the fruiting-capacity of these two trees, which were of the same age, apparently equally thrifty, and grown on the same piece of level land not two hundred feet apart. For this reason it is somewhat difficult to draw comparisons between the effect of different fungicides on fruitage and on the quality of the fruit. Still, it is very evident that, with respect to the first point, the potassium sulphide and the normal copper acetate are in a class by themselves, as the only fungicides which did not cause a serious diminution of the crop.

As to their effectiveness in preventing the inroads of fungi on the fruit, little of a favorable nature can be said.

In Table II are presented the results of a careful examination of the fruit at the time of harvesting. For reasons stated

TABLE II.—QUANTITY AND QUALITY OF THE PEACH CROPS UNDER EXPERIMENT.

		Number of Sound Peaches.	Number of Scabby Peaches.	Number of Rotten Peaches.	Total Number.	Percentage Sound.
Bordeaux mixture, 5-5-50.						
Row V.	No. 9	6	1	1	8	75
	No. 8	2	1	1	4	50
Bordeaux mixture, 3-3-50.						
Row V.	No. 7	3	1	1	5	60
	No. 6	19	1	7	27	70
Bordeaux mixture, 2-4-50.						
Row V.	No. 5	86	22	24	132	65
	No. 4	16	12	4	32	50
Bordeaux mixture, 1-2-50.						
Row V.	No. 3	68	6	18	92	74
	No. 2	5	1	2	8	62
Soda-Bordeaux.						
Row IV.	No. 9	0	0	0	0	0
	No. 8	0	0	0	0	0
Am. Copper Carb.						
Row IV.	No. 7	4	3	1	8	50
	No. 6	25	5	9	39	64
Potass. Sulphide. (Six applications)						
Row IV.	No. 5	197	37	47	281	70
	No. 4	42	30	28	100	42
Potass. Sulphide. (Four applications)						
Row II.	No. 9	56	53	44	153	37
	No. 8	66	28	37	131	50
	No. 7	54	39	37	130	41
	No. 6	96	72	56	224	43
	No. 5	222	61	68	351	63
	No. 4	113	56	70	239	47
	No. 3	362	130	88	580	62
Cop. Acetate (Verdegris).						
Row I.	No. 3	280	301	127	708	40
	No. 4	304	134	81	519	59
Cop. Acetate (Verdegris) followed by normal acetate.						
Row I.	No. 5	33	129	52	214	15
	No. 6	87	77	34	198	44
Cop. Acetate (normal).						
Row I.	No. 7	137	106	57	300	46
	No. 8	119	70	6	250	48
Unsprayed.						
Row I.	No. 10	113	79	71	263	43
	No. 11	85	121	156	262	32
Row IV.	No. 3	204	46	55	305	67
	No. 2	4	15	12	31	13
	No. 1	58	56	78	192	30

above, the actual number of fruits in each class affords an unsatisfactory ground for comparison, and special attention is therefore called to the percentages of sound fruit given in the last column. In the case of the trees sprayed with the first six fungicides named, the odd-numbered trees were sprayed throughout the season with potassium sulphide, after the use of the stronger fungicide had been discontinued owing to its injurious action upon the foliage. The even-numbered tree in each case received no further treatment and may, therefore, be considered as an unsprayed tree. In three cases out of the six, the tree sprayed with potassium sulphide shows a gain, in percentage of sound fruit, over the other; in two, the reverse is true, and in one there was no fruit on either tree. Owing to the small amount of fruit present, these results would be valueless even had they been uniform.

A fairer basis for conclusions is found in the trees which produced a normal crop, but it is evident again that no very marked advantage was derived from the treatment. The unsprayed trees gave an average of 37 per cent. of sound fruit; six applications of potassium sulphide gave 56 per cent. of sound fruit; four applications of the same gave 49 per cent.; one late application of verdegris gave about 50 per cent., one of verdegris and one of the normal copper acetate, about 29 per cent.; one of the normal acetate, 47 per cent. These figures offer little inducement to spraying, especially considering the fact that, in the case of the potassium sulphide at least, the applications were made more frequently and much more thoroughly than would be considered practicable in ordinary culture.

The results are the more discouraging, in that the past season was exceptionally unfavorable to the development of fungous diseases. The following figures, kindly furnished by the Weather Bureau in New Haven, show the total rainfall in inches for the Summer months of 1900, compared with the normal rainfall.

	Rainfall, 1900.	Normal Rainfall.
April	1.95 in.	3.50 in.
May	3.30 "	3.65 "
June	1.79 "	2.95 "
July	2.28 "	4.94 "
August	0.90 "	5.12 "

A heavy rain occurred during the night of July 3rd; on July 6th there was a light shower at night; a heavy thunder shower fell on July 12th, and again a light shower on the 15th. This was succeeded by eight days of generally clear, dry weather. Light rain fell on the 24th, and was continuous all night on the 25th, and during the morning of the 26th. This was the last rainfall during July and until August 5th. With the exception of a heavy thunder-shower during the night on the latter date, the month of August was characterized by long periods of clear, hot weather, broken only by very light, local showers on the 12th, 13th, 16th, 17th, 24th, and 29th. The first appearance of scab on the fruit of the Early Rivers was noted on July 12th. The fruit began to ripen during the first week in August; harvesting was begun on August 8th, and completed on August 17th. It will thus be seen that not only the total rainfall, but its distribution, was highly favorable to the development of a sound and perfect crop of fruit. Only once, from August 13th to 17th, did there occur even a brief period of the close, damp weather usually associated with the rapid spread of fungous diseases, and in the present case the damage had, at this time, already been done, the records of the individual pickings showing no increase in the percentage of scabby or rotten fruit during or after that period, excepting incidentally from the attacks of wasps upon the rapidly ripening fruit. That under such circumstances the constant and thorough use of potassium sulphide should have secured an increase of sound fruit amounting to no more than 12-19 per cent., and that the only form of copper acetate which proved safe to use, increased the percentage of sound fruit in an even smaller degree, it does not appear possible at present to recommend either of these fungicides very highly.* It will, of course, be objected that the copper acetate was not given a fair trial, and this is, in a measure, true. Still, inasmuch as the one application of this fungicide was made within a few

* It is to be noted that this conclusion is based upon the result of spraying during a single season only. It is probable that more favorable results will follow the use of fungicides upon the same trees during a second season. Thus, at the Ohio Experiment Station, the result of spraying during one season was to reduce the amount of scab from 70 per cent. to 39 per cent., but a second season's spraying resulted in a crop of fruit of which only 3 per cent. was scabby. (Ohio Agr. Exp. Sta., Bull. 111, pp. 136-137, 1899.)

days of the first appearance of the scab, and no rain interfered with its action, a decidedly favorable result might have been expected had it been highly efficient.

Conclusions. The effect upon the fruit, of fungicides containing copper, was, in this experiment, seen in arrested development resulting in a serious diminution of the yield. This result appeared to be due to the direct action of the fungicide upon the fruit, rather than to its indirect action upon the foliage. An exception must be made in favor of copper acetate which, when applied late in the season, did no injury to the fruit.

Potassium sulphide, used continuously throughout the season, had no ill effect upon the yield.

Both copper acetate and potassium sulphide are, to a certain degree, preventives of scab (Cladosporium) *and rot* (Monilia). *To be effective, however, even in a dry season, the applications must be frequent and thorough.*

Of the two forms of copper acetate used in this experiment, viz: the normal acetate and the sub-acetate or verdegris, the former only can be used, owing to the injurious effect of the latter upon the foliage.

Experiments at Orange.

The orchard of Mr. George F. Platt at Orange occupies a level tract of gravelly soil, somewhat shut in on three sides by woodland. The trees are eight years old, and, on account of their size, which made it difficult to reach their tops with a fine spray, they presented a less favorable opportunity for experiment than the trees at West Haven. A portion of the orchard was selected comprising three varieties, viz.: Freehold, Elberta, and Stump, and of these, two of each variety were selected for the earlier treatment, the plan being as before, to test the effect upon the foliage of certain fungicides and then to continue and extend the use of whichever one seemed the most desirable, in order that its effectiveness in preventing the scab and rot might also be tested.

The fungicides used at first were Bordeaux mixture, 5-5-50, 3-3-50, and 2-2-50, and the Ammonia-solution of Copper carbonate prepared as described on p. 223. Later Potassium sulphide was used considerably. It was known that scab (*Cladosporium carpophilum,* Thm.) had been very abundant in

the orchard the previous season, and consequently the trees selected (two of each variety at first) were sprayed early, in order to kill, as far as possible, the spores of the fungus which had wintered on the twigs.

The first application was made on April 26th, two or three days before the blossoms opened. This was followed by a second application on May 21st, after the fruit had set. Heavy showers occurred shortly after the second application had been made, and the fungicides were therefore largely washed from the leaves within six hours after they had been applied. Nevertheless, when the orchard was visited on May 26th for the purpose of making a third spraying, it became evident that a good deal of injury had already resulted. The leaves of all the sprayed trees showed some shot-hole injury and their tips were slightly burned, but the amount of injury was not at all serious and none of the foliage had fallen. Moreover no difference was apparent between the condition of the foliage sprayed with the strong mixtures and of that sprayed with the weaker ones. On all of the trees sprayed, fruit had set abundantly. Under these circumstances it was considered safe to repeat the same treatment and this was accordingly done at once. A week of dry weather followed this application. On June 12th, the orchard was visited again and now the injurious effects of the fungicides were very apparent. All of the sprayed trees had suffered severely and about equally, and even the adjoining trees, to which the wind had carried some of the spray, showed its effects. The sprayed trees had lost fully one-third of their foliage, the ground beneath them was covered with yellow leaves, and many of those still remaining on the trees were badly spotted and were falling with the slightest breeze. The only leaves which showed no evidence of injury were those at the tops of the trees where the spray did not reach them, and those which had developed since the last spraying. As in the West Haven orchard, the evidence here pointed to the fact that young leaves are less susceptible to injury than older ones.

The amount of injury on this date (June 12th) was so great that it was manifestly unwise to continue the treatment with any of the fungicides thus far used, viz.: Bordeaux mixture, 5-5-50, 3-3-50, 2-2-50, and ammoniacal copper carbonate. The

plan of the experiment was therefore changed, and it was decided to attempt the prevention of the scab and rot of the fruit by means of some fungicide which would be less injurious to the foliage. The experiment at West Haven had already demonstrated the fact that potassium sulphide, dissolved at the rate of one ounce to three gallons of water, could be safely applied to peach-foliage. This, therefore, was the only fungicide used on and after June 12th, in the orchard at Orange. It was applied to the two trees of each variety which had hitherto been sprayed with the Bordeaux 2-2-50, to two others which had not been sprayed at all, and later to a block of seven Elberta trees which had received no previous treatment. The dates of spraying were June 12th, July 3rd and 13th, and August 2nd, and 17th.

Before proceeding to a consideration of the results obtained with this fungicide, it will be interesting to note the effect upon the fruit produced by the early treatments with the stronger fungicides. It will be remembered that the effect of similar fungicides in the West Haven orchard was practically the destruction of the crop. In the Orange orchard this effect was much less pronounced. A reference to Table III, on p. 241. giving the crop-record of the Elbertas, shows in detail the effect upon the crop in the case of that variety. No such record was kept of the other varieties, but it was evident from direct observation throughout the season that the injury to the foliage caused by the stronger fungicides was correlated with a decided diminution of the crop. On June 20th, after a careful examination of the sprayed trees, it was noted that, while in no case was there a complete destruction of the crop such as was observed in some instances in the West Haven orchard, the effect of the spray was apparent both in the quantity and in the size of the fruit. In every case the fruit on the lower portion of the trees was small and scanty, while above, on branches not reached by the spray, it was normal both in size and quantity. The same remarkable variation in the susceptibility of individual trees, which was noted at West Haven, was also seen in this orchard, some trees exhibiting but slight injury to the foliage accompanied by a very serious loss of fruit, while in others the conditions were exactly reversed. In no instance did the trees sprayed with potassium sulphide

show any noteworthy degree of injury. These notes were confirmed by another examination of the trees on September 11th. On that date the trees of the Freehold variety sprayed with the stronger fungicides had almost entirely recovered so far as their leafage was concerned, though the latter was even then rather thin as compared with the unsprayed trees, but the fruit was uniformly small and scanty, especially below, with the exception of that on a single tree sprayed with the ammonia copper carbonate. None of the trees of the Stump variety produced much fruit, but those sprayed with the fungicides (excepting potassium sulphide) matured practically none at all, even though, at the close of the season, the leafage was equally abundant on these and on the unsprayed trees. If we examine the detailed record of the yield from the Elberta trees, the same facts are observable, though the record is not as complete as it should have been. Thus one of the trees sprayed with the 5-5-50 Bordeaux mixture proved to be, not an Elberta, but a Freehold, and therefore no record of the fruit from this tree was kept; one tree sprayed with Bordeaux 3-3-50 and one sprayed with potassium sulphide were much smaller than the average and produced only a very light crop which could not fairly be considered in estimating the average crop; and finally, of the seven trees sprayed with potassium sulphide exclusively, five were attacked by Yellows and were therefore destroyed before the fruit matured. Notwithstanding these drawbacks, the following table gives a fair idea of the effect of the fungicides upon the yield.

TABLE III.

AVERAGE YIELD OF FRUIT.

Fungicide used.	Total average number of peaches per tree.
Bordeaux mixture, 5-5-50*	116
" " 3-3-50*	395
" " 2-2-50†	280
Ammonia Copper Carbonate*	252
Potassium Sulphide. (Five applications)	513
" " (Four applications)	598
Unsprayed	557

* Three applications. April 26th, May 21st and 26th.
† Three applications as above, followed by four of Potassium sulphide.

It is very evident from these figures that all of the stronger fungicides caused a very decided diminution of the yield. This is most marked in the case of the strongest Bordeaux mixture. Here again, as at West Haven, the only fungicide which did not reduce the yield was potassium sulphide. The effect of the stronger mixture would probably have been still more apparent had it not been for two factors which helped to equalize the yields. In the first place, as has been said before, the force of the spray was insufficient to carry it to the tops of the trees and consequently a good proportion of the fruit in that location escaped injury; the quantity of fruit which came to maturity on the lower branches was very small. Secondly, in thinning the fruit when it was about half grown, a larger proportionate quantity was removed from the heavily-loaded unsprayed trees and from those sprayed with the potassium sulphide, than from those sprayed with the stronger fungicides. As a matter of fact, it was necessary to remove little if any of the fruit from the latter. Had none of the fruit been thinned, the differences in yield would have been far greater.

A somewhat remarkable fact in this connection is that the diminished crop on the sprayed trees was not accompanied by any marked increase in the size of the individual fruits. Thus, while the fruit from the unsprayed trees averaged eighty to the basket, that from none of the trees sprayed with the ammonia copper carbonate or Bordeaux mixture averaged less than seventy-six to the basket, and in some cases it averaged considerably more. This is a rough method of calculating the size of the fruit, but it shows fairly well that the injurious effects of the fungicides were such that the usual results following the process of thinning by ordinary methods were not attained.

It is evident then, that, of the many fungicides tested, potassium sulphide is the only one which can be used with absolute safety, but unfortunately, as a glance at the following table will show, it is doubtful if much reliance can be placed upon it as a preventive of peach-scab (*Cladosporium*). Notwithstanding frequent and thorough applications immediately previous to the ripening of the fruit, the percentage of imperfect fruit was quite as large as on the unsprayed trees, even though the weather conditions throughout the season were distinctly unfavorable to the development of fungous diseases.

As to the effect of fungicides upon the prevalence of rot (*Monilia*), the experiment at Orange gave no basis for conclusions, since, as seen from the following table, there was very little trouble from this fungus even upon the unsprayed trees.

TABLE IV.—QUALITY AND QUANTITY OF THE PEACHES UNDER EXPERIMENT.

		Number of Sound Peaches.	Number of Scabby Peaches.	Number of Rotten Peaches.	Total Number.	Percentage Sound.
Bordeaux mixture, 5-5-50.						
Row V.	No. 13	18	96	2	116	15
	No. 14*	---	---	---	---	---
Bordeaux mixture, 3-3-50.						
Row V.	No. 10	92	299	4	395	23
	No. 11†	2	19	0	21	9
Bordeaux mixture, 2-2-50, (followed by Potass. Sulphide.)						
Row V.	No. 7	98	158	0	256	38
	No. 8	90	213	1	304	29
Am. Copper Carbonate.						
Row V.	No. 4	108	182	3	293	37
	No. 5	72	139	0	211	34
Potassium Sulphide. (Five applications.)						
Row VII.	No. 14‡	---	---	---	---	---
	No. 15	146	365	2	513	28
Potassium Sulphide. (Four applications.)						
Row X.	No. 15†	8	32	0	40	20
	No. 16‡	---	---	---	---	---
	No. 17‡	---	---	---	---	---
	No. 18‡	---	---	---	---	---
	No. 19	97	490	11	598	16
Unsprayed.						
Row VI.	No. 12	132	427	7	566	23
Row VII.	No. 3	107	375	5	487	24
	No. 13	133	462	5	600	22
Row VIII.	No. 3	107	458	11	576	18

Conclusions. In the experiment at Orange similar results upon the foliage attended the use of fungicides containing copper, as at West Haven. The injury was such as to render the use of such fungicides of very doubtful expediency.

* This tree proved to be of the Freehold variety. No record of its yield was kept.

† This was a small tree and therefore produced only a light crop.

‡ This tree showed symptoms of Yellows and was therefore destroyed while the fruit was still immature.

No injury, in this respect, resulted from frequent applications of potassium sulphide.

The latter fungicide proved ineffective in preventing scab (CLADOSPORIUM), *though the results obtained were doubtless due, in a measure, to the size of the trees, which prevented the thorough spraying of the topmost branches, where the fruit was most abundant.*

Discussion of Results.

Varying Susceptibility of Foliage. It is an extremely difficult matter to find any satisfactory reason for the susceptibility of peach-foliage to injury from fungicides containing copper, and still more difficult is it to explain why the peach-trees in this vicinity show this susceptibility in a greater degree than in Delaware, Michigan, and other localities, where dilute Bordeaux mixture is used with apparent freedom and safety. The latter question may, for the present, remain in abeyance, since, so far as a single season's experience is of value, there can be no doubt that the fact is as stated.

The foliage of the peach is not an isolated example, among our common fruit trees, of peculiar susceptibility to injury from external agencies. It shares this characteristic in common with the foliage of the apricot, and notably with that of the Japanese plum. Nor is injury produced in these cases solely by the application of copper salts. Johnson* has shown that, in the case of nursery-stock treated with hydrocyanic-acid gas, the foliage of the apple and pear is uninjured while that of the plum is slightly susceptible and that of the peach decidedly so, especially in low-grade trees. Duggar† calls attention to a peculiar case where "shot-hole" injury very similar to that due to spraying with Bordeaux mixture, was caused by hot sunshine following rain. In the same Bulletin an account is given of some very instructive experiments on the production of "shot-hole" injury upon leaves of Japanese plums, by the use of a Bordeaux mixture which did not injure the leaves of other fruit-trees. It is evident, then, that fruit trees differ very decidedly in the susceptibility of their foliage to injury from the application of fungicides and from other external agencies, and

* Cf. Exp. Sta. Record, Vol. xi, No. 11, p. 1009. 1900.
† Cornell Univ. Agr. Exp. Sta., Bull. 164, p. 388. 1899.

that the peach, the Japanese plum, and, in a lesser degree, the apricot, are among the most susceptible.

The Nature of the Injury. In the case of the peach, microscopic examination of the leaves injured by Bordeaux mixture, shows that it is the chlorophyl which first suffers. Within a few days after spraying, certain portions of the leaf, generally near the tip or the margin, but not always in connection with the deposit formed by the mixture, become yellow, owing to the bleaching-out of the chlorophyl grains. Later these yellow spots become brown and dry. If sections through such spots are now examined, the tissues are seen to be fairly normal, that is, the cells are of the normal shape and size, but the chlorophyl grains have become disorganized and, together with the other contents of the cells, form an amorphous, brownish mass. These tissues are therefore functionally useless, and within a short time the cells dry out and shrink and the affected portion becomes delimited, by a circular line, from the surrounding sound tissue. If the shrinkage is sufficient, the brown spot later falls out leaving a circular hole, or, in case the injury is more extensive, larger portions may fall away giving the leaf a very ragged appearance (Pl. III, fig. 2). Sometimes the injury is not confined to definite portions of the leaf, but the whole leaf becomes yellow and eventually falls from the tree without exhibiting any "shot-hole" injury. This is evidently due to the bleaching and death of the chlorophyl, and the consequent loss of functional activity on the part of the leaf. Most of the serious injury caused in the experiments described above, was of this nature.

Possible Explanations of the Injury. The causes usually assigned for injury to foliage sprayed with Bordeaux mixture, are connected with (1) the use of poor materials, (2) defects in the manner of preparing the mixture, or (3) atmospheric conditions following its application.*

(1) The most common source of error under the first heading is the use of partially air-slaked lime. Under these conditions, not only does a certain quantity of normal copper sulphate remain in solution, but basic copper sulphate is formed which also is injurious to foliage and is further-

* For a full discussion of this matter the reader is referred to Bull. 6, U. S. Dept. Agr., Div. Veg. Path., entitled "Bordeaux mixture as a Fungicide."

more changed by the action of air and water into the normal sulphate. It is readily apparent that in such cases copper sulphate might accumulate upon the leaves in sufficient quantity to injure them, especially if they were peculiarly susceptible to injury. This explanation certainly does not apply in the experiments under discussion. The lime used was fresh stone-lime, free from impurities, and kept in a practically air-tight can from which it was removed only to be slowly and carefully slaked with water.

(2) Under the second heading are such errors as the use of an insufficient quantity of lime, whereby basic copper sulphate is formed; mixing the solutions in too concentrated a form and thus preventing the action of the lime upon the basic sulphate; and mixing them too slowly and without sufficient stirring. Particular care was taken to avoid these errors in the present instance. In no case was the weight of lime used less than that of the copper sulphate, and in some cases it was twice as great. The injury to the crop was serious in both cases, though it was far less marked where the weight of the lime was double that of the copper sulphate; in fact the results obtained at West Haven with the weaker forms of Bordeaux mixture containing a large excess of lime gave some hope that such mixtures might be used throughout the season. The remaining sources of error were avoided by diluting both the copper sulphate and the lime with half the required quantity of water, pouring them together rapidly, and mixing them thoroughly by means of the force-pump. It is apparent, therefore, that the injury can not be attributed to defective methods in preparing the mixtures.

(3) As to the atmospheric conditions following the spraying, the first application at West Haven was made on May 23rd. On June 12th, the injury to the foliage from all but the weakest form of Bordeaux mixture (1-2-50) was very apparent, and in some cases was so serious as to preclude further treatment. The rainfall during this period amounted to a very light sprinkle on June 3rd, and a light rain of six or seven hours duration on June 8th. The second application was made on June 12th and was followed by moderate rains during the night of June 13th and the morning of June 14th. A week later the foliage of the sprayed trees appeared to be in hardly worse condition than on June 12th, though the fruit was dropping badly.

In other words, the bulk of the injury resulted from an application followed only after a considerable interval (ten days) by rain, and but little increased injury resulted from an application followed within a few hours by rain.* These facts lend support to the theory that Bordeaux mixture containing basic copper sulphate, when exposed to the air and to light rains, undergoes a slow chemical change whereby the injurious normal copper sulphate is set free. The method of preparation adopted should, however, have precluded the presence of the basic sulphate, since the lime was always in excess. Moreover this theory does not explain the injury caused by the ammonia copper carbonate. In the orchard at Orange, the first application was made on April 26th. The weather was dry until May 2nd. On and after that date light showers occurred at frequent intervals until May 22nd. Nevertheless the foliage of the sprayed trees, when examined on May 21st, showed such very slight injury even from the strong mixture, that the application was repeated without hesitation. Owing to a very heavy rain on that date, the spraying was repeated on May 26th. A light sprinkle of rain occurred on June 3rd, a rain of some hours duration on the 8th, a heavy thunder-shower on the 11th, and on the 12th the injury to the foliage of the sprayed trees was found to be very severe. The theory above noted affords a possible clue to the injury resulting from the spraying of May 26th, but it offers no explanation of the lack of injury from the spraying of April 26th. However, it is a generally accepted fact that even fairly strong Bordeaux mixture may be used with impunity on peach-foliage early in the season, whereas the same mixture does serious damage if used later.

The only question, therefore, is whether the Bordeaux mixture used contained basic copper sulphate. If it did, the cause of the injury is explained; but if an excess of lime prevents its formation, then assuredly it must have been absent in the mixtures used, and the discrepancy between our results and those obtained in other States remains unexplained.

Injury possibly due to Peculiarities in the Structure of the Leaf. The question now arises as to the peculiar susceptibility

* The latter fact may possibly have been due to the washing-off of the mixture. The mixture, however, had abundant time in which to dry, and the succeeding rains were not very heavy.

of the foliage of certain kinds of fruit-trees, whether this may not be due to the character of the leaves themselves, or of their component parts. Thus a leaf of peculiarly thin texture, or one provided with a very delicate epidermis, might presumably be susceptible to injury from causes which might not be operative in the case of a thicker leaf. Or again, the degree of susceptibility of different leaves might possibly be connected with variations in the distribution or the size of the stomata.

A number of investigations were made upon the leaves of several kinds of fruit trees, in order to determine any differences which might exist between those susceptible to injury from Bordeaux mixture and those not susceptible. The trees selected were as follows:—Peach (seven varieties); Apricot; Japanese Plum (three varieties); European Plum (three varieties); Cherry; Quince; Pear (two varieties); and Apple. Of these, the first three are injured by Bordeaux mixture; the remainder, as a rule, are not. The leaves were first examined with regard to their total thickness and the thickness of their component parts. To ascertain this, five fully mature leaves were selected from each tree, and cross-sections were made, under similar conditions, of a small portion of each leaf taken from a point about midway between the tip and the base, and at a distance of 0.5 cm. from the midrib. Each part of the sections was accurately measured, and the average of the measurements was taken as a basis for comparison. This work was done during the month of July. The results of the inquiry are given in Table V. Even a cursory

TABLE V.—THICKNESS OF THE LEAVES OF FRUIT TREES.

	Susceptible.			Not Susceptible.				
	Peach.	Apricot.	Japan Plum.	European Plum.	Cherry.	Quince.	Pear.	Apple.
Upper Epidermis	*15.96	38.25	28.	24.75	20.25	14.25	16.88	13.62
Palisade Layer	69.75	99.75	67.75	89.75	57.75	129.	91.87	79.75
Spongy Parenchyma	65.56	86.25	57.	83.	53.25	120.75	87.75	81.
Lower Epidermis	15.58	19.5	15.67	17.	11.25	11.25	13.12	11.
Total thickness	166.85	243.75	168.42	214.5	142.5	275.25	209.62	185.37

* All measurements are in micromillimeters. 1 micromillimeter = $\frac{1}{25000}$ of an inch.

examination of these measurements shows that neither the total thickness of the leaves nor the thickness of their component parts can be considered as a determining cause of variations in susceptibility. Among the non-susceptible varieties, the Quince possesses the thickest leaf (275 μ), but this figure is nearly equalled by the Apricot (244 μ), the leaves of which are seriously injured by Bordeaux mixture. Of all the leaves examined, the Cherry is the thinnest, yet these may be sprayed with impunity. The Apricot-leaf possesses the thickest epidermis, both above and below, but it is nearly equalled in this respect by the non-susceptible leaf of the European Plum. Among the non-susceptible varieties is found the thickest palisade layer (Quince), and also the thinnest (Cherry); the thickest layer of spongy parenchyma occurs in the Quince (non-susceptible), and the thinnest in the Japanese Plum (susceptible), but a comparison of the thickness of this layer in the other varieties shows that these differences are without significance.

My attention was then directed to the distribution of stomata in the leaves examined. Although the stomata are confined to the lower surface of the leaves, it is just conceivable that, in spraying upwards, sufficient Bordeaux mixture might lodge upon this surface to choke the stomata, particularly if the latter were small and closely aggregated. The method employed in securing data on this subject was to draw, by means of the camera lucida, a square of a definite size; upon this square was projected the image of a portion of the lower epidermis of the leaf showing an apparently average distribution of stomata, and the number occurring within the square was noted. The size of the square being known, it was a simple matter to compute the number of stomata per square centimeter of surface. In each case the figures given in Table VI are the average result of several observations.

TABLE VI.

	Susceptible.			Not Susceptible.			
	Peach.	Apricot.	Japan Plum.	European Plum.	Quince.	Pear.	Apple.
Approximate number of stomata per sq. cm. of surface	16950	34100	71400	14350	27500	13300	38400

It will be seen that the largest number of stomata occur in the case of the Japanese Plum, which is extremely susceptible; but, on the other hand, the Peach, which is almost as susceptible, shows a smaller number than either the Quince or the Apple. Arranged according to the number of stomata per square cm., from the lowest to the highest, the list of varieties reads, Pear, European Plum, Peach, Quince, Apricot, Apple, Japanese Plum. It is evident that no relation exists between this order and the relative susceptibility of the varieties examined.

Similarly inconclusive results follow a comparison of the relative size of individual stomata. The largest stomata occur in the case of the Pear, and they are very scattered; practically the same conditions are seen in the European Plum. Next in size are the stomata of the Apricot and Peach; in the former they are abundant, in the latter few and scattered. Next comes the Apple, with stomata of medium size and not densely aggregated; the stomata of the Quince are of the same size, but are more sparsely distributed. In the case of the Japanese Plum (Burbank), they are very small and densely aggregated. The list of varieties, arranged according to the size of the stomata, from the largest to the smallest, reads, Pear and European Plum, Apricot and Peach, Apple and Quince, Japanese Plum. Here again, the order is not that of the relative susceptibility, and even if it were so it is hardly conceivable that a sufficient quantity of Bordeaux mixture could lodge on the lower surfaces of the leaves to cause any serious choking of the stomata. Moreover such a theory would not offer any explanation of the injurious effects of a clear solution, such as the ammonia copper carbonate.

It only remains to consider the anatomical structure of the various leaves examined. Practically no difference is observable between susceptible and non-susceptible leaves, as regards the structure of the epidermis or of the palisade layer. The cells of the epidermis may be very large as in the Apricot and in both species of Plum, or they may be comparatively small as in the Quince and Peach. The palisade layer is dense in all cases, though it may be formed of only one series of cells, as occasionally in the Cherry; of two or three in the European Plum, Apple and Pear; or of even more in the Japanese Plum. But when we come to the spongy parenchyma,—the aerating

tissue of the leaf,—a marked and very striking difference is observable between the susceptible and the non-susceptible varieties. In the former, viz. the Apricot, Japanese Plum, and Peach, this layer is very dense, consisting of cells arranged in a close network, with very small intercellular air-spaces. In the non-susceptible varieties, without exception, the spongy parenchyma is extremely loose and open in texture, with very large air-spaces. Whether this difference of structure is in any way related to the difference in susceptibility of the leaves, I am unable at present to say, but it is certainly a striking and, at least in the leaves examined, a uniform difference, and is moreover the only one of any importance which has been observed. As such, it has seemed to me worth recording.

Possible Benefit from Partial Defoliation. Attention has been called on a previous page to the peculiar fact that where the use of a fungicide caused the partial dropping of the fruit, the remainder did not show an increase of size, such as usually occurs when the fruit is thinned by hand. This fact, if proved by other experiments, would afford additional evidence against the use of Bordeaux mixture on peach-trees. There is a possibility, however, that this may be more than offset by certain advantages arising from the partial defoliation caused by the weaker forms of the mixture. It is frequently the case that peach-trees in a high state of cultivation and richly supplied with nitrogenous food-materials, exhibit an enormous development of foliage. This abundant leafage is in excess of that actually required by the tree to mature its fruit and ripen its new wood. Moreover the fruit produced on such a tree is deprived of the free access of air and sunshine essential to good color, and is far more subject to the attacks of fungi than fruit borne in a more exposed position. A distinct advantage, in respect to the ripening of the fruit, was observed in the West Haven orchard following the use of the 2-4-50 form of Bordeaux mixture. In this case the Early Rivers trees were, it is true, partially defoliated, but thus far there has been no indication that the trees have failed to ripen the new growth of wood, while it was very noticeable that on these trees the fruit ripened several days earlier than on trees with very dense foliage, and that it was far more highly colored and attractive. The same was true of the fruit on the trees sprayed with the sub-acetate of copper.

In view of this fact and of the statements by careful observers that, in the case of Japanese Plums for example, the very severe injury to the foliage caused by the use of Bordeaux mixture is so far outweighed by the beneficial results attained in the prevention of fungous troubles, that the former may be disregarded, it has occurred to me that peach growers in Connecticut may have been inclined to emphasize unduly the ill-effects of Bordeaux mixture on the foliage, and to overlook its good effects upon the fruit. It is unfortunate that in the experiments of the past season the use of the weaker forms of the mixture was not continued throughout the season. It is hoped, however, that another year this may be done.

Treatment recommended for Peach-trees. In the light of past experience, it may not be amiss to offer some recommendations for the spraying of peach-trees.

(1) Early in the Spring, before the buds expand, spray the trees thoroughly with strong Bordeaux mixture (5-5-50). This is preferable to a simple solution of Copper sulphate, since it will adhere to the twigs longer. This spraying will go far toward destroying the spores of the scab-fungus which have wintered upon the twigs and whose presence is indicated by the blotched appearance of the latter. Before this spraying is made, the trees should be examined carefully and all mummified fruit removed and burned.

(2) Just before the blossoms open, spray with weaker Bordeaux mixture (2-4-50), and repeat the same treatment once after the fruit has set.

(3) When the fruit begins to show the first sign of color, spray thoroughly with potassium sulphide (one pound to fifty gallons of water), and repeat this once or twice until the fruit is ripe. This solution may be used on completely ripened fruit without injuring either its quality or its appearance.

SUMMARY.

1. The use upon peach-trees of Bordeaux mixture containing more than two pounds of copper sulphate to fifty gallons of water, proved so injurious both to the foliage and to the fruit, that it cannot at present be recommended. The injury to the leaves was of the type commonly known as "shot-hole" and "tip-burn." This was, in most cases, accompanied by severe defoliation. The injury to the fruit was seen in arrested development, resulting in a serious diminution of the crop, amounting in some cases to a total loss.

2. Similar injurious effects followed the use of strong Soda-Bordeaux mixture, in which caustic soda is used in place of lime. This mixture was used only of the full strength, viz. 3¼ lbs. of copper sulphate to 30 galls. of water. Made in this proportion it proved more injurious to the fruit than the Lime-Bordeaux mixture of full strength.

3. The Ammonia Solution of Copper carbonate, of full strength, produced about the same degree of injury to the foliage and the fruit as did Bordeaux mixtures of the 3-3-50 formula.

4. The weaker forms of Bordeaux mixture proved much less injurious to the foliage, and it is possible that, if used continuously throughout the season, the resulting injury might be more than counterbalanced by the improved quality of the fruit. But data upon this point are lacking, and without further experiment we are not justified in recommending freely the use of such mixtures.

5. The diminished yield, caused by the direct action of strong fungicides upon the development of a portion of the fruit, did not appear to be offset by an increase in the size of the remainder, as in the case of fruit thinned by hand. This fact affords further evidence against the use of strong fungicides upon peach-trees, after the fruit has set.

6. The Sub-acetate of Copper, or Verdegris, usually sold as copper acetate, used in the proportion of 8 oz. to 45 gall. of water, caused serious defoliation. It was used only after the fruit had begun to ripen, so that no data were secured relative to its effect on the development of the fruit. The trees sprayed with it showed an increase of 17 per cent. of perfect fruit over the trees not sprayed. It can at present be recommended, if at all, only for use toward the close of the season when the fruit is beginning to ripen.

7. Normal Copper Acetate, used in the same proportion as the verdegris, had only a slightly injurious effect upon the foliage. One spraying just before the fruit ripened, increased the yield of perfect fruit by 10 per cent. as compared with trees not sprayed. As a fungicide it is valuable; the difficulty of procuring it, however, seems to preclude its general use.

8. Potassium Sulphide, dissolved at the rate of 1 ounce to 3 gallons of water, (1 pound to 50 gallons), had no injurious effect upon either the foliage or the fruit. In order to be effective it must be used constantly and applied thoroughly, especially during the ripening period. Under such conditions it increased the yield of perfect fruit by almost 20 per cent., as compared with trees which were not sprayed. It is probable that this fungicide would prove more efficacious during a second season than it did during the first, and it is certain that better results would have followed its use had the sprayed trees not been surrounded with sources of infection in the shape of unsprayed trees. In view of these experiments, it is safe to say that potassium sulphide as a fungicide for use on peach-trees, is deserving of commendation.

9. It is by no means certain that well-grown peach-trees suffer any serious or permanent injury from the partial defoliation caused by fungicides of medium strength, applied late in the season. A decided advantage may accrue in such cases, as seen in the earlier ripening of

the fruit, its higher color, and its free exposure to air and sunshine which renders it less liable to fungous attack.

10. From the experiments of the past season we feel justified in recommending, for the spraying of peach-trees, Bordeaux mixture, 5-5-50, before the buds expand; Bordeaux mixture, 2-4-50, just before the blossoms open, and once after the fruit has set; and Potassium sulphide, 1 pound to 50 gallons of water, two or three times during the period of ripening.

11. In comparing the results obtained during the past season with those recorded from other States, a marked discrepancy is apparent, indicating that peach-trees in this locality are peculiarly susceptible to injury from strong fungicides. This can hardly be explained on the ground of defective methods of preparing or applying the fungicides, or to peculiar atmospheric conditions inducing the formation, from the Bordeaux mixture, of substances injurious to the foliage.

12. The injury resulting from the application of Bordeaux mixture, and commonly known as "shot-hole," appears to be due to the direct effect of the chemical upon the chlorophyll, whereby the latter is disorganized and ceases to perform its normal function of assimilation.

13. The peculiar susceptibility of the leaves of the Peach, Apricot, and Japanese plum, as compared with those of the Apple, Pear, Quince, and other fruit-trees, does not appear to be connected in any way with the total thickness of the leaves, with that of their component parts, or with differences in the size and distribution of the stomata though those differences are very marked. It is noteworthy that the layer of tissue known as the spongy parenchyma is of a very different character in the susceptible and in the non-susceptible leaves examined. In the former it is very dense, with small intercellular air-spaces; in the latter its texture is loose and open. Whether this fact has any direct bearing upon the question of susceptibility, has not been determined.

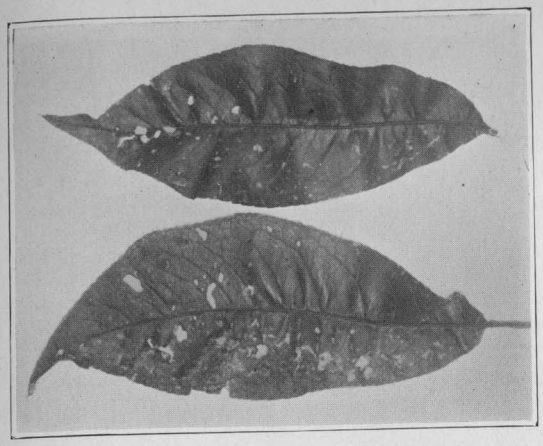

FIG. 1.—Peach-leaves showing injury from applications of weak Bordeaux mixture, (3-3-50).

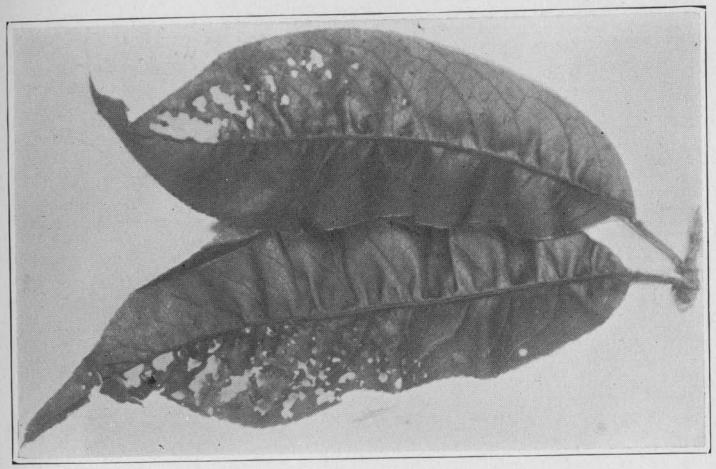

FIG. 2.—Peach-leaves showing injury from a single application of the Ammonia Solution of Copper Carbonate.

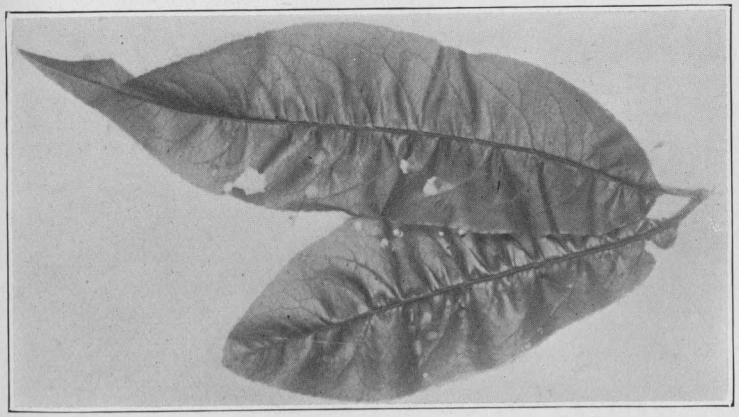

FIG. 3.—Peach-leaves showing slight injury from applications of Potassium Sulphide solution.

FIG. 1.—Fruiting branch of Peach, not sprayed.

FIG. 2.—Fruiting branch of Peach, sprayed with weak Bordeaux mixture, (3–3–50).

PLATE V.

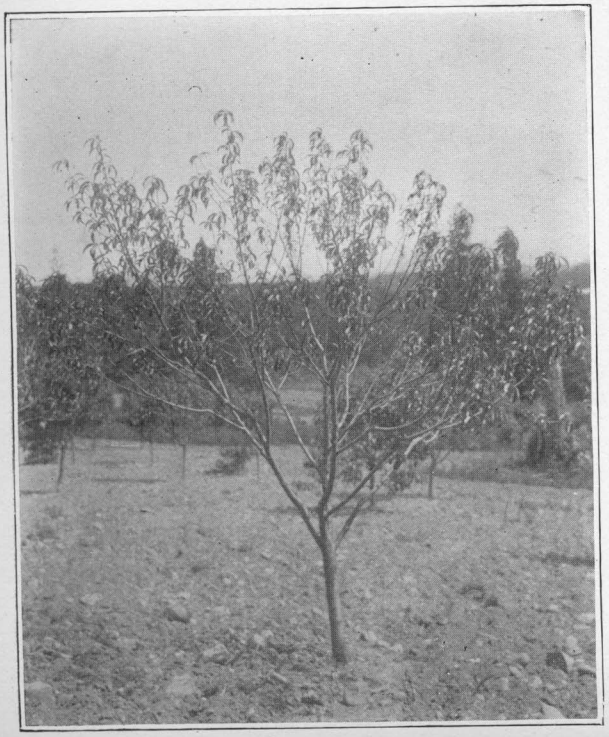

FIG. 1.—Peach-tree, showing injury from applications of weak Bordeaux mixture, (3–3–50).

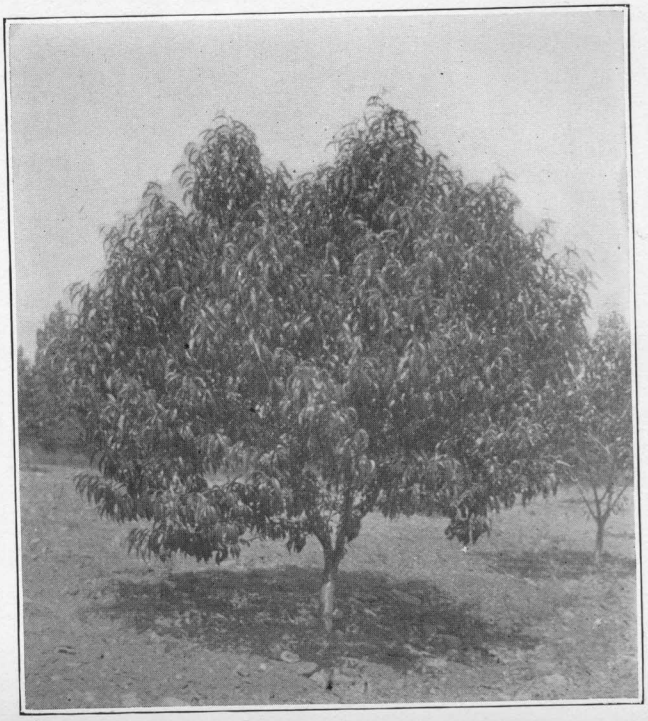

FIG. 2.—Peach-tree, sprayed with Potassium Sulphide solution.

LITERATURE OF PLANT-DISEASES.

By W. C. Sturgis.

A PROVISIONAL BIBLIOGRAPHY OF THE MORE IMPORTANT WORKS PUBLISHED BY THE U. S. DEPARTMENT OF AGRICULTURE AND THE AGRICULTURAL EXPERIMENT STATIONS OF THE UNITED STATES FROM 1887 TO 1900 INCLUSIVE, ON FUNGOUS AND BACTERIAL DISEASES OF ECONOMIC PLANTS.

The substance of the following pages was originally published in 1893 as Bulletin 118 of this Station. The edition was exhausted before the demand for it had ceased and it was therefore republished in our Seventeenth Annual Report, for the year 1893.

The rapid advance in the study of the diseases of plants, and the increasing literature of the subject rendered it necessary, four years later, to issue a revision of the original work. This was done in 1897 and the work, brought up to date, was published in our Twenty-first Annual Report. The work done in the study of plant-diseases since 1897 again makes revision desirable. The following pages have therefore been compiled from the revised work of 1897 and from my own notes made since that date.

The general scope of the work is the same as that of the original publication. It is not intended to be a complete bibliography of the subject, its object being rather to enable the practical observer of plant-diseases to ascertain what are the principal sources of information regarding the specific cause of a certain disease and the methods of prevention as recorded in the publications of our own Department of Agriculture and of the various State Experiment Stations.

It is therefore unnecessary to restate in detail the general scope and plan of the present work or the arrangement of the topics. For such information the introduction to the edition of 1897 may be consulted.

The same is true regarding the plan adopted of selecting only those references which seemed to me to deal most thoroughly with the particular disease in hand, and of arranging the various

diseases in alphabetical order according to common names of a more or less descriptive character. It will be seen that the number of references to foreign publications, appended in the form of notes for the convenience of specialists, has been somewhat increased. This, I think, is justified by the apparent usefulness of the limited number of such references appended, as a trial, to the edition of 1897.

In some instances it will be noted that diseases referred to at some length in the previous editions are omitted without comment in the present work. This is to be explained by the fact that later research has shown such supposed parasitic diseases to be due rather to purely physiological causes or to errors of observation on the part of the earlier investigators. Such instances are seen in the so-called "Brunissure" of Grapes and the "Mosaic Disease" or "Calico" of Tobacco.

In previous editions very few attempts were made to include references to diseases of forest or shade-trees, since these have formed the subject of special treatises such as Hartig's *"Lehrbuch der Baumkrankheiten,"* and furthermore because very little had been done in this country in the study of such diseases. Since 1897, however, the subject has received an increasing degree of attention, and such careful investigations as those of von Schrenck on the fungous diseases of certain coniferous trees can not be overlooked. These have therefore been included, but, as a rule, anyone desiring information on the diseases of forest and shade-trees would find it more profitable to consult Sargent's *"Silva of North America,"* where, under the various species, is usually given some information regarding the parasitic fungi affecting them.

I would again call attention to the practical utility of maintaining some system in the selection of common names of fungous diseases. The system which I have adopted is not wholly satisfactory, nevertheless it is at least consistent and is not open to the objections incident to the adoption at haphazard of local names which are neither appropriate nor descriptive. The present system can be bettered only by frank criticism. Such criticism would be greatly appreciated and I should also be grateful for having my attention called to any errors or omissions, of which there are doubtless many, in the following pages.

ALFALFA.

(*Medicago sativa*, L.)

Chitridiose (*Physoderma leproides*, (Trab.) v. Lagerh.) (1)
Leaf-Spot (*Pseudopeziza Medicaginis*, (Lib.) Sacc.)
Descr. Illus., Del. Agr. Exp. Sta., Rep. 3, 1890, pp. 79-82 (1891)
Ia. Agr. Exp. Sta., Bull. 36, pp. 858-859 (1897)
Treat. (rec.), Del. Agr. Exp. Sta., Rep. 3, 1890, pp. 82-84 (1891)
Root-Rot (*Ozonium auricomum*, Lk.)
Occ., Tex. Agr. Exp. Sta., Bull. 22. (1892)
Ariz. Agr. Exp. Sta., Rep. 9, '97-'98, pp. 161-162 (1898)
Treat. (rec.), Ariz. Agr. Exp. Sta., Rep. 9, '97-'98, p. 163. (1898)
Cf. Cotton (Root-Rot).

ALMOND.

(*Prunus* (*Amygdalus*) *communis*, L.)

Anthracnose (*Glœosporium amygdalinum*, Briz.) (2)
Crown-Gall (*Dendrophagus globosus*, Toumey)
Descr. Illus., Ariz. Agr. Exp. Sta., Bull. 33, pp. 7-61 (1900)
Treat. (rec.), Ariz. Agr. Exp. Sta., Bull. 33, pp. 61-62. (1900)
Leaf-Blight (*Cercospora circumscissa*, Sacc.)
Descr. Illus., Jour. Mycol., Vol. VII, pp. 66-76. (1892)
Treat. (pos.), Jour. Mycol., Vol. VII, pp. 232-239. (1893)

APPLE.

(*Pirus malus*, L.)

Anthracnose of Fruit, or Ripe-Rot (*Glœosporium fructigenum*, Berk.)
Descr. Illus., Jour. Mycol., Vol. VI, p. 164. (1891)
Va. Agr. Exp. Sta., Bull. 40, pp. 59-70. (1894)
Treat. (pos.), Journ, Mycol., Vol. VI, p. 172. (1891)
Ky. Agr. Exp. Sta., Bull. 44, pp. 20-22. (1893)
Cf. Grape (Ripe-Rot).
Cf. N. J. Agr. Exp. Sta., Rep. 13, 1892, pp. 326-333.
Anthracnose of Bark, or Canker (*Glœosporium malicorticis*, Cordley) (3)
Descr. Illus., Oreg. Agr. Exp. Sta., Bull. 60, pp. 3-7. (1900)
Treat. (rec.), Oreg. Agr. Exp. Sta., Bull. 60, pp. 7-8. (1900)
Black-Rot (*Sphæropsis Malorum*, Pk.)
Descr., Scribner, Fung. Dis., p. 81.
Descr. Illus., R. I. Agr. Exp. Sta., Rep. 7, 1894, pp. 192-193. (1895)
Treat. (pos.), Ky. Agr. Exp. Sta., Bull. 59. (1895)
Canker (*Sphæropsis Malorum*, Pk.)
Descr. Illus., N. Y. Agr. Exp. Sta., Bull. 163, pp. 180-190. (1899)
Treat. (rec.), N. Y. Agr. Exp. Sta., Bull. 163, pp. 190-192. (1899)
Canker (*Nectria cinnabarina*, (Tode) Fr., and *N. ditissima*, Tul.) (4)
Occ. Illus., N. Y. Agr. Exp. Sta., Bull. 163, p. 204 (1899)
Fire-Blight (*Bacillus amylovorus*, (Burrill).)
Descr., Conn. Agr. Exp. Sta., Rep. 18, 1894, pp. 113-117. (1895)
Colo. Agr. Exp. Sta., Bull. 41, pp. 3-13. (1898)

Fire-Blight (*Bacillus amylovorus*, (Burrill).)
Treat. (pos.), Conn. Agr. Exp. Sta., Rep. 18, 1894, p. 116. (1895)
Colo. Agr. Exp. Sta., Bull. 41, pp. 13-14. (1898)
Susceptible varieties. Gar. and For., Vol. IX, p. 467. (1896)
Cf. Pear (Fire-Blight).
Fly-Speck (*Leptothyrium Pomi*, (Mont. & Fr.) Sacc.)
Descr., Gar. and For., Vol. IX, pp. 474-475. (1896)
Descr. Illus., Ohio Agr. Exp. Sta., Bull. 79, pp. 133-134. (1897)
Fruit-Mold (*Sclerotinia fructigena*, (Pers.) Schrt.)
See Apple (Twig-Blight).
Cf. Peach (Fruit-Mold).
Fruit-Spot or Dry-Rot (*Fungus indet.?*) ([5])
Descr. Illus., N. Y. Agr. Exp. Sta., Bull. 164, pp. 215-219. (1899)
Vt. Agr. Exp. Sta., Rep. 12, '98-'99, pp. 159-163. (1899)
Treat. (pos.), N. H. Agr. Exp. Sta., Bull. 65, p. 106. (1899)
(rec.), Vt. Agr. Exp. Sta., Rep. 12, '98-'99, p. 163. (1899)
Leaf-Spot (*Phyllosticta pirina*, Sacc.)
Descr. Illus., R. I. Agr. Exp. Sta., Rep. 7, 1894, pp. 188-189. (1895)
Treat. (rec.), R. I. Agr. Exp. Sta., Rep. 7, 1894, pp. 190-192. (1895)
Leaf-Spot (*Phyllosticta limitata*, Pk.)
Descr., N. Y. Agr. Exp. Sta., Rep. 14, 1895, p. 545. (1896)
Treat. (neg.), N. Y. Agr. Exp. Sta., Rep. 15, 1896, p. 454. (1897)
Powdery-Mildew { (*Podosphaera oxyacanthae*, (DC.) DBy.) / (*Sphærotheca Mali*, (Duby) Burr.) ([6])
Descr., Iowa Agr. Exp. Sta., Bull. 23, pp. 921-922. (1894)
Treat. (pos.), U. S. Dep. Agr., Sec. Veg. Path., Circ. 8, p. 8. (1889)
Rust (*Gymnosporangium* spp. Syn. *Rœstelia* spp.)
Descr. Illus., U. S. Dep. Agr., Rep. for 1888, pp. 370-378. (1889)
Del. Agr. Exp. Sta., Rep. 8, pp. 63-69. (1896)
Descr., Ky. Agr. Exp. Sta., Bull. 80, pp. 230–231. (1899)
Treat. (pos.), U. S. Dep. Agr., Rep. for 1888, p. 379. (1889)
Ky. Agr. Exp. Sta., Bull. 80, pp. 231-232. (1899)
Cf. Conn. Agr. Exp. Sta., Bull. 107.
Scab (*Fusicladium dendriticum*, (Wallr.) Fckl.=*Venturia inæqualis*, (Cke.) Ad.) ([7])
Descr. Illus., U. S. Dep. Agr., Rep. for 1887, p. 341. (1888)
Ohio Agr. Exp. Sta., Bull. 9, Vol. IV, pp. 187-189. (1891)
N. Y. (Corn. Univ.) Agr. Exp. Sta., Bull. 84, pp. 10-15. (1895)
Treat. (pos.), N. Y. (Corn. Univ.) Agr. Exp. Sta., Bull. 60. (1893)
Vt. Agr. Exp. St., Rep. 11, '97-'98, pp. 195-198. (1898)
Ill. Agr. Exp. Sta., Bull. 54 (1899)
Ohio Agr. Exp. Sta., Bull. 111, pp. 95-115. (1899)
Sooty Blotch (*Phyllachora pomigena*, (Schw.) Sacc.)?
Descr., Conn. Agr. Exp. Sta., Rep. 21, '97, pp. 171-173. (1898)
Twig-Blight (*Sclerotinea fructigena*, (Pers.) Schrt.) ([8])
See Peach (Twig-Blight).

APRICOT.

Leaf-Spot (*Septoria cerasina*, Pk.) ([9])

ARBOR VITAE.

(*Thuya occidentalis*, L.)

Root-Rot (*Polyporus Schweinitzii*, Fr.)
Descr. Illus., U. S. Dept. Agr., Div. Veg. Phys. & Path., Bull. 25, pp. 18-24. (1900)

ARTICHOKE.

(*Cynara Cardunculus*, L.) ....

Leaf-Blight (*Ramularia Cynaræ*, Sacc.) ([10])

ASPARAGUS.

(*Asparagus officinalis*, L.)

Anthracnose (*Colletotrichum*, sp.)
Occ. Illus., N. J. Agr. Exp. Sta., Rep. 17, 1896, p. 410. (1897)
Anthracnose (*Fungus indet.*)
Descr. Illus., Md. Agr. Exp. Sta., Bull. 50, pp. 163-164. (1897)
Treat. (rec.), Md. Agr. Exp. Sta., Bull. 50, p. 167. (1897)
Rust (*Puccinia Asparagi*, D. C.)
Descr. Illus., N. J. Agr. Exp. Sta., Bull. 129, pp. 3-5. (1898)
S. C. Agr. Exp. Sta., Bull. 38, pp. 3-8. (1899)
Mass. Agr. Exp. Sta., Bull. 61, pp. 4-10. (1899)
Iowa Agr. Exp. Sta., Bull. 53. (1900)
Treat. (rec.), U. S. Dep. Agr., Farm. Bull. 61, pp. 32-33. (1897)
N. J. Agr. Exp. Sta., Bull. 129, pp. 6-15. (1898)
Mass. Agr. Exp. Sta., Bull. 61, pp. 14-19. (1899)
Iowa Agr. Exp. Sta., Bull. 53, pp. 64-66. (1900)
Cf. Mass. Agr. Exp. Sta., Rep. 12, pp. 61-73. (1900)

ASTER (CHINA).

(*Callistephus hortensis*, Cass.)

Wilt (*Fusarium* sp.) ([11])

BARLEY. ([12])

(*Hordeum sp.*)

Ergot (*Claviceps purpurea*, Tul.)
See Rye (Ergot).
Leaf-Blight (*Scolecotrichum graminis*, Fckl., and *Helminthosporium graminis*, Rab.)
Descr. Illus., U. S. Dep. Agr., Rep. for 1886, p. 129. (1887)
Descr., Jour. Mycol., Vol. VII, pp. 96-97. (1892)
Mold (*Hormodendron Hordei*, Bruhne). ([13])
Rust (*Puccinia graminis*, P. and *P. Rubigo-vera*, (DC.) Wint.)
See Oats and Wheat (Rust).

Smut (*Ustilago Hordei,* (P.) Kell. & Sw., and *U. nuda,* (Jens.) Kell. & Sw.)
Descr. Illus., Kan. Agr. Exp. Sta., Rep. 2, 1889, pp. 268-283. (1890)
Ill. Agr. Exp. Sta., Bull. 57, pp. 317-318. (1900)
Tr. (pos.), U. S. Dep. Agr., Farm. Bull. 75, pp. 11-14. (1898)
N. Dak. Agr. Exp. Sta., Bull. 37, p. 161. (1899)

Bean.

(*Phaseolus vulgaris,* L.; *P. lunatus,* L., &c.)

Anthracnose (*Colletotrichum Lindemuthianum,* (Sacc. & Magn.) Bri. & Cav.) [14]
Descr. Illus., U. S. Dep. Agr., Rep. for 1887, p. 361. (1888)
N. Y. Agr. Exp. Sta., Bull. 48, pp. 310-318. (1892)
Me. Agr. Exp. Sta., Rep. 1893, p. 152. (1894)
Treat. (pos.), N. Y. Agr. Exp. Sta., Bull. 48, pp. 312-317. (1892)
N. J. Agr. Exp. Sta., Bull. 108, p. 30. (1895)
Cf. N. J. Agr. Exp. Sta., Rep. 13, 1892, pp. 326-333.
Blight (*Bacillus Phaseoli,* Smith) [15]
Descr. Illus., N. Y. Agr. Exp. Sta., Bull. 48, pp. 329-331. (1892)
N. J. Agr. Exp. Sta., Rep. 13, 1892, p. 283. (1893)
Treat. (pos.), N. J. Agr. Exp. Sta., Bull. 108, pp. 24-30. (1895)
N. J. Agr. Exp. Sta., Rep. 17, 1896, pp. 328-333. (1897)
Downy Mildew (*Phylophthora Phaseoli,* Thaxter).
Descr. Illus., Conn. Agr. Exp. Sta., Rep. 13, 1889, pp. 167-170. (1890)
Treat. (pos.), Conn. Agr. Exp. Sta., Rep. 21, 1897, pp. 162-166. (1898)
Leaf-Spot (*Phyllosticta* sp.)
Descr., N. J. Agr. Exp. Sta., Rep. 12, 1891, p. 287. (1892)
Powdery Mildew (*Erysiphe Polygoni,* DC.)
Treat. (pos.), Journ. Mycol., Vol. V, p. 214. (1889)
Rust (*Uromyces appendiculatus,* (P.) Lév.)
Descr. Illus., N. Y. Agr. Exp. Sta., Bull. 48, p. 331. (1892)
Treat. (neg.), N. Y. Agr. Exp. Sta., Bull. 48, p. 333. (1892)

Beet.

(*Beta vulgaris,* L.)

Bacteriosis (*Bacillus* sp.)
Descr., Ind. Agr. Exp. Sta., Bull. 39, pp. 54-58. [16] (1892)
Chytridiose (*Physoderma leproides,* (Trab.) v. Lagerh.) [17]
Gummosis (*Bacillus* spp.) [18]
Heart-Rot (*Phoma Betæ,* Frank). [19]
Leaf-Blight (*Cercospora beticola,* Sacc.)
Descr. Illus., Iowa Agr. Exp. Sta., Bull. 15, pp. 239-242. (1891)
N. Y. (Corn. Univ.) Agr. Exp. Sta., Bull. 163, pp. 352-356. (1899)
Treat. (pos.), N. J. Agr. Exp. Sta., Bull. 107, pp. 8-11. (1895)

Leaf-Spot (*Phoma Betæ,* Frank). [20]
Root-Rot (*Rhizoctonia Betæ,* Kühn).
Descr. Illus., N. Y. (Corn. Univ.) Agr. Exp. Sta., Bull. 163, pp. 339-346. (1899)
Treat. (rec.), N. Y. (Corn. Univ.) Agr. Exp. Sta., Bull. 163, pp. 350-351. (1899)
See U. S. Dep. Agr., Exp. Sta. Rec., XI-2, p. 163. (1899)
Root-Rot and Leaf-Spot (*Phyllosticta* (*tabafica,* Prill.?)) [21]
Descr. Illus., N. J. Agr. Exp. Sta., Bull. 107, pp. 4-6. (1895)
Treat. (rec.), N. J. Agr. Exp. Sta., Bull. 107, p. 6. (1895)
Rust (*Uromyces Betæ,* (P.) Kühn).
Descr. Illus., U. S. Dep. Agr., Rep. for 1887, p. 350. (1888)
Descr., Iowa Agr. Exp. Sta., Bull. 15, p. 235. (1891)
Treat. (rec.), U. S. Dep. Agr., Rep. for 1887, p. 353. (1888)
Iowa Agr. Exp. Sta., Bull. 15, p. 236. (1891)
Scab (*Oospora scabies,* Thaxter).
Descr. Illus., Ind. Agr. Exp. Sta., Bull. 39, pp. 58-60. (1892)
N. Y. (Corn. Univ.) Agr. Exp. Sta., Bull. 163, pp. 359-361. (1899)
Treat. (rec.), Ind. Agr. Exp. Sta., Bull. 39, p. 60. (1892)
Cf. Conn. Agr. Exp. Sta., Rep. 20, 1896, p. 266.
Cf. Potato (Scab).
White-Rust (*Cystopus Bliti,* (Biv.) Lév.)
Descr. Illus., Iowa Agr. Exp. Sta., Bull. 15, pp. 237-238. (1891)
Yellows (Bacterial).
See U. S. Dep. Agr., Exp. Sta. Rec., X-7, p. 649. (1899)

Blackberry.

(*Rubus* spp.)

Anthracnose (*Glœosporium Venetum,* Speg.)
See Raspberry (Anthracnose).
Blight (Bacterial).
See Raspberry (Blight).
Crown-Gall.
See Raspberry (Crown-Gall).
Leaf-Spot (*Septoria Rubi,* Westd.)
Descr., Ohio Agr. Exp. Sta., Bull. IV-6, p. 126. (1891)
Treat. (neg.), Journ. Mycol., Vol. VII, p. 22. (1891)
Rust (*Cæoma* (*Uredo*) *luminatum,* Lk.; Syn. *Puccinia Peckiana,* Howe.)
Descr. Illus., Ill. Agr. Exp. Sta., Bull. 29, pp. 273-286. (1893)
Treat. (rec.), Mass. Agr. Exp. Sta., Rep. 8, 1890, p. 224. (1891)
White Rust (*Chrysomyxa albida,* Kühn.)
Descr. Occ., Mass. (Hatch.) Agr. Exp. Sta., Rep. 9, 1896, p. 74. (1897)

Broom-Corn.

(See Sorghum.)

BUCKWHEAT.

(*Fagopyrum esculentum,* Mœnch.)

Leaf-Blight (*Ramularia rufomaculans,* Pk.)
Descr., Conn. Agr. Exp. Sta., Rep. 14, 1890, p. 98. (1891)
Treat. (rec.), Conn. Agr. Exp. Sta., Rep. 14, 1890, p. 98. (1891)

BUTTERNUT.

(*Juglans cinerea,* L.)

Anthracnose (*Glœosporium Juglandis,* (Lib.) Mont.)
Occ., Mass. Agr. Exp. Sta., Rep. 10, p. 69. (1898)

CABBAGE, CAULIFLOWER, ETC.

(*Brassica oleracea,* L.)

Brown Rot (*Pseudomonas campestris,* (Pammel) Smith).
Descr., U. S. Dep. Agr., Farm. Bull. 68. (1898)
Descr. Illus., Wis. Agr. Exp. Sta., Bull. 65. (1898)
Treat. (rec.), U. S. Dep. Agr., Farm. Bull. 68, pp. 20-21. (1898)
(pos.), Wis. Agr. Exp. Sta., Bull. 65, pp. 36-39. (1898)
Cf. Turnip (Brown Rot).
Club-Root (*Plasmodiophora Brassicæ,* Wor.)
Descr. Illus., N. J. Agr. Exp. Sta., Bull. 98. (1893)
Vt. Agr. Exp. Sta., Bull. 66, pp. 3-10. (1898)
Treat. (pos.), N. J. Agr. Exp. Sta., Bull. 108, pp. 14-18. (1895)
N. Y. Agr. Exp. Sta., Rep. 14, '95, pp. 527-529. (1896)
Vt. Agr. Exp. Sta., Bull. 66, pp. 10-12. (1898)
Downy Mildew (*Peronospora parasitica,* (P.) Tul.)
Occ., N. J. Agr. Exp. Sta., Rep. 11, 1890, p. 349. (1891)
N. C. Agr. Exp. Sta., Bull. 84, p. 15. (1892)
Treat. (rec.), N. C. Agr. Exp. Sta., Bull. 84, p. 15. (1892)
Leaf-Blight (*Macrosporium Brassicæ,* Berk.)
Occ., N. J. Agr. Exp. Sta., Rep. 11, 1890, p. 349. (1891)
Powdery Mildew (*Oidium Balsamii,* Mont.)
See Turnip (Powdery Mildew).
White Rust (*Cystopus candidus,* (P.) Lév.)
Occ., N. C. Agr. Exp. Sta., Bull. 84, p. 15. (1892)
Treat. (rec.), N. C. Agr. Exp. Sta., Bull. 84, p. 15. (1892)

CARNATION. [22]

(*Dianthus Caryophyllus,* L.)

Anthracnose (*Colletotrichum* sp.)
Descr., N. J. Agr. Exp. Sta., Rep. 12, 1891, p. 301. (1892)
Anthracnose, (*Volutella Dianthi,* Atkins.)
Descr., N. J. Agr. Exp. Sta., Rep. 14, 1893, pp. 385-386. (1894)
Leaf-Mold or Fairy-Ring (*Heterosporium echinulatum,* (Berk.) Cke.) [23]
Descr., N. J. Agr. Exp. Sta., Rep. 14, 1893, p. 386. (1894)
Treat. (pos.), R. I. Agr. Exp. Sta., Rep. 9, pp. 203-206. (1897)

Leaf-Spot, (*Fusarium* sp.)
Descr. Illus., N. Y. Agr. Exp. Sta., Bull. 164, pp. 219-220. (1899)
Leaf-Spot (*Septoria Dianthi,* Desm.)
Descr., N. J. Agr. Exp. Sta., Rep. 14, 1893, pp. 384-385. (1894)
Treat. (pos.), N. J. Agr. Exp. Sta. Rep. 11, 1890, p. 363. (1891)
Rust (*Uromyces caryophyllinus,* (Schrank) Schrt.)
Descr. Illus., Gar. and For., Vol. V, pp. 18-19. (1892)
Treat. (pos.), N. Y. (Corn. Univ.) Agr. Exp. Sta., Bull. 96, pp. 334-335. (1895)
N. Y. Agr. Exp. Sta., Bull. 100, pp. 50-68. (1896)
Cf. N. Y. Agr. Exp. Sta., Bull. 175. (1900)
Stem-Rot (*Rhizoctonia* sp.) [24]
Wilt (*Fusarium* sp?)
Descr., Conn. Agr. Exp. Sta., Rep. 21, 1897, pp. 175-181. (1898)

CARROT.

(*Daucus Carota,* L.)

Rot (*Phoma sanguinolenta,* Grove) [25]

CATALPA.

(*Catalpa Bignonioides,* Walt.)

Leaf-Blight (*Macrosporium Catalpæ,* Ell. & Mart.)
Descr. Illus., U. S. Dep. Agr., Rep. for 1887, pp. 364-365. (1888)
Treat. (rec.), U. S. Dep. Agr., Rep. for 1887, p. 366. (1888)
Leaf-Spot (*Phyllosticta Catalpæ,* Ell. & Mart.)
Descr. Illus., U. S. Dep. Agr., Rep. for 1887, pp. 364-365. (1888)
Treat. (rec.), U. S. Dep. Agr., Rep. for 1887, p. 366. (1888)

CEDAR.

(*Libocedrus; Thuya; Juniperus.*)

"Pin-Rot" or "Pecky" Disease (*Fungus indet.*) [26]
Red Rot or "Pecky" Disease (*Polyporus carneus,* Nees).
Descr. Illus., U. S. Dep. Agr., Div. Veg. Phys. & Path., Bull. 21, pp. 16-20. (1900)
White Rot (*Polyporus Juniperinus,* v. Schr.)
Descr. Illus., U. S. Dep. Agr., Div. Veg. Phys. & Path., Bull. 21, pp. 7-16. (1900)

CELERY.

(*Apium graveolens,* L.)

Bacteriosis (*Bacterium Apii,* Brizi?)
Descr. Illus., N. J. Agr. Exp. Sta., Rep. 12, 1891, pp. 257-258. (1892)
Cf. U. S. Dep. Agr., Exp. Sta. Rec., IX-9, p. 850, '98.

Leaf-Blight (*Cercospora Apii,* Fres.)
Descr. Illus., U. S. Dep. Agr., Rep. for 1886, pp. 117-120. ([27]) (1887)
Treat. (pos.), N. J. Agr. Exp. Sta., Rep. 12, 1891, p. 251. (1892)
N. Y. (Corn. Univ.) Agr. Exp. Sta., Bull. 132, pp. 203-205. (1897)
R. I. Agr. Exp. Sta., Bull. 44, pp. 22-25. (1897)
Conn. Agr. Exp. Sta., Rep. 21, 1897, pp. 167-171. (1898)
Leaf-Spot (*Phyllosticta Apii,* Halsted.)
Descr. Illus., N. J. Agr. Exp. Sta., Rep. 12, 1891, p. 253. (1892)
Leaf-Spot (*Septoria Petroselini,* Desm., *var. Apii,* Br. & Cav.)
Descr. Illus., N. Y. Agr. Exp. Sta., Bull. 51, pp. 137-138. (1893)
N. Y. (Corn. Univ.) Agr. Exp. Sta., Bull. 132, pp. 206-215. (1897)
Treat. (rec.), N. Y. Agr. Exp. Sta., Bull. 51, pp. 139-141. (1893)
Rust (*Puccinia bullata,* (Pers.) Schrt.)
Descr. Illus., N. J. Agr. Exp. Sta., Rep. 12, 1891, p. 256. (1892)

CHERRY.

(*Prunus Cerasus,* L.)

Black Knot (*Plowrightia morbosa,* (Schw.) Sacc.) ([28])
Descr. Illus., Mass. Agr. Exp. Sta., Rep. 8, 1890, pp. 200-210. (1891)
N. J. Agr. Exp. Sta., Bull. 78, pp. 2-10. (1891)
N. Y. (Corn. Univ.) Agr. Exp. Sta., Bull. 81, pp. 638-646. (1894)
Cf. N. Y. Agr. Exp. Sta., Rep. 12, 1893, pp. 686-688. (1894)
Treat. (pos.), N. Y. (Corn. Univ.) Agr. Exp. Sta., Bull. 81, pp. 646-653. (1894)
Fruit-Mold (*Sclerotinia cinerea,* (Bon.) Schrt.)
Descr. Illus., U. S. Dep. Agr., Rep. for 1888, pp. 349-352. (1889)
Ky. Agr. Exp. Sta., Rep. 2, 1889, pp. 31-34. (1890)
Mass. Agr. Exp. Sta., Rep. 8, 1890, p. 213. (1891)
Treat. (pos.), Ky. Agr. Exp. Sta., Rep. 2, 1889, pp. 35-42. (1890)
N. Y. (Corn. Univ.) Agr. Exp. Sta., Bull. 98, p. 409. (1895)
Cf. Cherry (Twig-Blight.)
See also Peach, (Fruit-Mold.)
Leaf-Blight (*Clasterosporium Amygdalearum,* Sacc.) ([29])
Leaf-Curl (*Exoascus Cerasi,* (Fckl.) Sadeb.)
Descr., N. Y. Agr. Exp. Sta., Rep. 14, 1895, pp. 532-533. (1896)
Leaf-Spot (*Cylindrosporium Padi,* Karst., = *Septoria cerasina,* Pk.)
Descr. Illus., Scribner, Fung. Dis., p. 119. (1890)
Iowa Agr. Exp. Sta., Bull. 13, pp. 61-65. (1891)
Treat. (pos.), U. S. Dep. Agr., Rep. for 1890, pp. 396-397. (1891)
N. Y. Agr. Exp. Sta., Rep. 11, 1892, pp. 654-659. (1893)
Iowa Agr. Exp. Sta., Bull. 30, pp. 291-294. (1895)
Cf. Plum (Leaf-Spot.)

Leaf-Spot (*Mycosphaerella cerasella,* Aderh.; Syn. *Cercospora cerasella,* Sacc.) ([30])
Powdery Mildew (*Podosphaera oxyacanthae,* (DC). DBy.)
Descr. Illus., U. S. Dep. Agr., Rep. for 1888, pp. 352-356. (1889)
Treat. (pos.), Iowa Agr. Exp. Sta., Bull. 17, pp. 421-433. (1892)
Cf. Apple (Powdery Mildew).
Rust (*Puccinia Pruni,* Pers.)
Descr. Illus., U. S. Dep. Agr., Rep. for 1887, pp. 353-354. (1888)
Cf. Plum (Rust).
Scab (*Cladosporium carpophilum,* Thüm.) ([31])
See Plum and Peach (Scab).
Twig-Blight { (*Sclerotinia fructigena* (Pers.) Schrt.) ([32]) / (*Sclerotinia cinerea,* (Bon.) Schrt.) ([33])

CHESTNUT.

(*Castanea sativa,* Mill.)

Anthracnose { (*Cylindrosporium castanicolum,* (Desm.) Berl.) ([34]) / (*Cryptosporium epiphyllum,* C. & E.)
Treat. (pos.), Amer. Gardening, Vol. XX, p. 559. (1899)
Leaf-Spot (*Septoria ochroleuca,* B. & C.), (*Marsonia ochroleuca,* (B. & C.))
Descr. Illus., N. J. Agr. Exp. Sta., Rep. 17, 1896, p. 412. (1897)
Descr., Mass. Agr. Exp. Sta,, Rep. 10, 1897, p. 69. (1898)

CHRYSANTHEMUM.

(*Chrysanthemum Sinense,* Sabine & *C. indicum,* L.)

Anthracnose (*Cylindrosporium Chrysanthemi,* Ell. & Dearn.)
Descr. Illus., N. J. Agr. Exp. Sta., Rep. 15, 1894, pp. 365-368. (1895)
Treat. (rec.), N. J. Agr. Exp. Sta., Rep. 15, 1894, p. 369. (1895)
Leaf-Spot (*Phyllosticta Chrysanthemi,* Ell. & Dearn.)
Occ., N. J. Agr. Exp. Sta., Rep. 15, 1894, p. 368. (1895)
Leaf-Spot (*Septoria Chrysanthemi,* Cav.)
Descr. Illus., N. J. Agr. Exp. Sta., Rep. 15, 1894, pp. 363-365. (1895)
Treat. (pos.), N. Y. Agr. Exp. Sta., Rep. 11, 1892, pp. 557-560. (1893)
Rust (*Puccinia Chrysanthemi,* Roze) ([35])
(*Puccinia Hieracii,* (Schum.) Mart.?) ([36])
Occ., N. J. Agr. Exp. Sta., Circ., Nov. 15. (1899)
Descr., Treat. (rec.), Ind. Agr. Exp. Sta., Bull. 85. (1900)
Cf. Gardening, Vol. VI, p. 277, '98.

CLEMATIS.

(*Clematis* spp.)

Anthracnose (*Glœosporium Clematidis,* Sor.) ([37])
Root-Rot (*Phoma* sp.)? ([38])
Descr., N. Y. Agr. Exp. Sta., Rep. 3, 1884, pp. 383-384. (1885)

Clover.

(*Trifolium*, spp.)

Leaf-Spot (*Phyllachora Trifolii*, (P.) Fckl.)
Descr., N. J. Agr. Exp. Sta., Rep. 18, 1897, p. 319. (1898)
Rust (*Uromyces Trifolii*, (A. & S.) Wint.)
Descr. Illus., N. Y. (Corn. Univ.) Agr. Exp. Sta., Bull. 24. (1890)
Iowa Agr. Exp. Sta., Bull. 13, pp. 51-55. (1891)
Treat. (rec.), N. Y. (Corn. Univ.) Agr. Exp. Sta., Bull. 24, p. 139. (1890)
Stem-Rot (*Sclerotinia Trifolium*, Erick.)
Descr. Illus., Del. Agr. Exp. Sta., Rep. 3, 1890, pp. 84-88. (1891)
N. J. Agr. Exp. Sta., Rep. 18, 1897, pp. 314-318. (1898)
Treat. (rec.), Del. Agr. Exp. Sta., Rep. 6, 1893, p. 110. (1894)

Corn.

(*Zea Mays*, L.)

Blight (Bacterial).
Descr. Illus., Ill. Agr. Exp. Sta., Bull. 6, pp. 163-174. (1889)
Treat. (neg.), Ill. Agr. Exp. Sta., Bull. 6, p. 174. (1889)
Downy Mildew (*Peronospora Maydis*, Racib.) ([39])
Leaf-Blight (*Helminthosporium inconspicuum*, C. & E.)
Descr. Illus., N. Y. Agr. Exp. Sta., Rep. 15, 1896, p. 452. (1897)
Rust (*Puccinia Sorghi*, Schw.)
Descr. Illus., U. S. Dep. Agr., Rep. for 1887, p. 390. (1888)
Treat. (neg.), U. S. Dep. Agr., Rep. for 1887, p. 391. (1888)
Cf. U. S. Dep. Agr., Div. Veg. Phys. & Path., Bull. 16, p. 65. (1899)
Smut (*Ustilago Zeae*, (Beckm.) Unger) and (*U. Reiliana*, Kühn.)
Descr. Illus., Kans. Agr. Exp. Sta., Bull. 62, pp. 179-189 & 198-201. (1896)
Ind. Agr. Exp. Sta., Rep. 12, pp. 99-112. (1900)
Treat. (rec.), Neb. Agr. Exp. Sta., Bull. 11, pp. 31-34. (1889)
Ind. Agr. Exp. Sta., Rep. 12, pp. 118-119. (1900)
Ill. Agr. Exp. Sta., Bull. 57, p. 335. (1900)
Wilt (*Pseudomonas Stewarti*, Smith). ([40])
Descr. Illus., N. Y. Agr. Exp. Sta., Bull. 130, pp. 423-438. (1897)
Treat. (rec.), N. Y. Agr. Exp. Sta., Bull. 130, pp. 438-439. (1897)

Cosmos.

(*Cosmos bipinnatus*, Cav.)

Stem-Spot (*Phylctæna*, sp.)
Descr. Illus., N. J. Agr. Exp. Sta., Rep. 15, 1894, pp. 371-372. (1895)
Treat. (neg.), N. J. Agr. Exp. Sta., Rep. 17, 1896, p. 400. (1897)

Cotton.

(*Gossypium*, spp.)

Anthracnose (*Colletotrichum Gossypii*, Southworth.)
Descr. Illus., Ala. Agr. Exp. Sta., Bull, 41, pp. 40-49. (1892)
U. S. Dep. Agr., Office Exp. Sta's., Bull. 33, pp. 293-299. (1896)
Boll-Rot (*Bacillus Gossypina*, Stedm.?)
Descr. Illus., Ala. Agr. Exp. Sta., Bull. 55. (1894)
Cf. Ala. Agr. Exp. Sta., Bull. 107, pp. 311-312. (1900)
Treat. (rec.), Ala. Agr. Exp. Sta., Bull. 107, p. 313. (1900)
Damping-off (*Rhizoctonia* sp.)
Descr., Ala. Agr. Exp. Sta., Bull. 41, pp. 30-39. (1892)
Cf. Ala. Agr. Exp. Sta., Bull. 107, pp. 295-296. (1900)
Leaf-Blight (*Mycosphærella gossypina*, (Atk.) Eng. & Pr., = *Cercospora gossypina*, Cke.)
Descr. Illus., U. S. Dep. Agr., Rep. for 1887, pp. 355-356. (1888)
Ala. Agr. Exp. Sta., Bull. 41, pp. 58-61. (1892)
Cf. Ala. Agr. Exp. Sta., Bull. 107, p. 308. (1900)
Leaf-Mold (*Ramularia areola*, Atkinson.)
Descr. Illus., Ala. Agr. Exp. Sta., Bull. 41, pp. 55-58. (1892)
Root-Rot (*Ozonium auricomum*, Lk.)
Descr. Illus., Tex. Agr. Exp. Sta., Rep. 2, 1889, pp. 67-76. (1890)
U. S. Dep. Agr., Office Exp. Sta's., Bull. 33, p. 300. (1896)
Treat. (rec.), U. S. Dep. Agr., Office Exp. Sta's., Bull. 33, p. 304. (1896)
Rust (*Uredo Gossypii*, Lagerh.)
Descr., Journ. Mycol., Vol. VII, pp. 47-48. (1891)
Smut (*Doassansia Gossypii*, Lagerh.)
Descr., Journ. Mycol., Vol. VII, pp. 48-49. (1891)
Wilt (*Neocosmospora vasinfecta*, (Atk.) Smith.)
Descr. Illus., Ala. Agr. Exp. Sta., Bull. 41, pp. 19-29. (1892)
U. S. Dep. Agr., Div. Veg. Phys. & Path., Bull. 17. (1899)
Treat. (pos.), U. S. Dept. Agr., Div. Veg. Phys. & Path., Bull. 27. (1900)

Cranberry.

(*Vaccinium Oxycoccus*, L.)

Gall. (*Synchytrium Vaccinii*, Thomas.)
Descr. Illus., N. J. Agr. Exp. Sta., Bull. 64, pp. 4-9. (1889)
Treat. (rec.), N. J. Agr. Exp. Sta., Bull. 64, p. 16. (1889)
N. J. Agr. Exp. Sta., Rep. 11, 1890, p. 333. (1891)
"Scald" (*Fungus indet.*)
Descr. Illus., N. J. Agr. Exp. Sta., Bull. 64, pp. 30-34. (1889)
Treat. (rec.), N. J. Agr. Exp. Sta., Bull. 64, pp. 39-40. (1889)
Journ. Mycol., Vol. VI, p. 18. (1890)

CUCUMBER.

(*Cucumis sativus,* L.)

Anthracnose (*Colletotrichum Lagenarium,* (Pass.) Ell. & Hals.)
Descr. Illus., Ohio Agr. Exp. Sta., Bull. 89, pp. 109-110. (1897)
Treat. (pos.), N. J. Agr. Exp. Sta., Rep. 17, 1896, pp. 340-343. (1897)
N. Y. Agr. Exp. Sta., Bull. 138, pp. 636-639. (1897)
Cf. Melon (Anthracnose).
Bacteriosis or Wilt (*Bacillus tracheiphilus,* Smith.) ([41])
"Damping-off" or Seedling-Mildew (*Pythium De Baryanum,* Hesse.)
Descr. Illus., Mass. Agr. Exp. Sta., Rep. 8, 1890, p. 220. (1891)
Treat. (rec.), Mass. Agr. Exp. Sta., Rep. 8, 1890, p. 221. (1891)
Downy Mildew (*Plasmopara Cubensis,* (B. & C.) Humphrey.)
Descr. Illus., N. Y. Agr. Exp. Sta., Bull. 119, pp. 158-165. (1897)
Ohio Agr. Exp. Sta., Bull. 89, pp. 103-108. (1897)
Cf. Ohio Agr. Exp. Sta., Bull. 105, pp. 219-220. (1899)
Treat. (pos.), N. Y. Agr. Exp. Sta., Bull. 156. (1898)
Ohio Agr. Exp. Sta., Bull. 105, pp. 223-229. (1899)
Leaf-Glaze (*Acremonium* sp.)
Descr., Mass. Agr. Exp. Sta., Rep. 9, 1891, p. 227. (1892)
Descr. Illus., Mass. Agr. Exp. Sta., Rep. 10, 1892, p. 230. (1893)
Leaf-Spot (*Phyllosticta Cucurbitacearum,* Sacc.)
Occ., Ohio Agr. Exp. Sta., Bull. 105, p. 222. (1899)
Powdery Mildew (*Erysiphe Polygoni,* DC.)
Descr. Illus., Mass. Agr. Exp. Sta., Rep. 10, 1892, p. 225. (1893)
Treat. (pos.), N. Y. (Corn. Univ.) Agr. Exp. Sta., Bull. 31, p. 138. (1891)
Mass. Agr. Exp. Sta., Rep. 9, 1891, p. 225. (1892)
Scab (*Cladosporium cucumerinum,* Ell. & Arth.) ([42])
Descr. Illus., Ind. Agr. Exp. Sta., Bull. 19, pp. 8-10. (1889)
Mass. Agr. Exp. Sta., Rep. 10, 1892, pp. 227-229. (1893)
Stem-Rot (*Sclerotinia Libertiana,* Fckl.) ([43])
Descr. Illus., Mass. Agr. Exp. Sta., Rep. 10, 1892, pp. 212-224. (1893)
Treat. (rec.), Mass. Agr. Exp. Sta., Rep. 10, 1892, p. 222. (1893)
Wilt (*Neocosmospora vasinfecta,* (Atk.) Smith).
See Watermelon (Wilt).
Cf. Ohio Agr. Exp. Sta., Bull. 105, p. 221, '99.

CURRANT.

(*Ribes,* spp.)

Anthracnose (*Glœosporium Ribis,* (Lib.) Mont. & Desm.)
Descr. Illus., N. Y. (Corn. Univ.) Agr. Exp. Sta., Bull. 15, p. 196. (1889)
Cane-Blight (*Fungus indet.*)
Descr., N. Y. Agr. Exp. Sta., Bull. 167, pp. 292-294. (1899)
Knot (*Nectria cinnabarina,* (Tode) Fr. and *Pleonectria Berolinensis,* Sacc.)

Descr. Illus., N. Y. (Corn. Univ.) Agr. Exp. Sta., Bull. 125. (1897)
Treat. (rec.), N. Y. (Corn. Univ.) Agr. Exp. Sta., Bull. 125, p. 38. (1897)
Leaf-Spot (*Septoria Ribis,* Desm., and *Cercospora angulata,* Wint.)
Descr. Illus., Iowa Agr. Exp. Sta., Bull. 13, pp. 68-69. (1891)
Treat. (pos.), Iowa Agr. Exp. Sta., Bull. 30, pp. 289-291. (1895)
Powdery Mildew (*Sphaerotheca mors-uvae* (Schw.) B. & C.)
See Gooseberry (Powdery Mildew.)
Rust (*Puccinia Ribis,* DC.)
See U. S. Dep. Agr., Exp. Sta. Rec., X-6, p. 559. '99.

CYPRESS.

(*Taxodium distichum,* (L.) Rich.)

"Pecky" Disease (*Fungus indet.*) ([44])

EGG-PLANT.

(*Solanum Melongena,* L.)

Anthracnose (*Glœosporium Melongenae,* Ell. & Hals.)
Occ., N. J. Agr. Exp. Sta., Rep. 12, 1891, p. 281. (1892)
Cf. N. J. Agr. Exp. Sta., Rep. 13, 1892, pp. 330-333.
Blight (*Bacillus Solanacearum,* Smith.)
Descr. Illus., U. S. Dep. Agr., Div. Veg. Phys. & Path., Bull. 12. (1896)
Treat. (rec.), U. S. Dep. Agr., Div. Veg. Phys. & Path., Bull. 12, pp. 23-24. (1896)
"Damping-off," or "Seedling-Mildew (*Pythium DeBaryanum,* Hesse.)
Descr., N. J. Agr. Exp. Sta., Rep. 13, 1892, p. 286. (1893)
Cf. Cucumber (Damping-off.)
Fruit-Mold (*Botrytis fascicularis,* (Cord.) Sacc.)
Descr., N. J. Agr. Exp. Sta., Rep. 11, 1890, p. 357. (1891)
Leaf-Spot (*Phyllosticta hortorum,* Speg.)
Descr. Illus., N. J. Agr. Exp. Sta., Rep. 11, 1890, pp. 355-357. (1891)
Treat. (pos.), N. J. Agr. Exp. Sta., Rep. 17, 1896, pp. 337-340. (1897)
Rot (*Penicillium* sp.)
Descr. Illus., N. J. Agr. Exp. Sta., Rep. 14, 1893, pp. 362-366. (1894)
Seedling-Rot (*Phoma Solani,* Hals.)
Descr. Illus., N. J. Agr. Exp. Sta., Rep. 12, 1891, pp. 277-279. (1892)
Treat. (rec.), N. J. Agr. Exp. Sta., Rep. 12, 1891, p. 279. (1892)
Stem-Rot (*Nectria Ipomœae,* Hals.)
Descr. Illus., N. J. Agr. Exp. Sta., Rep. 12, 1891, pp. 281-283. (1892)

FIG.

(*Ficus Carica,* L.)

Leaf-Blight (*Cercospora Bolleana,* (Thm.) Sacc.) ([45])
Occ., U. S. Dep. Agr., Div. Pomol., Bull. 5, pp. 27-28. (1897)

Rust (*Uredo Fici,* Cast.)
Occ., N. C. Agr. Exp. Sta., Bull. 92, p. 117. (1893)
Scab (*Fusarium roseum,* Lk.)
Occ., N. C. Agr. Exp. Sta., Bull. 92, p. 117. (1893)

FILBERT.

(*Corylus Avellana,* L. and *C. Americana,* Walt.)

Black Knot (*Cryptosporella anomala,* (Pk.) Sacc.)
Descr., N. J. Agr. Exp. Sta., Rep. 13, 1892, pp. 287-289. (1893)
Cf. Hazel (Black Knot.)

FIR.

(*Abies balsamea,* (L.) Miller.)

Dry Rot (*Trametes Pini,* (Brot.) Fr.) } Descr. Illus., U. S. Dept.
Root-Rot (*Polyporus Schweinitzii,* Fr.) } Agr., Div. Veg. Phys.
Wet Rot (*Polyporus subacidus,* Pk.?) } & Path., Bull. 25. (1900)

FLAX.

(*Linum* spp.)

Rust (*Melampsora Lini,* (DC.) Tul.) [46]
Occ., Journ. Mycol., Vol. V, p. 215. (1889)

GERANIUM.

(*Pelargonium* spp.)

Leaf-Spot (*Bacteria?*)
Descr., Mass. Agr. Exp. Sta., Rep. 12, 1899, p. 57. (1900)
Rot (*Bacillus* sp.)
Descr. Illus., Journ. Mycol., Vol. VI, pp. 114-115. (1891)

GOOSEBERRY.

(*Ribes Grossularia,* L.)

Black-Knot (*Plowrightia Ribesia,* (P.) Sacc.) [47]
Leaf-Spot (*Septoria Ribis,* Desm., and *Cercospora angulata,* Wint.)
Cf. Currant (Leaf-Spot.)
Leaf-Spot (*Sphaerella Grossulariae,* (Fr.) Awd.?)
Occ. Illus., Iowa Agr. Exp. Sta., Bull. 13, p. 70. (1891)
Powdery Mildew (*Spaerotheca mors-uvae,* (Schw.) B. & C.)
Descr. Illus., U. S. Dep. Agr., Rep. for 1887, pp. 373-378. (1888)
Mass. Agr. Exp. Sta., Rep. 10, 1892, p. 240. (1893)
Treat. (pos.), N. Y. Agr. Exp. Sta., Bull. 161. (1899)
Root-Rot (*Dematophora* sp.?)
Descr., N. Y. Agr. Exp. Sta., Bull. 167, pp. 295-296. (1899)
Rust (*Aecidium Grossulariae,* Schum.) [48]
Descr., Mass. Agr. Exp. Sta., Rep. 10, 1892, p. 241. (1893)
Treat. (rec.), Mass. Agr. Exp. Sta., Rep. 10, 1892, p. 241. (1893)

GRAPE.

(*Vitis* spp.)

Anthracnose (*Sphaceloma ampelinum,* DBy.)
Descr. Illus., Tenn. Agr. Exp. Sta., Bull. IV-4, pp. 111-112. (1891)
Descr., U. S. Dep. Agr., Div. Veg. Path., Bull. 2, pp. 170-172. (1892)
Treat. (rec.), N. Y. Agr. Exp. Sta., Rep. 9, 1890, pp. 336-337. (1891)
Conn. Agr. Exp. Sta., Rep. 14, 1890, p. 102. (1891)
N. Y. (Corn. Univ.) Agr. Exp. Sta., Bull. 76, p. 443. (1894)
Bacteriosis (*Bacillus* sp.)
See U. S. Dep. Agr., Exp. Sta. Rec., VI-3, pp. 231-232.
Bitter-Rot (*Melanconium fuligineum,* (Scrib. & Viala.) Cav.)
Descr. Illus., U. S. Dep. Agr., Rep. for 1887, pp. 324-325. (1888)
Scribner, Fung. Dis., pp. 37-40. (1890)
Treat. (rec.), Scribner, Fung. Dis., p. 40. (1890)
Cf. N. Y. (Corn. Univ.) Agr. Exp. Sta., Bull. 61, pp. 302-305.
Black-Rot (*Guignardia Bidwellii,* (Ell.) V. & R. and *G. baccae,* (Cav.), Jacz.) [49]
Descr. Illus., U. S. Dep. Agr., Rep. for 1886, pp. 109-111. (1887)
Del. Agr. Exp. Sta., Bull. 6, pp. 18-27. (1889)
Tenn. Agr. Exp. Sta., Bull. IV-4, pp. 97-102. (1891)
Tex. Agr. Exp. Sta., Bull. 23, pp. 219-228. (1892)
Treat. (pos.), Conn. Agr. Exp. Sta., Rep. 14, 1890, pp. 100-101. (1891)
U. S. Dep. Agr., Farm. Bull. 4, pp. 8-9. (1891)
Del. Agr. Exp. Sta., Bull. 15, pp. 3-7. (1892)
Tex. Agr. Exp. Sta., Bull. 23, pp. 228-231. (1892)
Chytridiose (*Cladochytrium viticolum,* Prunet.)
See U. S. Dep. Agr., Exp. Sta. Rec., VI-7, pp. 642-644. (1895)
Downy Mildew (*Plasmopara viticola,* (B. & C.) Berl. & De Ton.)
Descr. Illus., U. S. Dep. Agr., Rep. for 1886, pp. 96-99. (1887)
Tenn. Agr. Exp. Sta., Bull. IV-4, p. 108. (1891)
Mich. Agr. Exp. Sta., Bull. 83, pp. 9-12. (1892)
Treat. (pos.), Ohio Agr. Exp. Sta., Bull. III.-10, p. 263. (1890)
U. S. Dep. Agr., Farm. Bull. 4, p. 8. (1891)
Tenn. Agr. Exp. Sta., Bull. IV-4, p. 110. (1891)
Fruit-Mold (*Botrytis,* sp.) [50]
Leaf-Blight (*Cercospora viticola,* (Ces.) Sacc.)
Descr. Illus., Scribner, Fung. Dis., pp. 60-62. (1890)
Descr., N. Y. Agr. Exp. Sta., Rep. 9, 1890, p. 324. (1891)
Treat. (rec.), N. C. Agr. Exp. Sta., Bull. 92, p. 122. (1893)
Leaf-Mold (*Septosporium heterosporum,* Ell. & Gall.)
Descr. Illus., U. S. Dep. Agr., Rep. for 1888, pp. 381-383. (1889)
Leaf-Spot (*Sphaerella* sp.) [51]
Necrosis (*Bacillus vitivorus,* Bacc.)
See U. S. Dep. Agr., Exp. Sta. Rec., X-9, p. 859. (1899)
Powdery Mildew (*Uncinula necator,* (Schw.) Burr.)
Descr. Illus., U. S. Dep. Agr., Rep. for 1886, pp. 105-108. (1887)

Descr., N. Y. Agr. Exp. Sta., Rep. 9, 1890, pp. 322-323. (1891)
U. S. Dep. Agr., Div. Veg. Path., Bull. 2, pp. 166-170. (1892)
Treat. (pos.), U. S. Dep. Agr., Farm. Bull. 4, p. 8. (1891)
Ind. Agr. Sta., Bull. 38, p. 17. (1892)
N. C. Agr. Exp. Sta., Bull. 92, pp. 120-121. (1893)

Ripe-Rot or Anthracnose (*Glœosporium fructigenum,* Berk.)
Descr. Illus., U. S. Dep. Agr., Rep. for 1890, p. 408. (1891)
Journ. Mycol., Vol. VI, pp. 164-171. (1891)
Cf. Apple (Anthracnose.)

Root-Rot (*Armillaria mellea,* (Wallr.) Fr. and *Dematophora necatrix,* Hartig.) ([52])
Descr. Illus., Scribner, Fung. Dis., pp. 64-69. (1890)
Descr., U. S. Dep. Agr., Div. Veg. Path., Bull. 2, pp. 153-159. (1892)
Treat. (rec.), Scribner, Fung. Dis., pp. 70-71. (1890)
N. C. Agr. Exp. Sta., Bull. 92, p. 122. (1893)

Root-Rot (*Pseudodematophora,* Behr.) ([53])

Scab (*Cladosporium viticolum,* Ces.)
Descr., U. S. Dep. Agr., Div. Veg. Path., Bull. 2, pp. 173-174. (1892)

Scald (*Aureobasidium Vitis,* Viala & Boyer.) ([54])
See U. S. Dep. Agr., Exp. Sta. Rec., VI-3, pp. 230-231. (1894)

Tuberculosis (*Bacillus ampelopsorae,* Trev.)
See U. S. Dep. Agr., Exp. Sta. Rec., X-9, pp. 858-859. '99.
Cf. Grape (Necrosis).

Twig-Blight (*Botrytis cinerea,* Pers.) ([55])

Whit-Rot (*Charrinia Diplodiella,* Viala & Rav.; Syn. *Coniothyrium Diplodiella,* (Speg.) Sacc.) ([56])
Descr. Illus., U. S. Dep. Agr., Rep. for 1887, pp. 325-326. (1888)
Scribner, Fung. Dis., pp. 41-44. (1890)
Treat. (pos.), U. S. Dep. Agr., Sec. Veg. Path., Bull. 11, p. 69. (1890)
Cf. U. S. Dep. Agr., Exp. Sta. Rec., IX-3, pp. 249-250. '97.

Hazel.

(*Corylus,* spp.)

Black-Knot (*Cryptosporella anomala,* (Pk.) Sacc.)
Descr. Illus., Mass. Agr. Exp. Sta., Rep. 10, 1892, p. 242. (1893)
Treat. (rec.), Mass. Agr. Exp. Sta., Rep. 10, 1892, p. 243. (1893)
Cf. Filbert (Black-Knot).

Hemlock.

(*Tsuga Canadensis,* (L.) Carr.)

Dry Rot (*Trametes Pini,* (Brot.) Fr.)
Wet Rot (*Polyporus subacidus,* Pk.?)
} Descr. Illus., U. S. Dep. Agr., Div. Veg. Phys. & Path., Bull. 25. (1900)

Hollyhock. ([57])

(*Althaea rosea,* Cav.)

Anthracnose (*Colletotrichum Malvarum,* (Braun. & Casp.) Southworth.)
Descr. Illus., Journ. Mycol., Vol. VI, pp. 46-48. (1890)

Treat. (pos.), Journ. Mycol., Vol. VI, p. 50. (1890)
N. J. Agr. Exp. Sta., Rep. 11, 1890, p. 362. (1891)

Leaf-Blight (*Cercospora althaeina,* Sacc.)
Descr., N. J. Agr. Exp. Sta., Rep. 11, 1890, p. 361. (1891)
Treat. (pos.), N. J. Agr. Exp. Sta., Rep. 11, 1890, p. 361. (1891)

Leaf-Spot (*Phyllosticta althaeina,* Sacc.)
Descr., N. J. Agr. Exp. Sta., Rep. 12, 1891, p. 297. (1892)

Rust (*Puccinia Malvacearum,* Mont.)
Descr. Illus., N. Y. (Corn. Univ.) Agr. Exp. Sta., Bull. 25, p. 154. (1890)
Treat. (rec.), N. Y. (Corn. Univ.) Agr. Exp. Sta., Bull. 25, p. 155. (1890)

Rust (*Puccinia heterogenea,* Lagerh.)
Descr. Illus., Journ. Mycol., Vol. VII, pp. 44-47. (1891)

Horse-Chestnut.

(*Æsculus Hippocastanum,* L.)

Leaf-Spot (*Phyllosticta sphaeropsoidea,* Ell. & Ev.)
Descr., N. Y. Agr. Exp. Sta., Rep. 15, 1896, p. 456. (1897)
Tr. (pos.), Journ. Mycol., Vol. VII, p. 353. (1894)

Horseradish.

(*Cochlearia Armoracia,* L.)

Leaf-Blight (*Ramularia Armoraciae,* Fckl.)
Occ., N. J. Agr. Exp. Sta., Rep. 11, 1890, p. 360. (1891)

Leaf-Mold (*Macrosporium herculeum,* E. & M.)
Occ., N. Y. Agr. Exp. Sta., Rep. 15, '96, p. 452. (1897)

Leaf-Spot (*Septoria Armoraciae,* Sacc.)
Descr., N. J. Agr. Exp. Sta., Rep. 11, 1890, p. 360. (1891)

Hyacinth.

(*Hyacinthus orientalis,* L.)

Bacteriosis (*Bacillus Hyacinthi septicus,* Heinz,) ([58])

Yellow Disease (*Bacillus Hyacinthi,* (Wakk.) Trev.) ([59])

Hydrangea.

(*Hydrangea Hortensia,* Siebold.)

Leaf-Spot (*Phyllosticta Hydrangeae,* Ell. & Ev.)
Occ., N. J. Agr. Exp. Sta., Rep. 12, 1891, p. 298. (1892)

Larch.

(*Larix laricina,* (DR.) Koch.)

Blister (*Peziza Willkommii,* Hartig.) ([60])

Dry-Rot (*Trametes Pini,* (Brot.) Fr.)
Descr. Illus., U. S. Dep. Agr., Div. Veg. Phys. & Path., Bull. 25, pp. 31-40. (1900)

LEMON.

(*Citrus Medica*, var. *Limon*, L.)

Foot-Rot (*Fusisporium Limoni*, Briosi?)
See Orange (Foot-Rot.)
Fruit-Spot (*Trichoseptoria Alpei*, Cav.) ([61])
Melanose (*Fungus indet?*)
See Orange (Melanose.)
Scab (*Cladosporium* sp.)
Descr. Illus., U. S. Dept. Agr., Div. Veg. Phys. & Path., Bull. 8, pp. 20-23. (1896)
Treat. (pos.), U. S. Dept. Agr., Div. Veg. Phys. & Path., Bull. 8, pp. 23-24. (1896)
Sooty Mold (*Meliola Penzigi*, Sacc. and *M. Camelliae*, (Catt.) Sacc.)
See Orange (Sooty Mold.)

LETTUCE.

(*Lactuca sativa*, L.)

Anthracnose (*Marsonia perforans*, Ell. & Ev.)
Descr. Illus., Ohio Agr. Exp. Sta., Bull. 73, pp. 222-223. (1897)
Treat. (rec.), Ohio Agr. Exp. Sta., Bull. 73, pp. 225-226. (1897)
Downy Mildew (*Bremia Lactucae*, Regel.)
Descr. Illus., N. Y. Agr. Exp. Sta., Rep. 4, 1885, p. 253. (1886)
Treat. (pos.), Mass. Agr. Exp. Sta., Bull. 4, pp. 11-14. (1889)
Ohio Agr. Exp. Sta., Bull. 73, p. 226. (1897)
Drop (*Sclerotinia Libertiana*, Fckl.) ([62])
Descr. Illus., Mass. Agr. Exp. Sta., Bull. 69, pp. 12-15. (1900)
Treat. (pos.), Mass. Agr. Exp. Sta., Bull. 69, pp. 17-35. (1900)
Leaf-Mold or Rot (*Botrytis cinerea*, Pers.) ([62])
Descr. Illus., Mass. Agr. Exp. Sta., Bull. 69, pp. 7-12. (1900)
Leaf-Rot (*Rhizoctonia* sp.)
Descr. Illus., Mass. Agr. Exp. Sta., Bull. 69, pp. 16-17. (1900)
Treat. (pos.), Mass. Agr. Exp. Sta., Bull. 69, pp. 39-40. (1900)
Leaf-Spot (*Septoria consimilis*, Ell. & Mart.)
Descr. Illus., Ohio Agr. Exp. Sta., Bull. 44, pp. 145-146. (1892)
Stem-Rot (Bacterial.)
Descr., Vt. Agr. Exp. Sta., Rep. 6, 1892, p. 87. (1893)
Treat. (rec.) Vt. Agr. Exp. Sta., Rep. 6, 1892, p. 88 (1893)

LILY.

(*Lilium* spp.)

Bermuda Disease.
See U. S. Dept. Agr., Div. Veg. Phys. & Path., Bull. 14. (1897)
Bulb-Rot (*Rhizopus necans*, Massee). ([63])
Mold or Ward's Disease (*Botrytis* sp.) ([64])
Treat. (pos.), Gar. and For., IX-414, p. 44. '96.
See N. J. Agr. Exp. Sta., Rep. 14, 1893, pp. 392-394. (1894)

LINDEN.

(*Tilia* spp.)

Leaf-Blight (*Cercospora microsora*, Sacc.)
Occ., N. Y. Agr. Exp. Sta., Rep. 15, 1896, p. 454. (1897)
Stem-Rot (*Botrytis cinerea*, Pers.) ([65])

LUPINE.

(*Lupinus* spp.)

Blight (*Pestalozzia Lupini*, Sor.) ([66])

MAPLE.

(*Acer*, spp.)

Anthracnose (*Glœosporium apocryptum*, Ell. & Ev.)
Descr., N. Y. Agr. Exp. Sta., Rep. 14, 1895, pp. 531-532. (1896)
Treat. (rec.), N. Y. Agr. Exp. Sta., Rep. 14, 1895, p. 532. (1896)
Leaf-Spot (*Phyllosticta acericola*, Cke. & Ell.)
Descr. Illus., U. S. Dep. Agr., Rep. for 1888, pp. 383-386. (1889)
Treat. (rec.), U. S. Dep. Agr., Rep. for 1888, p. 386. (1889)

MELON.

(*Cucumis Melo*, L.)

Anthracnose (*Colletotrichum lagenarium*, (Pass.) Ell. & Hals.)
Descr., U. S. Dep. Agr., Bot. Div., Bull. 8, p. 64. (1889)
Descr. Illus., Okla. Agr. Exp. Sta., Bull. 15, pp. 30-31. (1895)
Treat. (pos.), Md. Agr. Exp. Sta., Rep. 4, 1891, p. 387. (1892)
(neg.), Okla. Agr. Exp. Sta., Bull. 15, pp. 31-32. (1895)
Cf. Cucumber (Anthracnose).
Anthracnose (*Colletotrichum oligochætum*, Cav.) ([67])
Bacteriosis or Wilt (*Bacillus tracheiphilus*, Smith).
See Cucumber (Bacteriosis.)
Downy Mildew (*Plasmopara Cubensis*, (B. & C.) Humphrey.)
Occ. Descr., Conn. Agr. Exp. Sta., Rep. 23, '99, pp. 277-278. (1900)
Cf. Cucumber (Downy Mildew.)
Leaf-Blight (*Cercospora Melonis*, Cke.) ([68])
Leaf-Mold (*Alternaria Brassicae*, Sacc., var. *nigrescens*, Pegl.) ([69])
Descr., Conn. Agr. Exp. Sta., Rep. 19, 1895, pp. 186-187. (1896)
Descr. Illus., Ohio Agr. Exp. Sta., Bull. 73, pp. 235-236. (1897)
Treat. (pos.), Conn. Agr. Exp. Sta., Rep. 22, '98, pp. 229-235. (1899)
Cf. Conn. Agr. Exp. Sta., Rep. 23, 1899, pp. 270-273. (1900)
Leaf-Spot (*Phyllosticta Cucurbitacearum*, Sacc.?)
Descr. Illus., N. J. Agr. Exp. Sta., Rep. 14, 1893, p. 355. (1894)
Cf. Cucumber (Leaf-Spot.)
Scab (*Scolecotrichum melophthorum*, Pr. & Del.) ([70])
Wilt (*Neocosmospora vasinfecta*, (Atk.) Smith.)
See Watermelon (Wilt.)
Cf. Conn. Agr. Exp. Sta., Rep. 22, 1898, pp. 227-228. '99.

MIGNONETTE.

(*Reseda odorata,* L.)

Leaf-Blight (*Cercospora Resedæ,* Fckl.)
Descr. Illus., U. S. Dep. Agr., Rep. for 1889, pp. 429-430. (1890)
Treat. (pos.), U. S. Dep. Agr., Rep. for 1889, p. 431. (1890)

MULBERRY. ([71])

(*Morus,* spp.)

Bacteriosis (*Bacillus Cubonianus,* Macch.) ([72])
Chytridiose (*Cladochytrium Mori,* Prunet.)
See U. S. Dept. Agr., Exp. Sta. Rec., VI-9, p. 830. (1895)
Root-Rot (*Helicobasidium Mompa,* Ichik.) ([73])

NASTURTIUM.

(*Tropæolum Majus,* L.)

Leaf-Blight (*Alternaria,* sp., and *Pleospora Tropæoli,* Hals.)
Descr., N. J. Agr. Exp. Sta., Rep. 13, 1892, p. 290-293. (1893)

OATS.

(*Avena sativa,* L.)

Blight (Bacterial).
Descr., Journ. Mycol., Vol. VI, p. 72. ([74]) (1890)
Leaf-Spot (*Phyllosticta* sp.)
Descr., N. J. Agr. Exp. Sta., Rep. 15, 1894, p. 319. (1895)
Mild (*Helminthosporium inconspicuum,* Cke. & Ell., var *brittanicum* Gr., and *Cladosporium herbarum,* (Pers.) Lk.)
Descr., Me. Agr. Exp. Sta., Rep. for 1894, pp. 95-96. (1895)
Rust (*Puccinia coronata,* Cda., and *P. Graminis,* P.)
See Wheat (Rust).
Cf. U. S. Dep. Agr., Div. Veg. Phys. & Path., Bull. 16, pp. 45-52 & 60-65. '99.
Smut (*Ustilago Avenae,* (P.) Jens. and *U. levis,* Kell. & Sw.) Magn.)
Descr. Illus., Kan. Agr. Exp. Sta., Rep. 2, 1889, pp. 215-238 & 259-260. (1890)
Ohio Agr. Exp. Sta., Bull. 64, pp. 123-126. (1896)
Ill. Agr. Exp. Sta., Bull. 57, pp. 297-298. (1900)
Treat. (pos.), N. Y. Agr. Exp. Sta., Bull. 131. (1897)
U. S. Dep. Agr., Farm. Bull. 75, pp. 11-16. (1898)
Ohio Agr. Exp. Sta., Bull. 97, p. 61. (1898)
R. I. Agr. Exp. Sta., Rep. 11, '98, pp. 192-203. (1899)
Ill. Agr. Exp. Sta., Bull. 57, pp. 309-316. (1900)

OKRA.

(*Hibiscus esculentus,* L.)

Wilt (*Neocosmospora vasinfecta,* (Atk.) Smith?)
See U. S. Dep. Agr., Div. Veg. Phys. & Path., Bull. 17, p. 31. '99.
Cf. Cotton (Wilt).

OLIVE.

(*Olea Europæa,* L.)

Anthracnose (*Glœosporium Olivarum,* d'Almeida) ([75])
Fruit-Mold or Dry-Rot (*Alternaria* sp. and *Macrosporium* sp.)
Descr. Illus., Cal. Agr. Exp. Sta., Rep. for '95-'97, pp. 235-236. (1898)
Rot (Bacterial).
Descr., Cal. Agr. Exp. Sta., Bull. 123, p. 19. (1899)
Scab (*Cycloconium oleaginum,* Cast.)
Descr., Cal. Agr. Exp. Sta., Rep. 1892-93, pp. 297-298. (1894)
See U. S. Dep. Agr., Exp. Sta. Rec., XI-6, p. 554. 1900.
Sooty Mold (*Meliola* sp., Syn. *Capnodium Citri,* (P.) Berk. & Dmz.) ([76])
Cf. Orange (Sooty Mold).
Tuberculosis (*Bacillus Oleae,* (Arcang.) Trev.)
Descr. Illus., Cal. Agr. Exp. Sta., Bull. 120. (1898)
Treat. (rec.), Cal. Agr. Exp. Sta., Bull. 120, pp. 10-11. (1898)
Cf. Cal. Agr. Exp. Sta., Rep. for '97-'98, p. 178. 1900.

ONION.

(*Allium Cepa,* L.)

Anthracnose or Rot (*Vermicularia circinans,* Berk.)
Descr. Illus., Conn. Agr. Exp. Sta., Rep. 13, 1889, p. 163. (1890)
Treat. (rec.), Conn. Agr. Exp. Sta., Rep. 13, 1889, pp. 164-165. (1890)
Downy Mildew (*Peronospora Schleideniana,* DBy.)
Descr. Illus., Wis. Agr. Exp. Sta., Rep. 1, 1883, pp. 38-44. (1884)
Descr., Conn. Agr. Exp. Sta., Rep. 13, 1889, pp. 155-156. (1890)
Treat. (rec.), Conn. Agr. Exp. Sta., Rep. 13, 1889, p. 157. (1890)
Vt. Agr. Exp. Sta., Rep. 10, 1896-97, pp. 61-62. (1897)
Mold (*Macrosporium Sarcinula,* B., var. *parasiticum,* Thm., and *M. Porri,* Ell.)
Descr. Illus., Conn. Agr. Exp. Sta., Rep. 13, 1889, pp. 158-162. (1890)
Treat. (rec.), Conn. Agr. Exp. Sta., Rep. 13, 1889, p. 161. (1890)
Rot (Bacterial).
Descr. Illus., N. Y. Agr. Exp. Sta., Bull. 164, pp. 209-212. (1899)
Smut (*Urocystis Cepulae,* Frost).
Descr. Illus., Conn. Agr. Exp. Sta., Rep. 13, 1889, pp. 129-146. (1890)
Treat. (pos.), Conn. Agr. Exp. Sta., Rep. 13, 1889, pp. 147-153. (1890)
(By transplanting), Conn. Agr. Exp. Sta., Rep. 19, 1895, pp. 176-182. (1896)
Cf. Ohio Agr. Exp. Sta., Bull. III-9, pp. 244-249.
N. Dak. Agr. Exp. Sta., Bull. 12. (1894)
U. S. Dep. Agr., Farm. Bull. 39, pp. 16-20. (1896)

ORANGE.

(*Citrus Aurantium,* L.)

Anthracnose (*Colletotrichum adustum,* Ell.)
Descr. Illus., Fla. Agr. Exp. Sta., Bull. 53, pp. 171-173. (1900)
Treat. (rec.), Fla. Agr. Exp. Sta., Bull. 53, p. 173. (1900)

Foot Rot or Mal-di-gomma (*Fusisporium Limoni,* Briosi?)
Descr. Illus. Treat. (rec.), U. S. Dept. Agr., Div. Veg. Phys. & Path., Bull. 8, pp. 28-31. (1896)
Fla. Agr. Exp. Sta., Bull. 53, pp. 151-155. (1900)
Leaf-glaze (*Strigula complanata,* Fée.)
Occ., Journ. Mycol., Vol. VII, p. 36. (1891)
Melanose (*Fungus indet.*) ([77])
Descr. Illus. Treat. (pos.), U. S. Dept. Agr., Div. Veg. Phys. & Path., Bull. 8, pp. 33-38. (1896)
Scab (*Cladosporium* sp.)
See Lemon (Scab.)
Sooty Mold (*Meliola Penzigi,* Sacc. and *M. Camelliae,* (Catt.) Sacc. ([78])
Descr. Illus. Treat. (pos.), U. S. Dept. Agr., Div. Veg. Phys. & Path., Bull. 13. (1897)

Orchids. ([79])

(*Orchidaceae.*)

Anthracnose (*Glœosporium cinctum* B. & C. and *Colletotrichum Bletiae,* Hals.)
Descr., N. J. Agr. Exp. Sta., Rep. 14, 1893, pp. 414-417. (1894)
Anthracnose (*Glœosporium macropus,* Sacc.) ([80])
Leaf-Blight (*Cercospora Angreci,* Roum.) ([81])

Parsnip.

(*Pastinaca sativa,* L.)

Leaf-Blight (*Cercospora Apii,* Fres.)
Occ., N. J. Agr. Exp. Sta., Rep. 15, 1894, p. 351. (1895)
Cf. Celery (Leaf-Blight).

Pea.

(*Pisum sativum,* L.)

Damping-off (*Ascochyta Pisi,* Lib. and *Pythium* sp.)
Occ., Conn. Agr. Exp. Sta., Rep. 23, 1899, pp. 280-281. (1900)
Cf. Pea (Leaf-Spot).
Leaf-Spot (*Ascochyta Pisi,* Lib.) ([82])
Descr., N. J. Agr. Exp. Sta., Rep. 14, 1893, p. 358. (1894)
Treat. (rec.), Del. Agr. Exp. Sta., Bull. 41, pp. 9-11. (1898)
Leaf-Spot (*Septoria Pisi,* West.)
Occ., N. J. Agr. Exp. Sta., Rep. 14, 1893, p. 358. (1894)
Mold (*Pleospora Pisi,* (Sow.) Fckl.)
Occ., N. J. Agr. Exp. Sta., Rep. 14, 1893, p. 358. (1894)
Powdery Mildew (*Erysiphe Polygoni,* DC.)
Descr., N. J. Agr. Exp. Sta., Rep. 14, 1893, p. 357. (1894)
Cf. Bean (Powdery Mildew.)

Peach.

(*Prunus Persica,* Benth. & Hook.)

Anthracnose (*Glœosporium laeticolor,* Berk.)
Occ. Ohio Agr. Exp. Sta., Bull. 92, p. 225. (1898)
Crown-Gall (*Dendrophagus globosus,* Toumey.)
See Almond (Crown-Gall).
Fruit-Mold or Twig-Blight (*Oidium fructigenum,* Kze. & Schm.) ([83])
Descr. Illus., Journ. Mycol., Vol. VII, pp. 36-38. (1891)
Ga. Agr. Exp. Sta., Bull. 50. (1900)
Treat. (pos.), Del. Agr. Exp. Sta., Rep. 9, '96-'97, pp. 20-30. (1897)
Ga. Agr. Exp. Sta., Bull. 50, pp. 267-269. (1900)
Cf. Conn. Agr. Exp. Sta., Rep. 24, 1900, pp. 252-254. (1901)
Cf. Cherry (Fruit-Mold and Twig-Blight.)
Fruit-Spot (*Helminthosporium carpophilum,* Lév.)
Occ., Mich. Agr. Exp. Sta., Bull. 103, p. 57. (1894)
Treat. (pos.), Ohio Agr. Exp. Sta., Bull. 92, p. 225. (1898)
Leaf-Blight or Shot-hole (*Cercospora Persica,* Sacc.)
Occ., N. C. Agr. Exp. Sta., Bull. 92, p. 103. (1893)
Treat. (rec.), N. C. Agr. Exp. Sta., Bull. 92, p. 103. (1893)
Leaf-Blight or Frosty Mildew (*Cercosporella Persica,* Sacc.)
Occ., Journ. Mycol., Vol. VII, p. 91. (1892)
Leaf-Curl (*Exoascus deformans,* (Berk.) Fckl.)
Descr. Illus., N. Y. (Corn. Univ.) Agr. Exp. Sta., Bull. 73, pp. 324-325. (1894)
U. S. Dep. Agr., Div. Veg. Phys & Path., Bull. 20. (1900)
Treat. (pos.), Ohio Agr. Exp. Sta., Bull. 104, pp. 201-211. (1899)
N. Y. (Corn. Univ.) Agr. Exp. Sta., Bull. 180. (1900)
U. S. Dep. Agr., Div. Veg. Phys. & Path., Bull. 20. (1900)
Powdery Mildew (*Sphaerotheca pannosa,* (Wallr.) Lév.? and *Podosphaera oxyacanthae,* (DC.) DBy.)
Occ., Journ. Mycol., Vol. VII, p. 90. (1892)
Descr. Illus., N. Y. (Corn. Univ.) Agr. Exp. Sta., Bull. 74, p. 381. (1894)
Root-Rot (*Fungus indet.?*)
Occ., Journ. Mycol., Vol. VII, p. 377. (1894)
Ohio Agr. Exp. Sta., Bull. 92, p. 235. (1898)
Rust (*Puccinia Pruni,* P.) ([84])
See Cherry (Rust).
Scab (*Cladosporium carpophilum,* Thüm.) ([85])
Descr. Illus., Ind. Agr. Exp. Sta., Bull. 19, pp. 5-8. (1889)
Del. Agr. Exp. Sta., Rep. 8, 1895-96, pp. 60-63. (1896)
Ohio Agr. Exp. Sta., Bull. 92, pp. 220-222. (1898)
Treat. (pos.), Del. Agr. Exp. Sta., Rep. 8, 1895-96, p. 63. (1896)
Cf. N. J. Agr. Exp. Sta., Rep. 15, 1894, pp. 328-330. (On leaves.)
Conn. Agr. Exp. Sta., Rep. 20, 1896, pp. 269-271. (On twigs.)

Stem-Blight (*Phoma Persicae,* Sacc.)
Descr. Illus., Ohio Agr. Exp. Sta., Bull. 92, pp. 233-234. (1898)
Tuberculosis (*Clostridium Persicae tuberculosis,* Cav.) ([86])

PEAR.

(*Pirus Communis,* L.)

Anthracnose (*Colletotrichum,* sp.)
Occ., N. J. Agr. Exp. Sta., Rep. 15, 1894, p. 331. (1895)
Body-Blight or Canker (*Macrophoma Malorum,* (Berk.) Berl. & Vogl.?)
Occ., N. Y. Agr. Exp. Sta., Bull. 163, p. 203. (1899)
Dry-Rot (*Thelephora pedicellata,* Schw.)
Descr., Journ. Mycol., Vol. VI, pp. 113-114. (1891)
Treat. (pos.), Journ. Mycol., Vol. VI, p. 114. (1891)
Fire-Blight (*Bacillus amylovorus,* (Burr.) DeToni) ([87])
Descr. Illus., N. Y. Agr. Exp. Sta., Rep. 5, 1886, pp. 275-289. (1887)
Descr., Conn. Agr. Exp. Sta., Rep. 18, 1894, pp. 113-116. (1895)
U. S. Dept. Agr., Year-Book for 1895, pp. 295-298. (1896)
N. Y. (Corn. Univ.) Agr. Exp. Sta., Bull. 145, pp. 622-625. (1898)
Treat. (pos.), Conn. Agr. Exp. Sta., Rep. 18, 1894, p. 116. (1895)
U. S. Dept. Agr., Year-Book for 1895, pp. 298-300. (1896)
N. J. Agr. Exp. Sta., Rep. 18, 1897, pp. 378-383. (1898)
Cf. Apple (Fire-Blight.)
Leaf-Blight (*Entomosporium maculatum,* Lév.). ([88])
Descr. Illus., U. S. Dep. Agr., Rep. for 1888, pp. 357-362. (1889)
Del. Agr. Exp. Sta., Bull. 13, pp. 4-6. (1891)
N. Y. (Corn. Univ.) Agr. Exp. Sta., Bull. 145, p. 611. (1898)
Treat. (pos.), U. S. Dep. Agr., Div. Veg. Path., Bull. 3, pp. 46-47. (1892)
Journ. Mycol., Vol. VII, pp. 334-338. (1894)
R. I. Agr. Exp. Sta., Bull. 31, pp. 5-9. (1895)
Cf. Quince (Leaf-Spot.)
Leaf-Spot (*Septoria piricola,* Desm.)
Descr. Illus., Treat. (pos.), N. Y. (Corn. Univ.) Agr. Exp. Sta., Bull. 145, pp. 597-611. (1898)
Rust (*Gymnosporangium globosum,* Farl.)
Occ., Conn. Agr. Exp. Sta., Rep. 14, 1890, p. 98. (1891)
Scab (*Fusicladium pirinum.* (Lib.) Fckl. = *Venturia pirina,* Aderh.) ([89])
Descr. Illus., N. Y. (Corn. Univ.) Agr. Exp. Sta., Bull. 145, pp. 616-620. (1898)
Treat. (pos.), N. Y. Agr. Exp. Sta., Bull. 67. (1894)
Vt. Agr. Exp. Sta., Bull. 44, pp. 85-90. (1895)
Cf. Apple (Scab).

PEONY.

(*Pæonia officinalis,* Linn.)

Mold (*Botrytis Pæoniæ,* Oud.) ([90])

PEPPERS.

(*Capsicum annuum,* L.)

Anthracnose (*Colletotrichum nigrum,* Ell. & Hals. and *Glœosporium piperatum,* Ell. & Ev.)
Descr. Illus., N. J. Agr. Exp. Sta., Rep. 11, 1890, pp. 358-359. (1891)
Treat. (neg.), N. J. Agr. Exp. Sta., Rep. 17, 1896, p. 337. (1897)
Cf. N. J. Agr. Exp. Sta., Rep. 13, pp. 332-333. (1893)
Mold (*Macrosporium* sp.)
Occ., N. J. Agr. Exp. Sta., Rep. 15, 1894, p. 351. (1895)

PERSIMMON.

(*Diospyros,* spp.)

Miscellaneous Fungous Diseases. { *Agaricus.* / *Cercosporæ.* / *Glœosporium.*
See N. C. Agr. Exp. Sta., Bull. 92, p. 116. (1893)

PINE.

(*Pinus* spp.)

Dry Rot (*Trametes Pini,* (Brot.) Fr., and *T. radiciperda,*—) ([91])
Descr. Illus., U. S. Dep. Agr., Div. Veg. Phys. & Path., Bull. 25, pp. 31-40. (1900)
Root-Rot (*Polyporus Schweinitzii,* Fr.)
Descr. Illus., U. S. Dep. Agr., Div. Veg. Phys. & Path., Bull. 25, pp. 18-24. (1900)
Rust (*Coleosporium Pini,* Gall.) ([92])
Descr., Journ. Mycol., Vol. VII, p. 44. (1891)
Wet Rot (*Polyporus subacidus,* Pk.?)
Descr. Illus., U. S. Dep. Agr., Div. Veg. Phys. & Path., Bull. 25, pp. 44-49. (1900)

PINK (SWEET WILLIAM).

(*Dianthus barbatus,* L.)

Mold (*Heterosporium echinulatum,* (Berk.) Cke.) ([93])
Rust (*Puccinia Arenariae,* (Schum.) Wint.)
Descr. Illus., N. J. Agr. Exp. Sta., Rep. 13, 1892, pp. 278-280. (1893)
Treat. (rec.), N. J. Agr. Exp. Sta., Rep. 13, 1892, p. 280. (1893)

PLUM.

(*Prunus,* spp.)

Black Knot (*Plowrightia morbosa,* (Schw.) Sacc.)
Descr. Illus. Treat., Ky. Agr. Exp. Sta., Bull. 80, pp. 250-256. (1899)

Cf. Cherry (Black Knot.)
Canker (*Nectria ditissima,* Tul.)
Descr., See U. S. Dep. Agr., Exp. Sta. Rec., IX--8, pp. 761-762. (1898)
Fire-Blight (Bacterial.)
Occ., Conn. Agr. Exp. Sta., Rep. 18, 1894, pp. 117-118. (1895)
Fruit-Mold (*Oidium fructigenum,* Kze. & Schm.)
Descr. Illus., Oreg. Agr. Exp. Sta., Bull. 57, pp. 3-12. (1899)
Treat. (pos.), N. Y. (Corn. Univ.) Agr. Exp. Sta., Bull. 86, pp. 71-72. (1895)
Mo. Agr. Exp. Sta., Bull. 31, pp. 16-18. (1895)
Cf. Cherry (Fruit-Mold.)
Leaf-Curl (*Exoascus mirabilis,* Atk.)
Descr. Illus., Conn. Agr. Exp. Sta., Rep. 19, 1895, pp. 183-185. (1896)
Treat. (pos.), Conn. Agr. Exp. Sta., Rep. 20, 1896, p. 281. (1897)
Leaf-Spot (*Cylindrosporium Padi,* Karst.)
Descr. Illus., N. Y. Agr. Exp. Sta., Rep. 5, 1886, pp. 293-296. (1887)
Idem., Rep. 6, 1887, pp. 347-350. (1888)
Treat. (pos.), U. S. Dep. Agr., Div. Veg. Path., Bull. 7, p. 30. (1894)
N. Y. Agr. Exp. Sta., Rep. 15, '96, pp. 384-401. (1897)
Cf. Cherry (Leaf-Spot.)
Plum-Pockets (*Exoascus Pruni,* Fckl.)
Descr. Illus., U. S. Dep. Agr., Rep. for 1888, pp. 366-369. (1889)
N. Y. (Corn. Univ.) Agr. Exp. Sta., Bull. 73. pp. 329-330. (1894)
Treat. (rec.), N. C. Agr. Exp. Sta., Bull. 92, p. 111. (1893)
Powdery Mildew (*Podosphaera Oxyacanthae,* (DC.) DBy.)
See Cherry (Powdery Mildew.)
Rust (*Puccinia Pruni,* Pers.)
Descr., Journ. Mycol., Vol. VII, pp. 354-356. (1894)
Treat. (pos.), Journ. Mycol., Vol. VII, pp. 356-362. (1894)
Cf. Cherry (Rust.)
Scab (*Cladosporium carpophilum,* Thüm.)
Descr., Journ. Mycol., Vol. VII, pp. 99-100. (1892)
Descr. Illus., Iowa Agr. Exp. Sta., Bull. 23, pp. 918-920. (1894)
Cf. Cherry and Peach (Scab.)

Poplar.

(*Populus* spp.)

Anthracnose (*Marsonia Populi,* (Lib.) Sacc.)
Descr., N. J. Agr. Exp. Sta., Rep. 15, 1894, pp. 394-396. (1895)
Rust (*Melampsora populina,* (Jacq.) Lév.)
Descr. Illus., U. S. Dep. Agr., Rep. for 1888, pp. 390-392. (1889)
Treat. (pos.), Mass. Agr. Exp. Sta., Rep. 7, 1894, p. 20. (1895)

Potato. [94]

(*Solanum tuberosum,* L.)

Anthracnose (*Vermicularia* sp.) [95]

Brown Rot (*Bacillus Solanacearum,* Smith.)
Descr. Illus. Treat. (rec.), U. S. Dep. Agr., Div. Veg. Phys. & Path., Bull. 12. (1896)
Chytridiose (*Chrysophlyctis endobiotica,* Schilb.) [96]
Downy Mildew or Rot (*Phytophthora infestans,* DBy.) [97]
Descr. Illus., U. S. Dep. Agr., Rep. for 1888, pp. 337-338. (1889)
N. H. Agr. Exp. Sta., Bull. 22, pp. 3-5 (1894)
N. Y. (Corn. Univ.) Agr. Exp. Sta., Bull. 113, pp. 249-254. (1896)
Treat. (pos.), N. Y. (Corn. Univ.) Agr. Exp. Sta., Bull. 140. (1897)
Vt. Agr. Exp. Sta., Bull. 72, pp. 25-32. (1899)
U. S. Dep. Agr., Farm. Bull. 91. (1899)
Dry-Rot (*Fusarium Solani,* (Mart.) Sacc.) [98]
Occ., Ill. Agr. Exp. Sta., Bull. 40, p. 139. (1895)
Internal Browning (Bacterial?) [99]
Descr., Ill. Agr. Exp. Sta., Bull. 40, pp. 138-139. (1895)
N. Y. Agr. Exp. Sta., Bull. 101, pp. 78-83. (1896)
Leaf-Mold or Early Blight (*Alternaria Solani,* (E. & M.) Jones & Grout)
Descr. Illus., Del. Agr. Exp. Sta., Rep. 4, 1891, pp. 58-59. (1892)
N. Y. (Corn. Univ.) Agr. Exp. Sta., Bull. 140, p. 393. (1897)
Vt. Agr. Exp. Sta., Bull. 72, pp. 16-25. (1899)
Cf. Vt. Agr. Exp. Sta., Rep. 10, '96-'97, pp. 45-51. (1897)
Conn. Agr. Exp. Sta., Rep. 18, '94, pp. 127-134. (1895)
Treat. (pos.), N. Y. (Corn. Univ.) Agr. Exp. Sta., Bull. 113, pp. 265-271. (1896)
N. Y. Agr. Exp. Sta., Bull. 123. (1897)
U. S. Dept. Agr., Farm. Bull. 91, pp. 5-7. (1899)
Root-Rot (*Entorrhiza Solani,* Fautr.)
See U. S. Dept. Agr., Exp. Sta. Rec., VII-10, p. 873. (1896)
Scab (*Oospora scabies,* Thaxter.)
Descr. Illus., Conn. Agr. Exp. Sta., Rep. 14, 1890, pp. 81-95. (1891)
Idem., Rep. 15, 1891, pp. 153-160. (1892)
Cf. W. Va. Agr. Exp. Sta., Sp. Bull. 2, pp. 97-111. (1895)
Treat. (pos.)
(Cor. Sub.) Mich. Agr. Exp. Sta., Bull. 108, pp. 38-45. (1894)
Ind. Agr. Exp. Sta., Bull. 56, pp. 70-80. (1895)
Conn. Agr. Exp. Sta., Rep. 19, 1895, pp. 166-176. (1896)
U. S. Dep. Agr., Farm. Bull. 91, pp. 9-10. (1899)
(Formalin) Ind. Agr. Exp. Sta., Bull. 65. (1897)
U. S. Dep. Agr., Farm. Bull. 91, pp. 9-10. (1899)
Scurf (*Rhizoctonia Solani,* Kühn.) [100]
Stem-Blight (*Fusarium acuminatum,* Ell. & Ev.?)
Descr., N. Y. Agr. Exp. Sta., Bull. 101, p. 85. (1896)
Cf. N. Y. Agr. Exp. Sta., Bull. 138, pp. 632-634. (1897)
Stem-Rot (*Botrytis* or *Sclerotinia.*) [101]
Wet Rot (*Bacterial.*) [102]

Descr., Del. Agr. Exp. Sta., Rep. 4, 1891, pp. 54-57. (1892)
Wilt (*Oospora rosea*, (Pr.) Sacc. & Vogl.?)
Occ., N. Y. Agr. Exp. Sta., Bull. 101, pp. 83-84. (1896)
Yellow Blight (*Sclerotinia Libertiana*, Fckl.; Syn. *Peziza postuma*, Berk. & Wils.?) ([103])
Cf. Potato (Stem-Rot.)

PRIMROSE.

(*Primula* spp.)

Miscellaneous Fungous Diseases. { *Phyllosticta primulicola*, Dmz. / *Ramularia Primulae*, Thm. / *Colletotrichum Primulae*, Hals. / *Ascochyta Primulae*, Trail.
See N. J. Agr. Exp. Sta., Rep. 15, 1894, pp. 377-380. (1895)

PRIVET.

(*Ligustrum vulgare*, L.)

Anthracnose (*Glœosporium cingulatum*, Atkinson.)
Descr. Illus., N. Y. (Corn. Univ.) Agr. Exp. Sta., Bull. 49. pp. 306-314. (1892)

QUINCE.

(*Pirus Cydonia.*)

Black-Rot (*Sphaeropsis Malorum*, Berk.)
Descr. Illus., N. J. Agr. Exp. Sta., Bull. 91, pp. 8-10. (1892)
Treat. (rec.), Conn. Agr. Exp. Sta., Bull. 115, pp. 6-7. (1893)
Cf. Apple (Black-Rot.)
Fire-Blight (*Micrococcus amylovorus*, Burrill.)
See Apple and Pear (Fire-Blight.)
Leaf-Spot (*Entomosporium maculatum*, Lév.)
Descr. Illus., See Pear (Leaf-Spot.)
Treat.(pos.), Conn. Agr. Exp. Sta., Rep. 15, 1891, pp. 150-152. (1892)
N. Y. (Corn. Univ.) Agr. Exp. Sta., Bull. 80, pp. 619-625. (1894)
Mold (*Sclerotinia Cydoniae*, Schellenb.) ([104])
Pale-Rot (*Phoma Cydoniae*, Sacc. & Schulz.?)
Descr. Illus., N. J. Agr. Exp. Sta., Bull. 91, pp. 10-11. (1892)
Ripe-Rot or Anthracnose (*Glœosporium fructigenum*, Berk.)
See Apple and Grape (Ripe-Rot.)
Rust (*Gymnosporangium* spp., Syn. *Rœstelia* spp.)
Descr. Illus., N. J. Agr. Exp. Sta., Bull. 91, pp. 2-5. (1892)
N. Y. (Corn. Univ.) Agr. Exp. Sta., Bull. 80, pp. 625-626. (1894)
Treat. (rec.), N. Y. (Corn. Univ.) Agr. Exp. Sta., Bull. 80, p. 627. (1894)

RADISH.

(*Raphanus sativus*, L.)

Club-Root (*Plasmodiophora Brassicae*, Wor.)
Occ., N. J. Agr. Exp. Sta., Rep. 11, 1890, pp. 348-349. (1891)
Cf. Cabbage (Club-Root.)
Downy Mildew (*Peronospora parasitica*, (P.) Tul.)
Occ., N. J. Agr. Exp. Sta., Rep. 11, 1890, p. 349. (1891)
Cf. Cabbage and Turnip (Downy Mildew.)
White Rust (*Cystopus candidus*, (P.) Lév.)
Occ., N. J. Agr. Exp. Sta., Rep. 11, 1890, p. 350. (1891)
Treat. (rec.), N. J. Agr. Exp. Sta., Rep. 11, 1890, p. 350. (1891)
Cf. Cabbage and Turnip (White Rust.)

RASPBERRY.

(*Rubus* spp.)

Anthracnose (*Glœosporium Venetum*, Speg. = *Gl. necator*, Ell. & Ev.)
Descr. Illus., U. S. Dept. Agr., Rep. for 1887, pp. 357-360. (1888)
Ohio Agr. Exp. Sta., Bull. IV-6, pp. 124-126. (1891)
N. Y. Agr. Exp. Sta., Bull. 124, pp. 262-264. (1897)
Treat.(pos.), N. Y. Agr. Exp. Sta., Bull. 124, pp. 265-274. (1897)
Ky. Agr. Exp. Sta., Bull. 80, p. 259. (1899)
Conn. Agr. Exp. Sta., Rep. 23, '99, pp. 274-276. (1900)
Black Blight (*Fusarium* sp.?) ([105])
Cane-Blight (*Phoma* sp.?)
Descr. N. Y. Agr. Exp. Sta., Bull. 167, pp. 305-307. (1899)
Crown-Gall (Possibly identical with Crown-Gall of Peach, q. v.)
See Ohio Agr. Exp. Sta., Bull. 79, pp. 108-112. (1897)
Fire-Blight (Bacterial.)
Descr., Ohio Agr. Exp. Sta., Bull. IV-6, pp. 128-129. (1891)
Leaf-Spot (*Septoria Rubi*, Westd.)
See Blackberry (Leaf-Spot.)
Rust (*Cæoma* (*Uredo*) *luminatum*, Lk.; Syn. *Puccinia Peckiana*, Howe.)
See Blackberry (Rust.)

RICE.

(*Oryza sativa*, L.)

Blight (*Fungus indet.?*)
Descr., S. Car. Agr. Exp. Sta., Bull. 41, pp. 4-7. (1899)
Smut (*Tilletia corona*, Scrib.)
Descr. Illus., S. Car. Agr. Exp. Sta., Bull. 41, pp. 7-11. (1899)
Treat. (rec.), S. Car. Agr. Exp. Sta., Bull. 41, pp. 15-29. (1899)

ROSE. ([106])

(*Rosa* spp.)

Anthracnose (*Glœosporium Rosae*, Hals.)
Descr. Illus., N. J. Agr. Exp. Sta., Rep. 14, 1893, pp. 401-405. (1894)

Downy Mildew (*Peronospora sparsa,* Berk.)
Occ., N. J. Agr. Exp. Sta., Rep. 13, 1892, p. 282. (1893)
Leaf-Blotch (*Actinonema Rosae,* (Lib.) Fr.)
Descr. Illus., U. S. Dep. Agr., Rep. for 1887, pp. 366-368. (1888)
Treat. (pos.), Mass, Agr. Exp. Sta., Bull. 4, pp. 10-11. (1889)
N. J. Agr. Exp. Sta., Rep. 13, 1892, p. 281. (1893)
Leaf-Spot (*Sphaerella rosigena,* Ell.)
Occ., See note ([106])
Powdery Mildew (*Sphaerotheca pannosa,* (Wallr.) Lév.)
Descr., N. J. Agr. Exp. Sta., Rep. 13, 1892, p. 281. (1893)
Treat. (pos.), Mass. Agr. Exp. Sta., Bull. 4, p. 11. (1889)
N. J. Agr. Exp. Sta., Rep. 13, 1892, pp. 281-282. (1893)
Rust (*Phragmidium subcorticium,* (Schrank) Wint. and *Ph. speciosum,* Fr.)
Descr. Illus., U. S. Dept. Agr., Rep. for 1887, pp. 369-372. (1888)
Treat. (rec.), U. S. Dept. Agr., Rep. for 1887, pp. 371-372. (1888)
(pos.), See U. S. Dept. Agr., Exp. Sta. Rec., X-7, p. 651. (1899)
Twig-Blight (*Botrytis cinerea,* Pers.) ([107])

Rye.

(*Secale cereale,* L.)

Ergot (*Claviceps purpurea,* Tul.)
Descr. Illus., S. Dak. Agr. Exp. Sta., Bull. 33, pp. 40-43. (1893)
Treat. (rec.), N. C. Agr. Exp. Sta., Bull. 76, p. 20. (1891)
Rust (*Puccinia graminis,* P., and *P. Rubigo-vera,* (DC.) Wint.)
See U. S. Dep. Agr., Div. Veg. Phys. & Path., Bull. 16, pp. 42-45 & 60.
Cf. Oats and Wheat (Rust.)
Smut (*Urocystis occulta,* (Wallr.) Rabh.)
Occ. Illus., Mass. Agr. Exp. Sta., Rep. 9, 1891, p. 247. (1892)
Treat. (pos.), See Oats and Wheat (Smut.)
Stem-Blight (*Leptosphaeria herpotrichoides,* de Not.) ([108])

Salsify.

(*Tragopogon porrifolius,* L.)

Rot (Bacterial.)
Descr., N. J. Agr. Exp. Sta., Rep. 11, 1890, p. 351. (1891)
White Rust (*Cystopus Tragopogonis,* Tul.)
Occ., N. J. Agr. Exp. Sta., Rep. 15, 1894, p. 355. (1895)

Shaddock or Grape-Fruit.

(*Citrus Decumana,* Lour.)

See Lemon and Orange.

Snapdragon.

(*Antirrhinum majus,* L.)

Anthracnose (*Colletotrichum Antirrhini,* Stewart.)
Descr. Illus. Treat. (pos.), N. Y. Agr. Exp. Sta., Bull. 179. (1900)
Stem-Rot (*Phoma* sp.)
Descr. Treat. (rec.), N. Y. Agr. Exp. Sta., Bull. 179, pp. 109-110. (1900)

Sorghum.

(*Sorghum vulgare,* P.)

Blight (*Bacillus Sorghi,* Burrill.) ([109])
Descr., Kan. Agr. Exp. Sta., Rep. 1, 1888, pp. 281-301. (1889)
Treat. (rec.), Kan. Agr. Exp. Sta., Rep. 1, 1888, pp. 301-302. (1889)
Smut (*Cintractia Sorghi-vulgaris,* (Tul.) Clint. and *C. Reiliana,* (Kühn) Clint.)
Descr. Illus., Kan. Agr. Exp. Sta., Bull. 23, pp. 95-96. (1891)
Ill. Agr. Exp. Sta., Bull. 47, pp. 374-388. (1897)
Ill. Agr. Exp. Sta., Bull. 57, pp. 335-347. (1900)
Treat. (pos.), Ill. Agr. Exp. Sta., Bull. 47, pp. 405-406. (1897)
Ill. Agr. Exp. Sta., Bull. 57, pp. 345-346. (1900)

Spinach.

(*Spinacia oleracea,* Mill.)

Leaf-Blight (*Cercospora beticola,* Sacc.)
Descr., N. J. Agr. Exp. Sta., Rep. 11, 1890, p. 355. (1891)
Cf. N. J. Agr. Exp. Sta., Rep. 18, 1897, p. 303. (1898)

Miscellaneous Fungous Diseases.
- Anthracnose (*Colletotrichum Spinaceæ,* Ell. & Hals.)
- Downy Mildew (*Peronospora effusa,* (Grev.) Rabh.)
- Leaf-Spot (*Phyllosticta Chenopodii,* Sacc.)
- Scab (*Cladosporium macrocarpum,* Preuss).
- White Smut (*Entyloma Ellisii,* Hals.)

Descr. Illus., N. J. Agr. Exp. Sta., Bull. 70. (1890)
Treat. (rec.), N. J. Agr. Exp. Sta., Bull. 70, pp. 13-14. (1890)

Spruce.

(*Picea* spp.)

Brown Rot (*Polyporus sulphureus,* (Bull.) Fr.)
Dry Rot (*Trametes Pini,* (Brot.) Fr.)
Root-Rot (*Polyporus Schweinitzii,* Fr.)
Wet Rot (*Polyporus subacidus,* Pk.?)
} Descr. Illus., U. S. Dep. Agr., Div. Veg. Phys. & Path., Bull. 25. (1900)

Squash.

(*Cucurbita* spp.)

Anthracnose (*Colletotrichum lagenarium,* (Pass.) Ell. & Hals.)
See Melon (Anthracnose.)
Bacteriosis or Wilt (*Bacillus tracheiphilus,* Smith.)
See Cucumber (Bacteriosis.)

Downy Mildew (*Plasmopara Cubensis,* (B. & C.) Humphrey.)
See Cucumber (Downy Mildew.)
Fruit-Mold (*Macrosporium* sp.) ([110])
Powdery Mildew (*Erysiphe Cichoracearum,* DC. and *E. Polygoni,* DC.)
Descr. Illus., See Cucumber (Powdery Mildew.)
Treat. (pos.), N. Y. (Corn. Univ.) Agr. Exp. Sta., Bull. 35, p. 330. (1891)

Strawberry.

(*Fragaria* spp.)

Blight (*Micrococcus* sp.?)
Descr., Mass. Agr. Exp. Sta., Rep. 9, 1896, pp. 59-61. (1897)
Leaf-Blotch (*Ascochyta Fragariae,* Sacc.)
Descr. Illus., N. Y. (Corn. Univ.) Agr. Exp. Sta., Bull. 14, pp. 182-183. (1889)
Treat. (rec.), N. Y. (Corn. Univ.) Agr. Exp. Sta., Bull. 14, p. 183. (1889)
Leaf-Spot (*Aposphaeria,* sp.)
Descr. Illus., N. J. Agr. Exp. Sta., Rep. 14, 1893, pp. 329-330. (1894)
Treat. (rec.) N. J. Agr. Exp. Sta., Rep. 14, 1893, pp. 331-332. (1894)
Leaf-Spot (*Sphaerella Fragariae,* (Tul.) Sacc.)
Descr. Illus., U. S. Dep. Agr., Rep. for 1887, pp. 334-339. (1888)
N. Y. (Corn. Univ.) Agr. Exp. Sta., Bull. 14, pp. 171-181. (1889)
Leaf-Spot (*Sphaerella Fragariae,* (Tul.) Sacc.)
Treat. (pos.), U. S. Dep. Agr., Rep. for 1890, p. 397. (1890)
Ky. Agr. Exp. Sta., Bull. 31, pp. 7-12. (1890)
Md. Agr. Exp. Sta., Rep. 3, 1890, pp. 106-108. (1891)
N. C. Agr. Exp. Sta., Bull. 92, p. 133. (1893)
Conn. Agr. Exp. Sta., Bull. 115, p. 14. (1893)
Powdery Mildew (*Sphaerotheca Castagnei,* Lév.)
Descr., N. Y. Agr. Exp. Sta., Rep. 5, 1886, pp. 291-292. (1887)
Descr. Illus., Mass. Agr. Exp. Sta., Rep. 10, 1892, p. 239. (1893)
Treat. (rec.), N. Y. Agr. Exp. Sta., Rep. 5, 1886, p. 293. (1887)
Mass. Agr. Exp. Sta., Rep. 10, 1892, pp. 243-245. (1893)

Sugar-Cane.

(*Saccharum officinarum,* L.)

——*Coniothyrium melasporum,* (Berk.) Sacc. ([111])
——*Trichosphaeria Sacchari,* Mass. ([112]) ([114])
Miscellaneous Diseases.
- *Bacillus vascularum,* Cobb. ([113])
- *Macrosporium graminum,* Cke. ([113])
- *Strumella Sacchari,* Cke. ([113]) ([114])
- *Uromyces Kühnii,* Krüg. ([113])
- *Colletotrichum falcatum,* Went. ([114])
- *Thielaviopsis ethaceticus,* Went. ([114])

See U. S. Dept. Agr., Exp. Sta. Rec., X, pp. 56-57, '98, and XI, p. 759, 1900.

Sweet Potato.

(*Ipomœa Batatas,* Lam.)

Black-Rot (*Ceratocystis fimbriata,* Ell. & Hals.)
Descr. Illus., N. J. Agr. Exp. Sta., Bull. 76, pp. 7-13. (1890)
Journ. Mycol., Vol. VII, pp. 1-9. (1891)
Treat. (pos.), La. Agr. Exp. Sta., Bull. 30, p. 1089. (1894)
(rec.), U. S. Dept. Agr., Farm. Bull. 26, p. 21. (1895)
Java-Rot (*Lasiodiplodia tubericola,* Ell. & Ev.) ([115])
Soil-Rot (*Acrocystis Batatas,* Ell. & Hals.)
Descr. Illus., N. J. Agr. Exp. Sta., Bull. 76, pp. 14-18. (1890)
Treat. (pos.), N. J. Agr. Exp. Sta., Rep. 20, 1899, pp. 345-354. (1900)
Stem-Rot (*Nectria Ipomœae,* Hals.)
See Egg-Plant (Stem-Rot.)
Miscellaneous Diseases.
- Dry-Rot (*Phoma Batatae,* Ell. & Hals.)
- Leaf-Spot (*Phyllosticta bataticola,* Ell. & Mart.)
- Scab (*Monilochaetes infuscans,* Ell. & Hals.)
- Soft-Rot (*Rhizopus nigricans,* Ehrb.)
- Whit-Rot (*Penicillium* sp.)
- White Rust (*Cystopus Ipomœae-panduranae,* (Schw.) Farl.)

Descr. Illus., N. J. Agr. Exp. Sta., Bull. 76. (1890)
Md. Agr. Exp. Sta., Bull. 60. (1899)
Treat. (rec.), U. S. Dept. Agr., Farm. Bull. 26. (1895)
Md. Agr. Exp. Sta., Bull. 60. (1899)

Sycamore.

(*Platanus occidentalis,* L.)

Anthracnose (*Glœosporium nervisequum,* (Fckl.) Sacc.)
Descr. Illus., U. S. Dep. Agr., Rep. for 1888, pp. 387-389. (1889)
Treat. (rec.), U. S. Dep. Agr., Rep. for 1888, p. 389. (1889)
Cf. Journ. Mycol., Vol. V, pp. 51-52.
Gar. and For., X-488, pp. 257-258.

Tobacco. ([116])

(*Nicotiana Tabacum,* L.)

Blue Mold (*Fungus indet.*) ([117])
Brown Spot (*Macrosporium longipes,* Ell. & Ev.)
Descr., Journ. Mycol., Vol. VII, p. 134. (1892)
Cf. U. S. Dept. Agr., Exp. Sta. Rec., XII-4, p. 359. (1900)
"Damping-off" (*Alternaria tenuis,* Nees.) ([118])
Downy Mildew
- (*Peronospora Hyoscyami,* DBy.) ([119])
- (*Phytophthora Nicotianae,* de Haan) ([120])

Leaf-Blight (*Cercospora Nicotianae,* Ell. & Ev.)
Descr. Illus., Conn. Agr. Exp. Sta., Rep. 20, 1896, pp. 273-277. (1897)
Treat. (rec.), Conn. Agr. Exp. Sta., Rep. 20, 1896, pp. 277-278. (1897)

Pole-burn (*Fungi and Bacteria*). ([121])
Descr., Conn. Agr. Exp. Sta., Rep. 15, 1891, pp. 168-173. (1892)
Idem., Rep. 17, 1893, pp. 84-85. (1894)
Treat.(rec.), Conn. Agr. Exp. Sta., Rep. 15, 1891, pp. 180-184. (1892)
Powdery Mildew (*Erysiphe Cichoracearum*, DC., Syn. *E. lamprocarpa*, (Wallr.) Lév.) ([122])
Root-Rot (*Thielavia basicola*, Zopf.) ([123])
Stem-Rot (*Botrytis longibrachiata*, Oud.) ([124])
Descr., Conn. Agr. Exp. Sta., Rep. 15, 1891, pp. 184-185. (1892)
Treat.(rec.), Conn. Agr. Exp. Sta., Rep. 15, 1891, pp. 185-186. (1892)
White Speck (*Macrosporium tabacinum*, Ell. & Ev.)
Descr., Journ. Mycol., Vol. VII, p. 134. (1892)
Cf. Conn. Agr. Exp. Sta., Rep. 20, 1896, p. 276. (1897)

Tomato.

(*Lycopersicum esculentum*, Mill.)

Anthracnose (*Colletotrichum phomoides*, (Sacc.) Chester.)
Descr. Illus., Del. Agr. Exp. Sta., Rep. 4, 1891, pp. 60-62. (1892)
Cf. Del. Agr. Exp. Sta., Rep. 6, 1893, pp. 111-115. (1894)
Treat. (rec.), Me. Agr. Exp. Sta., Rep. for 1893, p. 155. (1894)
Blight (*Bacillus Solanacearum*, Smith.)
Descr. Illus., See Egg-plant, (Blight.)
Treat. (pos.), Md. Agr. Exp. Sta., Bull. 54, pp. 123-125. (1898)
Fla. Agr. Exp. Sta., Bull. 47, pp. 133-136. (1898)
Blight (*Sclerotium* sp.)
Descr., Fla. Agr. Exp. Sta., Bull. 21, pp. 25-27. (1893)
Ala. Agr. Exp. Sta., Bull. 108, pp. 28-29. (1900)
Treat. (pos.), Fla. Agr. Exp. Sta., Bull. 21, pp. 32-36. (1893)
Downy Mildew (*Phytopthora infestans*, DBy.)
See Potato (Downy Mildew.)
Droop (*Plasmodiophora Tomati*, Abbey.)
See U. S. Dept. Agr., Exp. Sta., Rec. VI-11, p. 1000. (1895)
Fruit-Rot (*Bacillus* sp.?) ([125])
Descr., Ala. Agr. Exp. Sta., Bull. 108, pp. 19-25. (1900)
Cf. N. Y. Agr. Exp. Sta., Rep. 3, 1884, pp. 379-380. '85.
Idem., Bull. 125, pp. 305-306. '97.
Leaf-Blight (*Cylindrosporium*, sp.)
Descr., N. Y. Agr. Exp. Sta., Rep. 14, 1895, p. 529. (1896)
Treat.(rec.), N. Y. Agr. Exp. Sta., Rep. 14, 1895, pp. 530-531. (1896)
Leaf-Mold (*Alternaria Solani*, (E. & M.) Jones & Grout)
Descr., Fla. Agr. Exp. Sta., Bull. 47, pp. 124-125. (1898)
Treat. (pos.), Fla. Agr. Exp. Sta., Bull. 47, pp. 125-127. (1898)
Leaf-Spot (*Septoria* sp.)
Descr. Illus., Del. Agr. Exp. Sta., Rep. 7, 1894-95, p. 123. (1895)
Ohio Agr. Exp. Sta., Bull. 73, p. 241. (1897)
Treat. (pos.), Ohio Agr. Exp. Sta., Bull. 89, pp. 120-121. (1897)
Ala. Agr. Exp. Sta., Bull. 108, pp. 32-33. (1900)

Scab (*Cladosporium fulvum*, Cke.)
Descr. Illus., U. S. Dep. Agr., Rep. for 1888, pp. 347-348. (1889)
Treat.(pos.), U. S. Dep. Agr., Sec. Veg. Path., Bull. 11, p. 47. (1890)
Ala. Agr. Exp. Sta., Bull. 108, p. 33. (1900)
Wilt (*Fusarium Lycopersici*, Sacc.) ([126])

Turnip.

(*Brassica compestris*, L. and *B. Rapa*, Linn.)

Brown Rot (*Pseudomonas campestris*, (Pam.) Smith.) ([127])
Descr. Illus., Iowa Agr. Exp. Sta., Bull. 27, pp. 130-134. (1895)
Cf. Cabbage (Brown Rot.)
Club-Root (*Plasmodiophora Brassicae*, Wor.)
Descr. Illus., See Cabbage (Club-Root.)
Treat. (pos.), N. J. Agr. Exp. Sta., Rep. 20, '99, pp. 354-367. (1900)
Downy Mildew (*Peronospora parasitica*, (P.) Tul.)
Occ., Mass. Agr. Exp. Sta., Rep. 8, 1890, p. 222, (1891)
Treat. (rec.), Mass. Agr. Exp. Sta., Rep. 8, 1890, p. 223. (1891)
Cf. Cabbage (Downy Mildew.)
Dry Rot (*Phoma Brassicae*, Thüm.?)
See U. S. Dept. Agr., Exp. Sta. Rec., XII-3, p. 256. (1900)
Leaf-Mold (*Macrosporium herculeum*, E. & M.)
Descr. Illus., N. Y. Agr. Exp. Sta., Rep. 15, '96, pp. 451-452. (1897)
Powdery Mildew (*Erysiphe Polygoni*, DC.)
Occ., N. Y. (Corn. Univ.) Agr. Exp. Sta., Bull. 61, pp. 305-306. (1893)
White Rust (*Cystopus candidus*, P.) Lév.)
Occ., Mass. Agr. Exp. Sta., Rep. 8, 1890, p. 222. (1891)
Treat. (rec.), Mass. Agr. Exp. Sta., Rep. 8, 1890, p. 223. (1891)
Cf. Cabbage (White Rust.)

Verbena.

(*Verbena* sp.)

Powdery Mildew (*Erysiphe Cichoracearum*, DC.)
Occ., N. Y. (Corn. Univ.) Agr. Exp. Sta., Bull. 37, p. 405. (1891)
Treat. (pos.), N. Y. (Corn. Univ.) Agr. Exp. Sta., Bull. 37, p. 405. (1891)

Violet.

(*Viola odorata*, L. and *V. tricolor*, L.)

Anthracnose (*Glœosporium Violae*, B. & Br.)
Occ., N. J. Agr. Exp. Sta., Rep. 11, 1890, p. 362. (1891)
Anthracnose (*Colletotrichum Violae-tricoloris*, Smith) ([128])
Descr., Mass. Agr. Exp. Sta., Rep. 11, '98, pp. 152-153. (1899)
Treat. (pos.), Mass. Agr. Exp. Sta., Rep. 11, '98, p. 153. (1899)
Chytridiose (*Cladochytrium Violae*, Berl.)
See U. S. Dep. Agr., Exp. Sta. Rec., XI-3, p. 261. (1899)

Downy-Mildew (*Peronospora Violae,* DBy.)
Occ., N. J. Agr. Exp. Sta., Rep. 11, 1890, p. 362. (1891)
Dry Rot (*Merulius lacrymans,* (Jcq.) Fr.)
See U. S. Dep. Agr., Exp. Sta. Rec., XI-10, p. 947. (1900)
Leaf-Blight (*Cercospora Violae,* Sacc.)
Occ. Illus., N. J. Agr. Exp. Sta., Rep. 15, 1894, pp. 384-386. (1895)
Treat. (rec.), N. J. Agr. Exp. Sta., Rep. 15, 1894, pp. 386-389. (1895)
Leaf-Mold or Spot Disease (*Alternaria Violae,* Gall. & Dorsett)
Descr. Illus. Treat., U. S. Dep. Agr., Div. Veg. Phys. & Path., Bull. 23. (1900)
Leaf-Spot (*Phyllosticta Violae,* Desm.)
Descr., Mass. Agr. Exp. Sta., Rep. 10, 1892, pp. 231-232. (1893)
Treat. (rec.), Mass. Agr. Exp. Sta., Rep. 10, 1892, pp. 232-235. (1893)
N. J. Agr. Exp. Sta., Rep. 15, 1894, pp. 386-389. (1895)
Root-Rot (*Thielavia basicola,* Zopf)
Descr., Conn. Agr. Exp. Sta., Rep. 15, 1891, pp. 166-167. (1892)
White Mold (*Zygodesmus albidus,* Ell. & Hals.)
Occ., N. J. Agr. Exp. Sta., Rep. 11, 1890, p. 362. (1891)

WALNUT.

(*Juglans regia,* L.)

Bacteriosis (*Bacteria*)
See U. S. Dep. Agr., Exp. Sta. Rec., Vol. XI, p. 261. (1899)
Leaf-Spot (*Ascochyta Juglandis,* Boltsh.) [129]

WATERMELON.

(*Citrullus vulgaris,* Schrad.)

Anthracnose (*Colletotrichum lagenarium,* (Pass.) Ell. & Hals.)
Occ., N. J. Agr. Exp. Sta., Rep. 13, 1892, p. 326. (1893)
Treat. (neg.), Del. Agr. Exp. Sta., Rep. 5, 1892, p. 79. (1893)
Cf. N. J. Agr. Exp. Sta., Rep. 13, 1892, pp. 326-330.
Del. Agr. Exp. Sta., Rep. 5, 1892, pp. 75-79.
Cf. Melon (Anthracnose.)
Downy Mildew (*Plasmopara Cubensis,* (B. & C.) Humphrey.)
See Cucumber (Downy Mildew.)
Leaf-Blight (*Cercospora Citrullina,* Cke.)
Occ., Ohio Agr. Exp. Sta., Bull. 105, p. 232. (1899)
Leaf-Mold (*Alternaria Brassicae,* Sacc., var. *nigrescens,* Pegl.)
See Melon (Leaf-Mold.)
Leaf-Spot (*Phyllosticta* sp., and (?) *Sphaerella* sp.)
Descr. Illus., Del. Agr. Exp. Sta., Rep. 5, 1892, pp. 75-78. (1893)
Wilt (*Neocosmospora vasinfecta,* (Atk.) Smith.)
Descr. Illus. Treat. (rec.), U. S. Dep. Agr., Div. Veg. Phys. & Path., Bull. 17. (1899)

WHEAT. [130]

(*Triticum vulgare,* L.)

Blight (*Mystrosporium abrodens,* Neum.) [131]
Chytridiose (*Pyroctonum sphaericum,* Prunet)
See U. S. Dept. Agr., Exp. Sta. Rec., VI-3, pp. 226-227. (1894)

Ergot (*Claviceps purpurea,* Tul.)
See Rye (Ergot.)
Foot-Rot (*Ophiobolus* & *Leptosphæria*) [132]
See U. S. Dept. Agr., Exp. Sta. Rec., IX-11, p. 1057. (1898)
Idem. X-7, p. 650. (1899)
Leaf-Spot (*Leptosphæria eustoma,* (Fr.) Sacc., var. *Tritici,* Garov.) [133]
Leaf-Spot (*Septoria graminum,* Desm.) [134]
See U. S. Dept. Agr., Exp. Sta. Rec., X-5, p. 452. (1899)
Mold (*Sphaeroderma damnosum,* Sacc. & Berl.) [135]
Rust (*Puccinia graminis,* P., and *P. Rubigo-vera,* (DC.) Wint.) [136]
Descr. Illus., Ind. Agr. Exp. Sta., Bull. 26. (1889)
Kan. Agr. Exp. Sta., Bull. 38, pp. 1-3. (1893)
Treat. (neg.), Iowa Agr. Exp. Sta., Bull. 16, pp. 326-329. (1892)
Kan. Agr. Exp. Sta., Bull. 46, p. 9. (1894)
(rec.), Idaho Agr. Exp. Sta., Bull. 11, pp. 33-34. (1898)
Cf. U. S. Dept. Agr., Div. Veg. Phys. & Path., Bull. 16. (1899)
Scab (*Cladosporium herbarum,* (Pers.) Link.) [137]
Scab (*Fusarium culmorum,* (Smith) Sacc.)
Descr. Illus., Del. Agr. Exp. Sta., Rep. 3, 1890, pp. 89-90. (1891)
Ohio Agr. Exp. Sta., Bull. 44, pp. 147-148. (1892)
Scab (*Gibberella Saubenetii,* (Mont.) Sacc., Syn. *Fusarium roseum,* Lk.)
Descr. Illus., Ohio Agr. Exp. Sta., Bull. 97, pp. 40-42. (1898)
Smut (*Tilletia fœtens* (B. & C.) Schrt., *T. Tritici,* (Bjerk.) Wint., and *Ustilago Tritici,* (P.) Jens.)
Descr. Illus., Kan. Agr. Exp. Sta., Rep. 2, 1889, pp. 261-267. (1890)
N. Dak. Agr. Exp. Sta., Bull. 1, pp. 9-20. (1891)
U. S. Dept. Agr., Farm. Bull. 75, pp. 6-8. (1898)
Treat. (pos.), N. Dak. Agr. Exp. Sta., Bull. 27, pp. 137-161. (1897)
Idaho Agr. Exp. Sta., Bull. 11, pp. 8-20. (1898)
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(2) Descr. Illus., Riv. d. Patolog. Veg., Vol. IV, pp. 293-303. '96.
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(3) See Bot. Gaz., Vol. XXX, pp. 48-58. 1900.
(4) *N. ditissima,* Tul.; Science, N. S., Vol. XII, pp. 297-299. 1900.
(5) Canada Exp. Farms,. Rep. for 1896, pp. 171-172.
(6) Descr., Bull. Torrey Bot. Club, Vol. XXVI, p. 373. '99.
(7) Descr. Illus., Landwirthsch. Jahrb., XXV, pp. 880-897. '96.
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(14) Cf. U. S. Dep. Agr., Exp. Sta. Record, X-5, p. 451. '99.
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(16) Descr. Illus., Bot. Gaz., Vol. XXVIII, pp. 177-192. '99.
(17) See U. S. Dept. Agr., Exp. Sta. Rec., VI-7, p. 646. '95.
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(27) Cf. N. Y. (Corn. Univ.) Agr. Exp. Sta., Bull. 49, pp. 314-316. '92.
(28) Descr. Illus., Bull. Bussey Inst., Pt. V, pp. 440-453. '76.
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(31) *Venturia Cerasi,* Ader.? Landwirthsch. Jahrb., XXIX, pp. 541-588. 1900.
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(55) See Beih. z. Bot. Centralbl., V-2, pp. 144-145. '95.
Centralbl. f. Bak. u. Par'kunde (Abth. 2), III, pp. 141-146. '97.
(56) See Zeitschr. f. Pflanz'kr., Vol. V, pp. 115-116. '95.
(57) Miscellaneous Diseases. Gardening, Vol. VI, p. 315. '98.
(58) See Amer. Naturalist, 1897, pp. 34-41.
(59) See Amer. Naturalist, 1896, pp. 797-804 & 912-924.
(60) Descr. Illus., Gard. Chron., XIX-484, pp. 434-435. '96.
(61) See Zeitschr. f. Pflanz'kr., Vol. IV, p. 109. '94.
(62) Cf. Bot. Gaz., Vol. XXIX, pp. 369-406. 1900.
(63) Descr., See Gar. and For., X-504, p. 414. '97.
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(68) Descr., Gard. Chron., XX-506, p. 271. '96.
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(70) Descr. Illus., Bull. Soc. Myc. d. France, VII-4, pp. 218-220. '91.
(71) Miscellaneous Diseases. Zeitschr. f. Pflanz'kr., Vol. IV, pp. 174-176. '94.
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(72) See Centralbl. f. Bak. u. Par'kunde (Abth. 2), III-1, pp. 10-13 & 60-64. '97.
Cf. Zeitschr. f. Pflanz'kr., Vol. VIII, pp. 37 & 142. '98.
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(76) Descr. Illus., Bull. Bussey Inst., No. 21, pp. 404-414. '76.

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Idem. Vol. V, pp. 88-97. '96.
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ON THE USE OF COMMERCIAL FERTILIZERS FOR FORCING-HOUSE CROPS.

By E. H. Jenkins and W. E. Britton.

The cultures herein described are in continuation of those begun in 1894, the results of which have appeared in the Reports of this Station for 1895, pp. 75 to 98; 1896, pp. 205 to 221; 1897, pp. 278 to 308, and for 1899, pp. 219 to 235.

Lettuce Cultures in Sterilized and Unsterilized Compost and in Coal Ashes and Peat Moss, with Various Fertilizers.

In the Report of this Station for 1899, page 224, is an account of lettuce cultures in coal ashes and peat moss to which chemical fertilizers were added. The crops were compared with those of cultures made in a rich compost, and showed that better lettuce could be grown in compost which was "sterilized"* than in the unsterilized compost. The studies were continued during the season of 1898-1899 and in 1899-1900.

For this purpose, plots 207 and 211 were filled with sterilized compost; plots 208, 209 and 210 were filled with coal ashes with which had been mixed 8 per cent. of peat moss, both having been sifted to pass a quarter-inch mesh. The same amounts of nitrogen were added to these three plots; in form of nitrate of soda to plot 208, cotton seed meal to plot 209, and ground bone to plot 210. Muriate of potash was added alike to the three plots and dissolved bone black to two of them. Plot 210 received no dissolved bone black, because the ground bone itself furnishes a large quantity of phosphoric acid. Twenty plants of Rawson's Hot-House and eight plants of Grand Rapids were set in each plot.

The crops on the two plots of sterilized compost were uniform in quality and much larger and better than any from the three plots filled with coal ashes. Where nitrate was used, the crop was the smallest.

*The sterilization was done by heating for 75 minutes in steam, as described in our Report for 1897, page 310. Examination in the laboratory has shown that this method destroys all molds and yeasts, with their spores, and with few—and in many cases with no—exceptions, destroys all forms of bacteria which will grow in presence of oxygen. With this explanation we use the term "sterilized" in this paper to describe soil treated by the method referred to.

Where cotton seed meal was used, the crop was larger by nearly one-quarter; and where bone was used, the weight of crop was two and a half times as great as from the nitrate plot.

The bone contained 4.9 per cent. of nitrogen and 20 per cent. of phosphoric acid.

The statistics of the cultures are given in Table I.

Table I.—Lettuce Cultures. Season of 1898–1899.

Number of Plot.	207	208	209	210	211
Soil	Sterilized Compost.	Coal ashes and Peat moss.	Coal ashes and Peat moss.	Coal ashes and Peat moss.	Sterilized Compost.
Fertilizers applied.					
Nitrate of soda, grams	----	221.5	----	----	----
Cotton Seed Meal, "	----	----	781.24	----	----
Ground Bone, "	----	----	----	718.62	----
Equivalent Nitrogen, "	----	35	35	35	----
Dissolved Bone Black, "	----	47.12	47.12	0	----
Equivalent Phos. acid, "	----	8	8	0	----
Muriate of Potash, "	----	107.5	107.5	107.5	----
Equivalent " "	----	50	50	50	----
Yield.					
First crop, fresh weight, in grams.					
Hot-house (20 plants)	3486	1474	1196	2522	3176
Grand Rapids (8 plants)	1328	566	538	1076	1135
Second crop.					
Hot-house (20 plants)	3234	510	1160	2606	3290
Grand Rapids (8 plants)	1048	280	566	936	1328
Total of both crops	9096	2830	3460	7140	8929

During the season of 1899-1900, lettuce was grown in six plots (206-211) on the east side of the forcing house. Plot 206 was filled with sterilized compost, 207 and 208 with the same kind of compost untreated; 340 grams of air-slaked lime were mixed with the soil of plot 208. Plots 209, 210 and 211 were filled with screened coal ashes, containing 8 per cent. of peat moss. Plot 209 was fertilized with 31 grams of nitrogen in the form of nitrate of soda, 7 grams of phosphoric acid in form of dissolved bone black and 44 grams of potash in form of muriate; plots 210 and 211 with 35 grams each of ground bone nitrogen and 50 grams of potash in form of muri-

ate. Plots 209 and 210 each received 100 grams of lime, while plot 211 had 340 grams.

Three crops of Rawson's Hot-House lettuce were raised in these plots. For each, the seeds were sown in flats; when large enough the young plants were pricked out in a bench filled with compost and set 4 × 4 inches. About three weeks later, or when large enough, the plants were set about eight inches apart each way in the trial plots. For each of the first two crops forty plants were set in each plot and twenty-eight plants for the third crop. The plants for the first, second, and third crops were set in the benches Dec. 8th, 1899, Feb. 7th and April 17th, 1900, respectively. No additional fertilizers were used for the second and third crops, and the third crop was a failure apparently for lack of plant food in the soil.

TABLE II.—LETTUCE CULTURES. SEASON OF 1899–1900.

NUMBER OF PLOT.	206	207	208	209	210	211
Soil	Sterilized Compost	Unsterilized Compost.	Unsterilized Compost.	Coal ashes and Peat moss.	Coal ashes and Peat moss.	Coal ashes and Peat moss.
Fertilizers applied.						
Nitrate of Soda, grams	----	----	----	193.9	----	----
Ground Bone, "	----	----	----	----	718.62	718.62
Equivalent Nitrogen, "	----	----	----	31	35	35
Dissolved Bone Black, "	----	----	----	41.25	0	0
Equivalent Phos. acid, "	----	----	----	7	0	0
Muriate of Potash, "	----	----	----	94.1	107.5	107.5
Equivalent " "	----	----	----	44	50	50
Slaked Lime, "	0	0	340	100	100	340
Yield.						
First crop, fresh weight, in grams	4938	3648	4313	2270	3490	3518
Second crop, fresh weight, in grams	6169	4628	5377	1274	4471	3622
Third* crop, fresh weight, in grams	2853	3004	2972	538	1217	623
Total of three crops	13960	11280	12662	4082	9178	7763
Number of marketable heads.						
First crop	14	5	10	0	7	7
Second crop	35	23	34	0	31	25
Third* crop	8	5	10	0	0	0
Total, three crops	57	33	54	0	38	32

* Only 28 plants to each plot in this crop. In first and second crops 40 plants were grown.

Table II gives the quantities of fertilizers added to the soils, the weights of the crops and the number of marketable heads. The sterilized compost (plot 206) to which no lime was added gave the best results and a considerably larger yield of good lettuce than the unsterilized compost. The third crops, on plots 207 and 208, were slightly larger than on 206. Plot 208, containing compost with a larger quantity of lime, gave a greater total weight of crop and better heads than 207, to which no lime had been added. In the coal ashes and peat fertilized with bone nitrogen, the addition of a large amount of lime was of no benefit, a heavier yield and better heads being produced upon the plot having a small quantity of lime. The quantities of lime added to plots 210 and 211 were equivalent to 650 and 2240 lbs. per acre respectively.

In none of these plots was the lettuce of first-class marketable quality. The heads were not as compact and firm as they should have been, and we are convinced that the texture or mechanical condition, both of the compost and also of the ashes and peat moss, makes it impossible to produce the best lettuce on them, however skillful the fertilization of the soil or management of the house.

CARNATION CULTURES, SEASON OF 1899-1900.

Somewhat similar cultures have been described in the Twenty-first Annual Report of this Station for 1897, page 293, and in the Twenty-third Annual Report for 1899, page 226. The house, benches, and plots, are the same as described in the Report for 1899, page 227, and figured on page 228 (plots 174 to 185) of the same Report.

The object of the cultures here described was chiefly to note the effects of lime.

Soils and Fertilizers—Six plots (174 to 180) were filled with a mixture of bituminous coal ashes and 5 per cent. by weight of peat moss, screened to pass a quarter-inch mesh. The same kinds and quantities of fertilizers were thoroughly mixed with the soil of each plot before filling. Slaked lime, in three different amounts, was applied to these plots in two series; plots 174 and 177 each receiving 100 grams of lime, plots 175 and 178, 220 grams each, and plots 176 and 179, 340 grams each. The three plots 177, 178 and 179 were given additional nitrogen in form of nitrate of soda on Nov. 7, 1899, and on Jan. 16, 1900.

The remaining plots (180 to 185) were filled with compost; the first three, 180, 181 and 182, received 100, 220 and 340 grams of lime respectively. No fertilizers were added. Plots 183, 184 and 185 received fertilizers in connection with the compost.

The ashes were obtained at the Lake Whitney pumping station of the New Haven Water Company. The plots were filled Sept. 20th and 21st.

Plants—Rooted cuttings of the Daybreak, Portia and Flora Hill varieties, bought in May were set out on the Station grounds, where they made good growth during the summer, and were pinched back frequently to make them stocky. The Portias were ideal in vigor, form and size when set in the house; the Daybreaks were good, vigorous plants, though rather scraggy in appearance, as is usual with this variety. Plots 174 to 182, and 185, each received eighteen plants, nine each of Daybreak and Portia. Fifteen Flora Hill plants were set in plot 183. Nine plants each of Flora Hill and Portia were set in plot 184. The plants were set in the benches on Sept. 21st and shaded for a few days to prevent wilting.

Notes during Growth—On Oct. 6, the plants had begun to grow and none had wilted badly. On Oct. 26, the plants looked well, the Portias appearing the most thrifty. Some rust could be found on the Daybreaks, and buds were forming. On Nov. 7, 62.5 grams of nitrate of soda (10 grams nitrogen) were applied to each of plots 177, 178, 179, 183, 184 and 185. The fertilizer was spread evenly over the surface of the soil just before a copious watering. On the night of Nov. 12, as the result of an accident, the temperature dropped rapidly to 30° F. inside the house. Carnations did not appear to be injured in the slightest degree. On Nov. 22, the first flower, a Daybreak, was picked from plot 176.

On Dec. 19, red spider could be found on some of the plants in plot 185.

On Jan. 16, 1900, 62.5 grams of nitrate of soda were added to plots 177, 178, 179, 183, 184 and 185. Through a mistake, plot 177 received 112 grams and 62.5 grams were applied to plot 180. The plants were looking well at this time and were giving a fair number of flowers. The stems were rather weak on both the Daybreaks and Portias. Portia variety produced small flowers, but the plants were large and healthy.

On Jan. 20, the plants continued vigorous. Red spider had increased on Daybreak plants in south end of house, and the worst infested plants had been sprayed twice with fir-tree oil. On Jan. 24, harvested 139 blossoms, of which 56 were Daybreak, 70 Portia, and 10 Flora Hill. These were the largest and finest of any flowers yet harvested. On Feb. 2, the Daybreaks were still somewhat scraggy, but the Portia plants were large and vigorous. There was almost no difference between the plants in the different plots. A few Portia blooms showed a tendency not to open, i. e., for the petals to cohere, but the cohesion was not complete. It was only noticed from the plots receiving an application of fertilizers Jan. 16. On Feb. 13, picked 132 excellent blossoms. On Feb. 21, again sprayed Daybreak plants with fir-tree oil to kill red spider. On Feb. 23, harvested 127 blooms of good quality.

Through March, April and May, the plants grew well and produced a good number of flowers. It was necessary to apply fir-tree oil from time to time to keep down red spider. The plants finally grew light-colored as if for want of plant food and the flowers gradually became smaller. At no time was there a striking difference between the plants of the various plots. On June 11, kerosene and water (15 per cent. kerosene) was sprayed upon the plants and the red spider mostly killed while the plants were uninjured. In each of plots 180 and 181, one of the supposed Daybreak plants proved to be some other variety. Not a single plant had to be replaced on account of stem-rot or for any other reason while the experiment was in progress. On June 30, the plants were removed from the house.

Harvesting—The same methods employed in previous experiments were practiced here. The flowers were picked twice each week as if for market and a careful record kept of the diameter of the flower, length of stem, and the total weight of fresh-cut flowers of each variety from each plot.

A statement of the fertilizers applied to, and the yields of flowers obtained from, the several plots will be found in the following tables.

Discussion of the Tables—It is evident from Table III that 100 grams of slaked lime per plot gave better results than a larger quantity, when used with a soil of coal ashes and peat moss and fertilizer chemicals, and that where larger quantities

TABLE III.—CARNATION CULTURES, 1899–1900. SOIL OF COAL ASHES AND PEAT MOSS.

NUMBER OF PLOT.	174		175		176		177*		178*		179*	
Fertilizers applied.												
Nitrate of Soda, grams	187.5		187.5		187.5		375		312.5		312.5	
Equivalent Nitrogen, "	30		30		30		60		50		50	
Dissolved Bone Black, "	70.68		70.68		70.68		70.68		70.68		70.68	
Equivalent Phosphoric acid, "	12		12		12		12		12		12	
Muriate of Potash, "	132.36		132.36		132.36		132.36		132.36		132.36	
Equivalent Potash, "	60		60		60		60		60		60	
Slaked Lime, "	100		220		340		100		220		340	
Yield.												
Number of blooms per plot	399		362		338		371		386		341	
Weight of blooms per plot, grams	2606		2334		2235		2510		2475		2089	
VARIETY	Day-break	Portia	Day-break	Portia	Day-break	Portia	Day-break	Portia	Day-break	Portia	Day-break	Portia
Number of blooms	169	230	148	214	156	182	134	237	134	252	106	235
Weight of blooms, grams	1332	1274	1144	1190	1160	1075	1097	1413	982	1493	811	1278
Average weight of blooms, "	7.2	5.5	7.7	5.5	7.4	5.9	8.1	5.9	7.3	5.9	7.6	5.4
Average diameter of blooms, inches	2.20	2.00	2.23	2.06	2.17	1.97	2.14	1.96	2.12	1.99	2.23	1.92
Average length of stem, inches	14	15	13	15	13	15	13	15	13	15	13	14
Average number of blooms per plant	18.7	25.5	16.4	23.7	17.3	20.2	16	26.3	14.9	28	11.7	26.1

* 187.5 grams supplied at time of setting plants; 62.5 grams supplied Nov. 7, 1899; the remainder added Jan. 16, 1900.

TABLE IV.—CARNATION CULTURES, 1899–1900. SOIL OF COMPOST.

NUMBER OF PLOT.	180		181		182		183	184		185	
Fertilizers applied.											
Nitrate of Soda, grams	62.5		0		0		125†	125†		125†	
Equivalent Nitrogen, "	10		0		0		20	20		20	
Slaked Lime, "	100		220		340		0	0		100	
Yield.											
Number of blooms per plot	363		346		401		140	263		374	
Weight of blooms per plot, grams	2244		2187		2417		1332	1783		2189	
VARIETY	*Day-break	Portia	*Day-break	Portia	Day-break	Portia	Flora Hill‡	Flora Hill	Portia	Day-break	Portia
Number of blooms	112	251	99	247	150	251	140	85	178	159	215
Weight of blooms, grams	963	1281	864	1323	1123	1294	1332	860	923	1192	997
Average weight of blooms, grams	8.5	5.1	8.7	5.3	7.4	5.1	9.5	10.1	5.1	7.5	4.6
Average diameter of blooms, inches	2.23	1.96	2.23	1.90	2.22	1.95	2.54	2.53	1.90	2.19	1.85
Average length of stem, inches	14	14	14	14	13	14	13	14	14	12	13
Average number of blooms per plant	16.6	27.8	11.	27.3	16.6	27.9	9.3	9.4	19.6	17.6	24.

* Calculated from eight plants. † Applied Nov. 7, 1899. ‡ Fifteen plants.

were used, the number of flowers was considerably decreased. This was true, both where the fertilizer was all mixed with the soil at time of setting the plants and also where doses of nitrogen were subsequently applied. In the compost soil the greatest number of flowers was harvested from plot 182, which received the maximum quantity of lime.

Portia yielded better than Daybreak, averaging from 20 to 28 flowers per plant in the various plots. In no case did Daybreak yield over 18 flowers per plant.

The chief differences noted from varying quantities of lime were in the varying number of flowers per plant rather than in any marked difference in the average size and weight of the flowers or in the length of stem. The stiffness of the stems was not noticeably affected by the lime.

A VEGETATION HOUSE ARRANGED FOR POT EXPERIMENTS.*

By W. E. Britton.

A small vegetation house built on the Station grounds in 1894 was figured and described in the Report of this Station for that year, page 75.

The vegetation house here described has proved to be convenient and well adapted for pot experiments on the effects of fertilizers, carried out during the spring and summer months.

The house was originally provided with three benches, each being between three and four feet in width and upon which the pots were placed, sometimes in three or four rows—the distance apart depending on the crop grown. The plants are usually watered by weight and the water-content kept between 50 and 70 per cent. of the water-holding capacity of the soil. Not only was it very laborious to move 200 of these pots, each weighing about 35 pounds, to the scales, but leaves or stalks were sometimes broken by contact with those in adjacent pots—when removing cultures from the center of the bench.

This vegetation house has now been remodeled so as to eliminate most of the danger and much of the labor involved

* This paper, in slightly different form, was read by the writer before the section of Horticulture and Botany of the American Association of Agricultural Colleges and Experiment Stations at New Haven, November 13th to 15th, 1900.

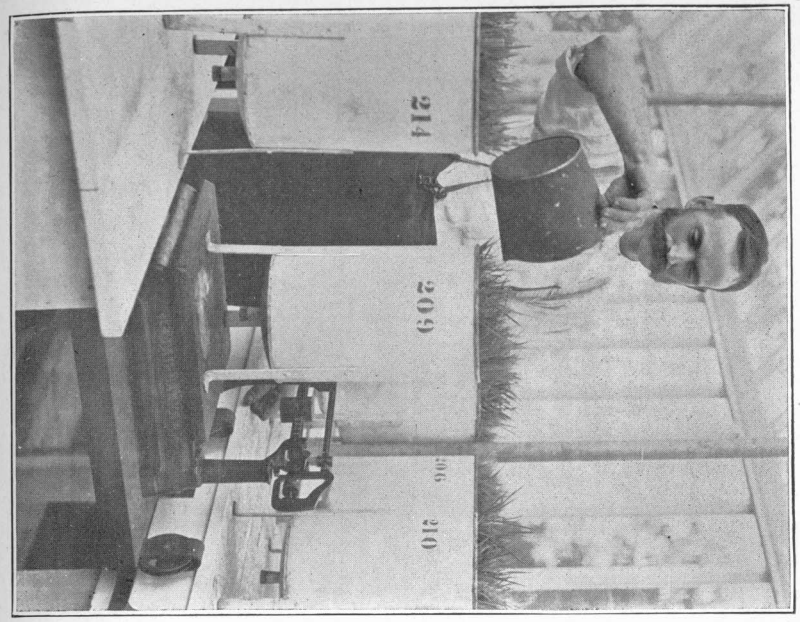


Fig. 1.—Method of watering pots in vegetation experiments. The truck carrying the scales and pot can be rolled along on the track between the benches.

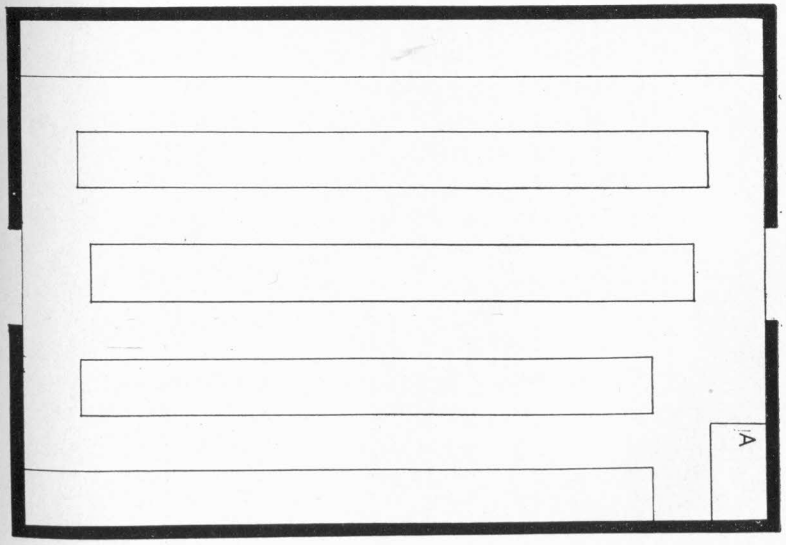


Fig. 2.—Plan of Summer Vegetation house, showing the five narrow benches with walks between. The water supply is at *A*.

in properly caring for the cultures. The three wide benches have been replaced by five narrower ones, each two feet wide, leaving four walks, each also two feet in width. These benches each carry two rows of pots, and are fitted with Lane's "O. N. T." steel track along the sides. Upon the track runs a small truck carrying the scales, the top of the scales being level with the tops of the benches. For ease in handling we have adopted Fairbanks' "Express Package Scales," which weigh only twenty-one pounds, and have a capacity of one ounce to fifty pounds. The scales are stable and conveniently arranged. The truck carrying the scales can be rolled along between the benches and a row of pots watered from each side, when the truck and scales may be transferred to the next walk, and so on through the house.

Sliding doors have been substituted for the swinging ones and the house is now well equipped for pot experiments. The plan of the house, showing the arrangement of the benches and a photograph showing the scales, truck, and method of watering, are reproduced on Plate VI.

TOP-GRAFTING NATIVE CHESTNUT SPROUTS.

By W. E. Britton.

During the spring and early summer of 1898, the writer grafted some chestnut sprouts near New Haven, and an account of the work was published in the Twenty-second Annual Report of this Station for 1898, page 276. A note regarding it is also found in the Twenty-third Report for 1899, page 239.

In the spring of 1900, observations were made on the proper time for setting cions in Connecticut, and further tests were made of the value of native sprouts as stocks upon which to graft the improved European and Japanese varieties. These tests were made on a tract of land in Windsor, owned by the Station, and partially covered by a three-years' growth of chestnut sprouts of suitable size for grafting.

Some of the largest sprouts were fourteen feet high and produced burrs in 1899, the third season of their growth. The soil is a very light and sandy loam containing little organic matter and consequently suffers severely from drouth. Besides chestnut, the natural growth is composed mostly of white or

grey birch, *Betula populifolia,* Ait., and pitch pine, *Pinus rigida,* Mill.

The season proved unfavorable in some respects for the grafting. On May 9th, when the unfolding leaves of the stocks were about two inches long, a severe frost killed all the new growth, the season's growth being thus retarded about two weeks and finally taking place from the adventitious buds which were dormant during the freeze. Such a freeze must impair the vigor of the stock, and probably more of the cions would have started into growth had it not occurred. During July and August a protracted drouth prevailed, and some of the cions were then killed after making considerable growth.

Nearly 1,000 cions of the Ridgely, Early Reliance, Coe and McFarland varieties were set by cleft-grafting between April 20th and June 12th. In most cases two cions were set in each stock and the stocks were from one to one and one-half inches in diameter where cut off. It will be seen from the accompanying tables that a larger proportion of the Ridgely cions lived and grew than of the other varieties. While the European species is probably easier to graft upon our native sprouts than the Japanese species, the difference should not be as great as shown in the table. In the opinion of the writer, this difference is in part accounted for by the fact that the Ridgely cions were taken by the writer from young grafted trees near New Haven and were in perfect condition, while all others had been purchased. Some had been taken from the tops of young nursery trees after they had been shipped several hundred miles. Many of the buds were bruised or crushed in packing and shipping. All such buds, when noticed, were discarded, but many died soon after being set, while the wood of the cion for a time remained alive, showing that many buds used were also damaged.

The condition of the buds and foliage of the grafted trees on the dates when grafting was done was as follows:

April 20. Buds barely starting.
" 27. Buds are increasing in size.
May 5. Buds opening. Advanced ones show an inch of green. Others show no green color.
" 11. Foliage of stocks about twice as large as on May 5th, but was killed by a freeze on the night of May 9th.
" 16. New leaves appearing from adventitious buds.
" 25. Leaves about one-third grown on stocks. Many cions starting.
June 4. Leaves nearly full grown.
" 12. Leaves full size.

TABLE I. RESULTS OF GRAFTING.

DATE OF SETTING.	No. of cions set.	No. of stocks.	No. of cions alive.	Average growth.	No. of stocks in which cions are alive.	No. of stocks where cions started to grow and then died.	Percentage of cions alive.	Percentage of stocks in which cions are alive.
COE.								
April 20	24	12	1	18 inch's	1	1	4	8
" 27	32	16	6	12 "	5	0	19	31
May 5	35	18	8	22 "	7	4	23	39
" 11	44	22	17	25 "	13	4	39	59
" 16	15	10	4	18 "	3	3	27	33
" 18	36	20	18	16 "	12	4	50	60
" 25	66	33	30	14 "	19	13	45	58
June 4	38	19	11	9 "	7	5	29	37
" 12	43	22	4	6 "	4	9	9	18
Total	333	172	99		71	43		
Average				15 "			30	41
EARLY RELIANCE.								
April 20	22	11	2	20 inch's	2	1	9	18
" 27	20	10	1	10 "	1	1	5	10
May 5	12	6	3	20 "	3	1	25	50
Total	54	27	6		6	3		
Average				17 "			11	22
MCFARLAND.								
April 20	28	16	2	12 inch's	2	0	7	13
" 27	22	11	4	18 "	2	0	18	18
May 5	41	21	14	23 "	9	4	34	43
" 11	16	8	5	24 "	4	0	31	50
" 16	36	18	15	25 "	12	1	41	66
" 25	30	15	7	19 "	5	9	23	33
June 4	32	17	3	9 "	3	7	9	18
" 12	12	6	0	0 "	0	1	0	0
Total	217	112	50		37	22		
Average				18 "			23	33
RIDGELY.								
April 27	26	13	8	68 inch's	7	0	31	53
May 5	20	10	11	69 "	9	0	55	90
" 11	44	22	17	63 "	14	1	39	67
" 16	54	27	20	61 "	15	0	37	55
" 18	48	24	35	65 "	22	0	73	91
" 25	28	14	25	47 "	14	0	73	100
June 4	66	33	33	24 "	22	0	50	66
" 12	66	33	26	19 "	19	0	38	54
Total	352	176	175		122	1		
Average				52 "			50	70

While the results of grafting are usually measured and recorded in the percentage number of cions which live and grow, yet *if one cion in each stock lived,* 50 per cent. of the whole number would be all that could be desired.

If both of the cions live and grow one should be cut away after the first year. The reason that two are used is to double the chances of having one live and grow upon the stock. It would seem advisable, therefore, to measure the results by the number of the stocks in which cions lived rather than by the number of the cions. The percentages of both are given in the preceding tables.

Sometimes both cions lived in all cases where either lived, as is the case with the McFarlands set April 27th. Or only one lived, as is the case with the McFarland and Coe cions set on June 4th and June 12th respectively.

A fair idea of the results which should follow careful work in chestnut-grafting may be obtained from the following figures, though some allowance should be made on account of the damaged buds in the Coe and McFarland varieties. The figures give the results of grafting between the 11th and 25th of May, 1900.

Date.	Variety.	Number of cions set.	Percentage of cions alive.	Percentage of stocks having living cions.
May 11th to May 25th.	Coe	161	40	52
	McFarland	82	32	49
	Ridgely	174	55	78
Total of three varieties		417		
Average "			42	60

If cions of the Japanese species can be cut from trees in the vicinity, thus avoiding the dangers of packing and shipping, a greater percentage may fairly be expected to live and grow.

A larger percentage of the cions of the Japanese varieties died after growth had commenced than of the European species.

A few Ridgely cions were broken off by winds, but besides these only one stock lost Ridgely cions after their growth had begun, while twenty-two lost McFarland and forty-three lost Coe cions which had already started to grow.

The results of the work of 1900 confirm the conclusions reached in 1898, that the best time for chestnut grafting in Connecticut is about the middle of May, when the stocks are well advanced in foliage.

EXPERIENCE WITH HYDROCYANIC ACID GAS IN BARN AND GREENHOUSE.

By W. E. Britton.

On June 5th, a bunch of timothy hay badly infested with the Clover-Hay Worm, *Pyralis costalis,* Fabr. was brought to the Station from a barn in North Guilford. The owner had previously covered a section of a bay, 11 x 16 x 5 feet, with blankets and treated with one pound of bisulphide of carbon. The hay in this section was solidly packed, considerable hay having been removed from on top of it, and the bisulphide fumes were not able to penetrate it. Consequently few of the caterpillars were killed.

A similar failure resulted from the use of hydrocyanic acid gas, under the writer's supervision. All livestock was removed from the barn, two stone-ware jars were placed in the bay under the blanket covering, and in each, 10 ounces of the strongest oil of vitriol were slowly mixed with one pint of water. A half pound of potassium cyanide was dropped into each jar, and the whole quickly covered. The barn was closed for nearly twenty-four hours and then thoroughly ventilated. The gas had failed to penetrate far into the solidly packed hay and had destroyed only a few of the caterpillars.

A brief account of this insect will be found on page 315 of this report.

On June 29th, after harvesting the tomato crop, as the "white fly," *Aleyrodes vaporariorum* Westwood, was very abundant, the tomato house was fumigated with hydrocyanic acid gas for the double purpose of killing the insects and of noting the effect of the gas on the mature tomato plant, which is said to be very susceptible to fumes of this kind. The gas was generated late in the afternoon and the house remained closed for thirty minutes. It was then ventilated, but no one was allowed to enter until the next morning.

The house contained 4,800 cubic feet, including the space occupied by the soil and benches. Three ounces of potassium cyanide per each 1,000 cubic feet of space were employed, the entire quantities of materials used being as follows:

Potassium cyanide	407.5	grams	= 14.4 ounces.
Sulphuric acid (97 per cent.)	750	c.c.	= 25 fluid ounces (1½ pt.)
Water	750	c.c.	= 25 " "

The gas was generated in two vessels, one at each end of the house and in the way above described.

The next morning not a living insect could be found in the house. As an insecticide the treatment was a success, but the tender portion at the top of nearly every plant in the house was more or less injured and some plants were damaged severely. The injury was somewhat greater near the generating vessels than in other portions of the house. A young potted plant standing on one of the benches was less injured than the older and taller plants.

In the experiments of Sanderson and Penny* at the Delaware Station, it was found that the gas diffuses very irregularly and that it is readily absorbed by the moisture of the soil or that adhering to plants.

It is evident that a quantity of cyanide smaller than 3 oz. per 1,000 cubic feet of space must be used in fumigating tomato houses.

ON THE BANDING OF TREES TO PREVENT INJURY BY THE FALL CANKER-WORM.†

By W. E. Britton.

For several years previous to 1897, the fruit and shade trees upon the Station grounds suffered annual defoliation by the Fall Canker-worm, *Anisopteryx pometaria* Harr. Not only did this insect attack apple, plum, and cherry trees, but large chestnuts and hickories were considerably damaged. It was not feasible to spray these large trees, as a special outfit containing a powerful pump would be required, and we decided to test the efficiency of bands coated with various substances. Accordingly in September, 1897, all trees on the grounds which had previously suffered injury from canker-worms, were banded. The bands consisted of a five-inch strip of black, tarred, roofing paper fastened around the tree and covered with some viscid

* Bulletin 26, New Series, Div. of Entomology, U. S. Dept. of Agriculture, p. 60, 1900.

† This paper, in slightly different form, was read by the writer before the Section of Entomology of the American Association of Agricultural Colleges and Experiment Stations, at New Haven, November 13th to 15th, 1900.

substance. Under the paper was placed a strip or layer of cotton batting to prevent insects from crawling beneath the paper; the cotton also allows some increase in the diameter of the trunk without breaking the paper band. The cotton was placed around the tree and fastened with a single tack. The paper was then drawn loosely around the cotton and fastened, where lapped, with three tacks. On a large tree a tack through the opposite side of the band may be necessary to hold it in place. The sticky substance was applied in a layer of about one-fourth of an inch in thickness around the upper portion of the band, leaving an inch or so of the lower edge of the paper uncovered to receive the ink, should it "run" on warm days.

Fifty-five bands were put on as described above, and two entire seasons passed before any had to be renewed. Several required new cotton and paper the third year where the old bands had been broken by the growth of the tree or torn off by storms. Fully one-half of the original bands are yet doing duty for the fourth season.

For coating the bands, printers' ink, pine tar, and Ermisch's Caterpillar Lime, were at first employed. The first was the most satisfactory, as it remained sticky for a longer period and did not penetrate the paper or the tree to such an extent as did the other substances. Some small fruit trees were injured by the pine tar and the caterpillar lime. Printers' ink, made up of "odds and ends" of different colors and grades left over from job work, is put up in ten pound cans and sold for protecting trees. Tree ink costs about fifteen cents per pound. It has a tendency to become hard on the outside in very cold weather and we looked about for something that could be used in connection with the ink to keep it in better condition. A local oil dealer advised a mineral oil known to the trade as "Black Virginia oil," used extensively as a lubricant for the axles of freight cars. A single gallon was purchased for twenty-five cents. This oil is non-drying and does not thicken with the cold. When mixed with printers' ink the preparation remains sticky for a long time, and though it finally hardens brushing with the oil restores it to a sticky condition. The oil when used alone as a coating for bands is not viscid enough to stay in place, but collects on the leeward side of the tree during a storm.

Though the bands were at first applied during the month of September according to the advice sometimes given in books, I have never known the adult moths to appear before November and usually they do not appear until there comes a warm day after the ground has been frozen. They are also seen on warm days during December and January. The bands must be kept viscid also through the spring and early summer or the caterpillars will ascend the trees after the eggs hatch. A strip of wire netting tacked by its upper edge around the tree and making a small angle with the trunk, was also given a trial and found to be quite as effectual as a sticky band in preventing the ascent of the females—but immediately after hatching, the young caterpillars crawl through the meshes and up the tree.

This season, Bowker's "Bodlime" has been given a trial and bids fair to give satisfaction, though it shows a tendency to "run" down the tree and is rather too light-colored.

The "Expansive Tree Protector," manufactured at Rochester, N. Y., has also given good satisfaction, and the viscid substance being under cover lasts almost the entire season without renewing.

It is certain that by the use of such bands as I have above described, the ravages of the Fall Canker-Worm, if not entirely, may be largely, prevented and the foliage kept sightly through the season. Many other leaf-eating and sucking insects are also kept away from the trees.

MISCELLANEOUS NOTES ON INSECTS AND INSECTICIDES.

By W. E. Britton.

The following notes have been suggested by personal observation and correspondence as well as by direct experiment. Species injurious in other localities, but unknown to many Connecticut farmers and fruit growers, are constantly appearing and injuring their crops. The more important of these pests have been noted each year in the Report of this Station. There is still great need of field observations regarding the insects of our State, and no person is in a better position to make such observations than the grower. Familiarity with the pests that attack his crops cannot be otherwise than advantageous to the agriculturist. The Station is prepared at all times to determine

insects and give such information regarding them as will enable growers to employ the best treatment known in fighting them. Specimens should be collected and packed with some of their food plant in a tin, wooden or pasteboard box, and sent by mail to the Station. If sent in a letter the specimens are liable to be so crushed that recognition is impossible. The mailing box only needs to be strong enough to prevent crushing. Ventilation is unnecessary, as the box contains all the air needed by the insects in transit. Do not be afraid of sending too many specimens. At least a dozen should be gathered if they can be found, and if the insects are accompanied by a sample of their work and notes regarding it, so much the better. During the past season we have received for identification more insects than ever before in a single year. Besides the information imparted to the growers, facts are here recorded about the distribution and spread of injurious species, injury and treatment, which will enable us to be of greater service to others. Each farmer, therefore, should feel that in reporting injurious insects, he is not only gaining information himself, but is indirectly giving real assistance to others. A large proportion of the specimens received have been scale-insects. On pages 316 and 317 is a list of the species received for identification between Oct. 31st, 1899 and Oct. 31st, 1900.

The Clover-Hay Caterpillar—*Pyralis* (*Asopia*) *costalis* Fabr.

Specimens of this insect infesting timothy hay were received at the Station from North Guilford on June 5th. Two days later the writer made a personal visit to the infested barn. Many caterpillars nearly full-grown were found in the mow, and the floor was covered with their excrement. A large number had pupated, and in many places on removing the hay the siding of the barn next the mow was seen to be literally covered with the cocoons.

Though this insect is known as the Clover-Hay Caterpillar, it feeds on almost any kind of hay, and in this case the only uninfested hay in the barn was second-crop clover, which had been stored on the cross-plates over the floor-way and not in contact with the mow. This was cut late in the season and

INSECTS SENT TO THE STATION FOR IDENTIFICATION.

Date.	Name.	Host.	Locality.	Remarks.
1899				
Nov. 8	Cherry Scale, *Aspidiotus forbesi* Johns.	Apple	New Canaan	Received from Penn., on nursery stock.
" 22	San José Scale, *Aspidiotus perniciosus* Comst.	Pear	"	Received from New York State.
Dec. 1	——— *Læmophlæus pusillus* Sch.	Wheat Middlings	New Haven	Infesting stored samples.
" 8	——— *Aspidiotus ostreæformis* Curtis.	Pear	New Canaan	Received from New York State.
" 20	San José Scale, *Aspidiotus perniciosus* Comst.	Peach	Milford	Fairly abundant on twigs.
1900				
Jan. 13	Oyster-Shell Bark-Louse, *Mytilaspis pomorum* Bouché	Butternut	Milford	Fairly abundant on twigs. Egg stage.
" 23	Scurfy Bark-Louse, *Chionaspis furfurus* Fitch.	Apple	Stratford	Fairly abundant on twigs. Egg stage.
" 24	Scale, *Kermes* —— ?	Spiræa	New Haven	Material insufficient for identification.
" 24	False Scorpion, *Chelifer cancroides* L.		"	
" 30	Oyster-Shell Bark-Louse, *Mytilaspis pomorum* Bouché	White Birch	"	On young sprouts. Egg stage.
Feb. 1	Red Scale, *Aspidiotus aurantii* Mask.		New Canaan	On greenhouse plant.
" 6	Oyster-Shell Bark-Louse, *Mytilaspis pomorum* Bouché	Lilac	New Haven	On twigs. Egg stage.
" 26	San José Scale, *Aspidiotus perniciosus* Comst.	Japan Plum	Shelton	Quite abundant on twigs.
Mar. 23	Oyster-Shell Bark-Louse, *Mytilaspis pomorum* Bouché	Lilac	New Haven	On twigs. Egg stage.
" 23	A Tree Hopper, *Membracis binotata* Say	Bittersweet	"	Egg stage.
Apr. 6	Scurfy Bark-Louse, *Chionaspis furfurus* Fitch	Apple	Norwichtown	On twigs. Egg stage.
" 9	San José Scale, *Aspidiotus perniciosus* Comst.	Peach	South Norwalk	Mostly dead; immature.
" 11	Putnam's Scale, *Aspidiotus ancylus* Put.	Black Currant	New Haven	Few alive. A fungus present.
" 24	Hemispherical Scale, *Lecanium hemisphæricum* Tar.	Orange	Milford	On orange leaves under glass; not mature
May 1	San José Scale, *Aspidiotus perniciosus* Comst.	Peach	Lebanon	On twigs.
" 2	Mite, —— —— ?	Peach	Stratford	Red eggs around buds
" 10	Scurfy Bark-Louse, *Chionaspis furfurus* Fitch	Apple	Melrose	Egg stage.
" 12	Scale, *Lecanium* —— ?	Rose	Middletown	Material insufficient for identification.
" 14	Buffalo Beetle, *Anthrenus scrophulariæ* L.	Tulip	West Cornwall	Both sexes in flowers.
" 21	Scurfy Bark-Louse, *Chionaspis furfurus* Fitch	Pear	Derby	Eggs just hatching.
" 22	Forest Tent Caterpillar, *Clisiocampa disstria* Hübn.	Apple	Wallingford	Half grown caterpillars.
" 26	Mite, *Phytoptus quadripes* Shimer	Silver Maple	New Canaan and Allenhurst, N. J.	Forming galls on leaves.
June 3	Scurfy Bark-Louse, *Chionaspis furfurus* Fitch	Pear	Somerville	Just hatched.

INSECTS SENT TO THE STATION FOR IDENTIFICATION.

Date.	Name.	Host.	Locality.	Remarks.
June 3	Elm Scale, *Gossyparia ulmi* Geoff.	Elm	New Haven	Infesting street trees.
" 5	Clover-Hay Caterpillar, *Pyralis (Asopia) costalis* Fabr.	Timothy hay	North Guilford	Barn badly infested.
" 5	Grape Plume Moth, *Oxyptilus periscelidactylus* Fitch	Grape	Yalesville	Injuring tips of new growth.
" 12	Apple Plant Louse, *Aphis mali* Koch	Apple	New Haven	Injuring tips of new growth.
" 26	White Pine Weevil, *Pissodes strobi* Peck	White Pine	New Haven	Injuring the leader of pine-tree. Over 30 larvæ found in stem two inches long.
July 5	——— *Anomala luticola* Fabr.	Grape	Suffield	Adults feeding on foliage.
" 6	San José Scale, *Aspidiotus perniciosus* Comst.	Pear	Bridgeport	On young fruit.
" 12	Abbot Sphinx, *Thyreus abbottii* Swains.	Grape	"	Larvæ feeding on foliage.
" 23	Striped Blister Beetle, *Epicauta vittata* Fabr.	Beet, Tomato	Yalesville	Adult feeding on foliage.
" 25	Red-Humped Caterpillar, *Œdemasia concinna* S. & A.	Apple	Norwichtown	Larvæ feeding on foliage.
" 30	Saw-toothed Grain Weevil, *Silvanus surinamensis* L.	Buckwheat Flour	New Haven	Adults, larvæ, and pupæ present.
Aug. 13	Rose Scale, *Diaspis (Aulacaspis) rosæ* Sand.	Rose	Groton	Scales of both sexes present.
" 22	Squash Lady-bird, *Epilachne borealis* L.	Melon	Bridgeport	Larvæ eating leaves.
" 17	Brown Colaspis, *Colaspis brunnea* Fabr.	Grape, Strawberry	Mt. Carmel	Adults injuring foliage.
" 17	Squash-vine Borer, *Melittia ceto* Westw.	Melon	"	Larva boring in stem.
" 17	Striped Blister-Beetle, *Epicauta vittata* Fabr.	Potato	"	Adults injuring foliage.
" 17	Black Blister-Beetle, *Epicauta pennsylvanica* DeG.	Beet	"	Adults injuring foliage.
Sept. 6	San José Scale, *Aspidiotus perniciosus* Comst.	Pear, Plum	New Haven	Few individuals on bark.
Oct. 1	Scurfy Bark-Louse, *Chionaspis furfurus* Fitch	Pear, Apple	Orange	Both sexes present. Females have produced eggs.
" 5	Apple Plant Louse, *Aphis mali* Koch	Apple	Newington	Winged and wingless forms present.
" 10	Mite, *Phytoptus* —— ?	Peach	South Glastonbury	Supposed to be the cause of a lead-colored appearance of the leaves. Mites were found around the buds and under the bud scales.
" 17	" " ——*	Peach	New Britain	
" 19	Scurfy Bark-Louse, *Chionaspis furfurus* Fitch	Pear	Hartford	Egg stage.
" 30	Cabbage Plusia, *Plusia brassicæ* Riley	Lettuce	Hamden	Larvæ devouring lettuce in greenhouse.

* Same as preceding and believed to be an undescribed species.

probably did not contain the eggs of the species when put into the barn.

The unsuccessful efforts to destroy the insect have been described on page 311 of this report.

The owner removed the hay from the barn and stacked it in the woods a long distance from any hay-field to watch the development of the insect. After cleaning out the barn it was thoroughly sprayed with kerosene emulsion. This application killed some of the caterpillars, but did not destroy the pupæ, which adhered to the side of the barn in great numbers. Consequently the moths were soon abundant, and the owner delayed filling the barn as long as possible, until July 15th, when nearly all had disappeared. In the stack the first young caterpillars were found September 1st, and were only about one-eighth of an inch in length, nearly transparent and quite numerous. Caterpillars could not be found in the barn until two or three weeks later.

Caterpillars brought to the laboratory June 5th pupated at once and the first moths appeared on June 18th. From pupæ taken at the barn June 7th and placed in breeding cage, the first adult emerged June 16th.

This insect is a European species, described by Fabricius over a hundred years ago. According to Lintner* the first account of its injury in this country was given in 1866 by B. D. Walsh, first State Entomologist of Illinois. The following year Prof. C. V. Riley studied the insect in Missouri, and published an account of his observations in his sixth report as Entomologist of that state, page 102. It was thought that the caterpillars fed only upon old hay, and that by cleaning out the barn thoroughly and not allowing the new hay to come in contact with the old, that injury would be forestalled; that salting the lower portion of the stack or mow tends to preserve the hay against attack.

More recent investigations have been made by Webster,† who placed growing clover in the breeding cages and eggs were deposited in the heads. He infers that eggs may be deposited on clover in the field and the larvæ carried to the stack or mow in the cured hay. The egg-laying habit should be further

* Eleventh Report of New York State Entomologist, p. 149, 1895.

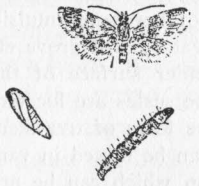
† Insect Life, Vol. iv, p. 121, 1891.

studied, for upon it depends, in a large measure, the methods to be employed in combating the insect.

The caterpillar is half an inch in length and of a dirty greenish-brown color, sometimes smooth and sometimes bearing a few scattered whitish hairs; head reddish; spins a whitish web and wriggles when disturbed; often suspends itself by a thread. The pupa is enclosed in a web-like case usually fastened to a straw or to the side of the barn.

The adult is a pretty moth, having a wing expanse of about three-fourths of an inch, of a delicate lilac-purple color, with marginal fringe and costal spots of golden-yellow. The costal spots extend across the front wings in some specimens and appear as bands.

The adult moth, caterpillar, and naked pupa are shown in the accompanying illustration.



The Clover-Hay Caterpillar, *Pyralis (Asopia) costalis* Fabr.

Elm Scale—*Gossyparia ulmi* Geoff.

Many of the elm trees in the western part of the city of New Haven were infested by this insect in 1900. The fact was first brought to my attention on June 3rd, by Mr. F. Chillingworth, who requested me to furnish a brief account of the insect for publication in the local papers. The following was prepared, and later appeared in one of the evening papers:

"Your communication and the accompanying specimens have been received. The insect is known as the Elm Scale, and its scientific name is *Gossyparia ulmi* Geoff. It is an imported species and commonly attacks the elm in Europe, where it is also said to occur upon the alder.

The elm scale was first observed in this country at Rye, N. Y., in 1884, and now seems to be quite thoroughly distributed over the United States. The insect is one of the 'soft scales' and has no 'shell' or covering. It collects in clusters at the forking of the twigs and in

the crevices of the bark, occurring mostly on the under sides of the branches. The bodies of the scales are dark-brown in color with margins of a white waxy substance having a fibrous structure resembling cotton which is secreted by the insects. The females are scarcely more than an eighth of an inch in length and bring forth living young instead of producing eggs. 'Honey dew' is exuded in great quantities and often drips upon the ground from badly infested trees. Two years ago my attention was called to a small tree near the corner of Prospect and Canner streets, which was infested by this pest. An application of strong soap-suds destroyed the parasites at the time, though a few are now present on the same tree.

An examination of the elm trees on West Chapel street near Norton street and Winthrop avenue, shows that quite a large number are at present infested. These are mostly young trees and the presence of numerous dead twigs indicates that the trees have already suffered some injury. Where the branches are literally covered with scales, as was the case with one elm on West Chapel street, injury is sure to follow. Just how much damage may be done to the trees of New Haven we cannot foretell and to predict would be only speculation. As the pest can easily be destroyed, it seems unwise to run the risk of any serious injury. A spray of kerosene emulsion or whale-oil soap (one pound in five gallons of water) will prove effective. The liquid should be thrown against the under surface of the leaves and branches, as it is there that most of the scales are located. If many trees are to be sprayed the least expensive form of treatment is to apply kerosene and water. The two liquids can be mixed in varying proportions by means of a special form of pump which can be procured from the manufacturers, Deming & Co., of Salem, Ohio, and the Goulds Mfg. Co., of Seneca Falls, N. Y. A mixture containing 15 per cent. of kerosene will probably kill all scales with which it comes in contact without injury to the foliage."

Some of the trees mentioned above were sprayed with whale-oil soap as directed and the scales killed. The writer used 10 and 15 per cent. of kerosene in water against the insect, both being effective in killing the scales without injuring the elm leaves.

Female scales brought to the laboratory June 3rd gave birth to living young on June 18th.

This insect is mentioned on page 336, and figured in Plate X, facing page 338 of this Report.

The Cabbage Plusia, *Plusia brassicæ* Riley, was found feeding on lettuce in several forcing houses near New Haven in

October. Handpicking was practiced, but caterpillars subjected to a spray of 15 per cent. of kerosene in water were killed.

Book-lice, *Atropos divinatoria* Fabr., were injuring museum specimens of corn in ground glass-stoppered jars at the Station on June 20th. The outer surface of kernels of the whole ears had been eaten off so as to render the variety entirely unrecognizable. Several samples were thus injured. The jars were fumigated with carbon bisulphide and the insects killed.

Apple worm, larva of the Codling Moth, *Carpocapsa pomonella* L., was found feeding inside an Abundance plum. The Abbott Sphinx, *Thyreus abbottii* Swains, was received from Bridgeport, where the larva was devouring the foliage of the grape. *Anomala lucicola* Fabr., a small brown beetle, was reported from Suffield as injuring grape leaves, and a lighter-colored species, *Colaspis brunnea* Fabr., attacked the grape and strawberry at Mount Carmel. The Forest Tent Caterpillar, *Clisiocampa disstria* Hübn., was received from Wallingford, where it was feeding upon apple foliage. The Grape Plume Moth, *Oxyptilus periscelidactylus* Fitch, caused injury by feeding in the unfolding leaves of the grape vine at Yalesville. The larva draws the young leaves together with a web to form a nest. As it usually eats away the bud, the season's growth is arrested. In a small plantation the caterpillars may be crushed inside their nests, but this as well as the other leaf-eating species just mentioned, may be destroyed by spraying the foliage with Paris green—1 lb. in 150 gallons of water.

Kerosene and Water.

This insecticide has been tried on various plants and trees during the season. In all cases it was applied with a small pail pump manufactured by the Deming Co. of Salem, Ohio. Mr. A. B. Plant sprayed pear trees June 10th, using 10 and 15 per cent. of kerosene. The foliage was uninjured by either strength, but it was too late in the season to be successful in killing the Pear Psylla, *Psylla pyricola* Först. Mr. Plant also used the 15 per cent. mixture against the purple aphis, *Aphis mali* Koch, on young apple twigs. Both the twigs and lice were destroyed.

The writer used the 10 per cent. mixture successfully against the Oyster-Shell Bark-Louse June 23rd, on an infested tree

of Kilmarnock Willow; the insects were killed and the foliage uninjured. On the same day some ornamental shrubs of Spiræa (*S. Van Houttei*) and Japanese Quince, *Cydonia Japonica,* were treated with a 10 per cent. mixture to kill Aphis. Neither leaves nor lice were destroyed. Dr. Sturgis used 15 per cent. on *Spiræa* and killed the lice without harming the foliage. Sweet peas were injured by 15 per cent. and lice killed. On July 28th squash vines at the Station were sprayed with a 10 per cent. mixture to kill young squash bugs. The spray was effective against the bugs and in a few places the squash leaves were injured slightly around the margins. On July 28th the writer placed one hundred elm leaf-beetle pupae in each of three wire baskets and sprayed with 10, 15, and 20 per cent. respectively. Not a single beetle emerged. Both 10 and 15 per cent. mixtures killed the elm scale without harming the foliage.

In the green-house, kerosene with water has been used on many different plants. Fifteen per cent. killed red spider on carnations and the plants were unharmed. The same mixture was successful in killing the white fly, *Aleyrodes vaporariorum* Westwood, in the tomato house and the plants were not injured.

On the Station grounds whale-oil soap (1 lb. in 5 gallons of water) was used as a spray on *Rudbeckia,* poppies, and broad beans which were attacked by lice. The poppies were severely and the beans slightly injured by the application. The lice were killed.

CAN WRAPPER LEAF TOBACCO OF THE SUMATRA TYPE BE RAISED IN CONNECTICUT?

By E. H. Jenkins.

For the past eight years this Station has carried out experiments on the fertilization, curing and fermentation of wrapper-leaf tobacco. These experiments have been made at Poquonock, with the coöperation of the Connecticut Tobacco Experiment Co., an association of tobacco growers, and on land belonging to this company which has been placed at the disposal of the Station for a term of years. During the whole time the field work has been entirely under the direction of Mr. John A. DuBon, a tobacco grower of many years' successful experience.

The results of this work have been annually published in the Report of the Station.

The main object of experiment in 1900 was to determine whether wrapper leaf tobacco of the Sumatra type could be raised in this State, which would compare favorably with imported Sumatra.

The Division of Soils of the U. S. Department of Agriculture coöperated with the Station in planning and executing these experiments and bore a part of the expense for the labor involved in them.

It was determined to shade the land on which the Sumatra leaf was raised, as has been already successfully practiced in Florida. The reasons for this will appear later. With such suggestions as we were able to get from Prof. Whitney and Mr. Floyd and the printed account of work in Florida, Mr. DuBon planned and put up the shade as follows:

It consisted of a frame, the top being nine feet from the ground, carrying a cheese-cloth covering on top and sides.

The frame is 490 feet long and 30 feet wide at the top, the slanting sides and ends making the extreme length and width 496 feet and 36 feet respectively. The whole rests on three rows twelve feet apart of 4″ × 4″ spruce posts, sunk three feet in the ground and standing ten feet apart, center to center, in the rows. The posts of the center row are vertical, those on the outside rows all slant inwards, so that while the tops are 15 feet from the center row, at the surface of the ground the distance from the center row is 18 feet.

Each outside post is nailed to the corresponding center post by a 2″ × 4″ scantling about 16 feet long, fastened to the sides of the posts, with the edge of the scantling flush with the top of the posts. The posts in each row are fastened together by 2″ × 4″ scantling, 20 feet long, nailed flat on top of the posts. Scantling 2″ × 5″ and 20 feet long are also nailed to the outer rows of posts close to the ground, on the outside, the length of the plot.

At one end is an eight-foot doorway, to be covered with cheese-cloth, through which a team may enter.

This whole framework is covered with a thin cheese-cloth sewed into strips of convenient size. It is to be fastened to the frame, wherever it bears on it, with laths tacked on the

outside. Two strips of cheese-cloth, where they come together, may be fastened by the same lath.

The building and covering of the frame was finished May 18th. The appearance of the structure is shown in Plate VII facing page 328.

The ground was prepared for the crop as follows:

After the harvest of 1899 the field was plowed, harrowed and sown with rye. Later the stalks from the last tobacco crop were put on the land.

After plowing in the spring of 1900, there were sown broadcast, *per acre,* 800 pounds of cotton hull ashes, 1800 pounds of cotton seed meal, 200 pounds of castor pomace and 200 pounds of Essex brand dry fish. This was harrowed in on May 3d.

Sumatra seed, understood to have been raised in Florida from seed directly from Sumatra, was provided by the Division of Soils, U. S. Department of Agriculture. This was sown in the beds in the usual way, but evidently is slower to grow and needs more heat at first than the Connecticut Havana seed.

The field, outside the shade, was set in the usual way with "Conn. Havana" tobacco plants.

One-half the area under shade was set with plants of this variety, the other half with plants from the Sumatra seed described above.

Both varieties under shade were in rows about 3¼ feet apart and the plants stood 12 inches apart in the row. This is much closer planting than is commonly practiced. The usual distance is about 18 inches apart in the rows, which are themselves 3½ feet apart.

The planting was finished June 9th by Mr. DuBon, who cared for the crop through the growing season.

The occasional wind and rain storms of the summer did no serious damage to the cheese-cloth except where, through errors in fastening, it chafed badly in the wind. To make repairs required perhaps a day's work of three or four men during the season. After harvest came a very severe wind storm, following the Galveston hurricane, which blew down trees and did considerable damage, but did not injure the cheese-cloth shade at all.

The cover was a perfect protection against insect pests. Cutworms did some damage to the young plants, but no flying

insects preyed on the tobacco. At harvest it was very hard to find a leaf which showed insect bites.

The tobacco was also perfectly protected from wind-whipping and from light hail.

The temperature under the shade was considerable higher than outside and fluctuated less.

Most noticeable, however, was the way in which the shaded crop was protected from drought. The slightest patter of rain went through the thin cheese-cloth readily, but evaporation from the crop and soil into the air were greatly hindered. The air under the cloth was very moist, and at a time when the crop outside suffered for lack of rain, that under the shade continued to grow thriftily and the soil very near the surface was still visibly damp, while outside it was dry and powdery.

We have no measure of the amount of sunlight intercepted by the cloth, but the "shade" was scarcely evident to the senses, and the light beneath it was more trying than the clear sun, probably because of the greater heat and humidity. Probably the close planting shaded the leaves much more than the cheese-cloth.

Two rows each of Havana seed leaf and of Sumatra grown under the shade were topped, rather high. The leaf from the topped plants, however, after curing, was seen to be distinctly inferior to that from the untopped plants.

The untopped tobacco of both varieties grew to the cover, nine feet from the ground, and the Sumatra stalks bent over and grew to a length of 10 or 11 feet.

Mr. Floyd, who had been engaged with official duties at the Paris Exposition, returned in July, and gave us his opinion as to when the tobacco was ready to prime and he also staid to show how the priming and stringing of the leaves should be done.

When the bottom leaves were judged to be ripe, two men with large baskets went through the field, picking off two, three or four of the bottom leaves from each stalk and laid them flat in the baskets, which, when full, were brought to a barn, where children strung the leaves back to back and front to front on strings, which were finally drawn tight on laths, leaving the separate leaves about a finger-breadth apart. From 40 to 50 leaves were put on a single lath. These were hung in tiers in

the barn to cure. A little later a second priming, and then a third, fourth, and in some cases a fifth, was made, the whole crop being finally secured, leaving the stalks standing in the field. The whole operation of harvesting was completed in the week beginning August 21st.

It was necessary, for lack of room, to cure this primed crop, grown under shade, in the same curing barn with tobacco curing on the stalk, and it was difficult to keep the conditions in the barn just right for the proper curing of the tobacco harvested in these very different ways. Naturally the tobacco on the strings dried out quicker than that on the stalks, so that when, for the sake of one kind of tobacco, it was better to close the barn, for the sake of the other it might be better to leave it open. By skillful management and close watching, Mr. DuBon cured both crops successfully in the same barn.

When the crop was taken down, the string was cut or broken at each end of the lath and wrapped around the butts of the leaves, making a single hand of tobacco from each lath. The crop of shaded tobacco was not sorted, but was fermented and sold in these original hands, as it was taken from the lath.

The shaded tobacco, after lying in the bundle for some weeks, was fermented in a bulk with the "Connecticut Havana" crop grown in the open in the same field. The method of doing this work was fully described in the last report of this Station. The fermentation was completed in about six weeks and the crop was sold.

Samples of the shaded Sumatra and Connecticut Havana were sent to a considerable number of leading tobacco dealers in New York and Philadelphia, with a request that they would examine the samples carefully and give us their opinion of the merits of the leaf as well as of its defects.

These samples represented the several primings of Sumatra and of the Connecticut Havana, after being fermented, the leaves still on the strings as they came down from the curing barn.

The leaves had not been in any way selected or picked over.

The opinions of leading men, who are engaged in the leaf-tobacco trade, must of course decide the question as to the quality and value of any lot of tobacco. If tobacco meets the views, the taste, the requirements of the trade, it is all right; if it does

not meet them, it is all wrong. The grower must produce the kind of leaf which the trade likes and accepts, however much he may differ from the trade in his estimate of what is a good cigar wrapper.

Mr. Walter G. Wilson, Secretary of the Philadelphia Cigar Leaf Tobacco Board of Trade, said before the Committee on Agriculture of the U. S. House of Representatives:

"The samples of tobacco grown in Connecticut, especially of wrapper leaf, have been submitted to our board, and we are unanimously of the opinion that both in the Sumatra and domestic grades that were produced, these were the finest ever seen. The Sumatra style, especially, was submitted to actual tests for burn, yield and colors, and in every case far excelled the imported article, while in the domestic grades the goods raised under Government direction were far above the best of those produced in the ordinary way."

"I took personally the Sumatra end of the string, and gave several hands to one of the largest cigar manufacturing firms in the city of Philadelphia, and had them use them in the regular way to make up their cigars as made regularly. They brought them over to me, and upon inquiry they pronounced it, as Mr. Cullman has said, superior to (imported) Sumatra tobacco, both in color, yield and burn."

"The only criticism that might be made was that some was a little green. The color had not been set, and it was right out of the fermenting, but that would be remedied by simply a little more time."

Mr. Joseph F. Cullman, President of the New York Tobacco Board of Trade, also stated that the samples of the Sumatra leaf, grown under shade at Poquonock, were, in his opinion, superior to the average imported Sumatra.

To the same committee were also presented the following letters from manufacturers to whom samples had been sent.

ONEIDA, N. Y., January 2, 1901.

Messrs. SUTTER BROTHERS, New York.

Gentlemen: We received your favor of December 28, in which you say you have sent us samples of Connecticut Habana seed tobacco, also of Sumatra seed which was grown under cover at the Government experimental station, Poquonock, Conn.

We have received the samples and have carefully examined the same and are more than pleased with the Sumatra seed, as it is far superior in every way to the Habana seed of which you sent us samples. The leaf is much tougher, thinner, finer grain; the burn is excellent, and the tobacco shows good quality. We think the tobacco is an exact counterpart of the Sumatra grown on the Sumatra Islands, and we believe

if these experiments would be continued by the Government still better results could be obtained.

We thank you very kindly for submitting the samples to us, as we are always trying to learn all we can in regard to any improvements in tobaccos that are coming up.

Yours respectfully,

POWELL & GOLDSTEIN.

BALTIMORE, January 5, 1901.

Messrs. SUTTER BROTHERS, New York.

Gentlemen: Referring to your esteemed favor of December 28 advising shipment of the experimental tobacco raised at the Government station at Poquonock, Conn., and asking for our opinion on same, we beg to state that the tobacco reached us at rather an unfavorable time, as owing to our annual inventory we do not work our hands in the interval between Christmas and New Year; however, promptly on resuming work after the first we have taken the matter up. We find that the sample of Connecticut Habana seed tobacco shows up very well, and we consider such an improvement over any Connecticut Habana seed we have ever heretofore worked, and have no doubt tobacco of this character would find very ready sale in this country.

As regards the Sumatra seed, the sample indicates a tobacco of considerable merit and compares very favorably to the genuine imported Sumatra. The sample, however, owing to its immature condition, being deficient in curing, does not work up as well as would be the case were the tobacco in perfect condition, the colors being as yet unsettled, and, therefore, in the condition as received, does not come up in appearance to the genuine Sumatra. This defect, however, can of course be easily remedied by giving the tobacco the proper attention. As regards the yield and smoking qualities, we consider same of very superior merit. We consider there is a very large field for the development of this tobacco in this country, and if conducted on a commensurate scale would ultimately make the manufacturer independent of foreign Sumatra leaf.

We will be glad to render you any service in our power in promoting this matter, and remain,

Yours, very truly,

KRAUS & Co.,

Per KRAUS.

CHICAGO, ILL., December 31, 1900.

Messrs. SUTTER BROTHERS, New York City.

Gentlemen: Replying to your favor of the 28th instant, would say that the samples of tobacco raised in the experimental station at Poquonock, Conn., have been examined leaf for leaf. We pronounce the Sumatra very, very fine, and equal to the imported, and in some respects superior. The Habana seed also is very fine and a great improvement over tobacco raised in the old way. There is no doubt in our minds but that Connecticut can grow the finest wrapper tobacco in the world.

Yours, very truly,

SUTTER BROS.

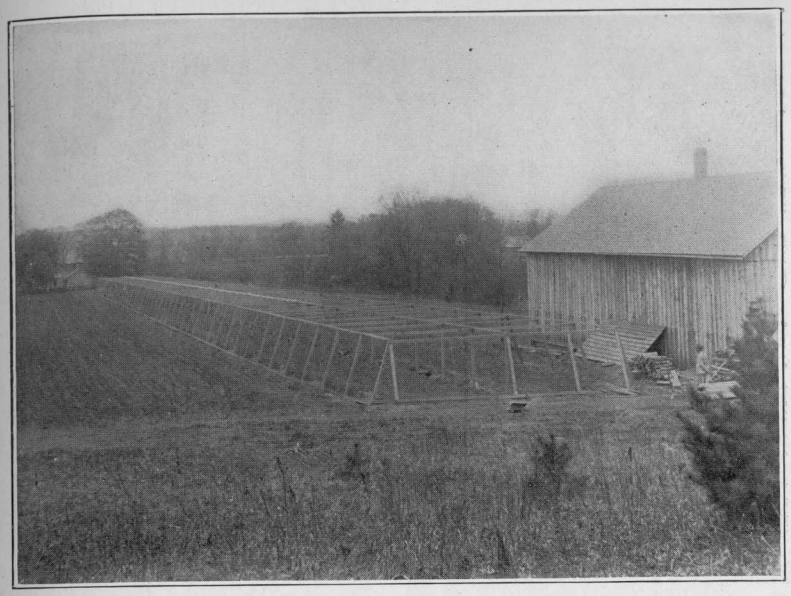


Fig. 1.—Frame-work for Shading Tobacco.

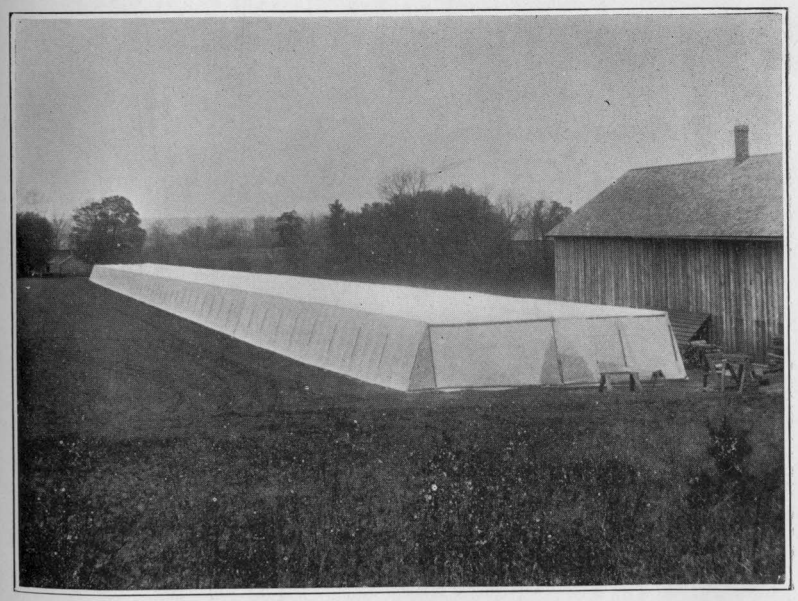


Fig. 2.—Cloth Cover, Shading Tobacco.

In reply to an inquiry of the writer, the following letter was received from the New York house of Sutter Brothers:

NEW YORK, January 17, 1901.

MR. EDWARD H. JENKINS, New Haven.

Dear sir: We are in receipt of your favor of the 15th inst., and in reply would say that we submitted the tobacco to about four or five of our largest customers who have been working Sumatra and Havana seed, and all their reports are in favor of the experiment. They claim that the goods are much finer than anything they have ever seen, and call our especial attention to the Sumatra seed as being as fine in every particular as the imported article. Our customers' letters were very encouraging indeed, and they all express the wish that the experiment be continued as it would be for the benefit of all concerned, especially to the dealers and manufacturers, and of course to the smoking public at large. We certainly trust that the experiment will be continued next year, and if there is anything we can do to advance same we are at your disposal.

Yours respectfully,

SUTTER BROS.

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.

THE PROTECTION OF SHADE TREES.

By E. H. Jenkins and W. E. Britton.

In November, 1900, a Bulletin on this subject was issued by this Station. The Bulletin, which is in substance reprinted in the following pages, was in the form of a report on the shade trees of New Haven made to the Mayor of the city by a committee of which the writers were members; the other members being Prof. Graves of the Yale Forestry School and Mr. Henry T. Blake, President of the New Haven Park Commission.

The report in its main features is applicable to most of the cities, towns and villages of this State.

In every one of them may be found the same mutilations by vandals, the same evidence of lack of care and skill in planting, pruning and trimming and the same insect enemies.

In many of them too, may be found an increasing respect for shade trees, a desire for their better protection and more active interest in tree-planting.

In view of these facts and of the fact that much of the work on this Report was done by members of the Station staff, it is altogether proper that the Station should bring the results of this work to the attention of those individuals and communities which are reached by its bulletins.

In the smallest village, as well as in the largest city, trees can only be protected by the creation of an intelligent public sentiment on the subject. Small villages can more easily produce and maintain exceptionally fine shade trees than can cities, where "modern improvements" do so much to damage them, and few material things add more to the attractiveness of small country places and their value to those who are seeking temporary or permanent homes, than well-shaded and well-kept streets.

In regard to the illustrations following page 338, Figs. 7, 8 and 9 of Plate XI, and Plates XIV and XV, are from electrotypes kindly supplied by Dr. E. P. Felt, State Entomologist of New York. Fig. 17, Plate XVI, was used in Bulletin 121 of this Station, 1895, by permission of the U. S. Department of Agriculture. Figure 16, Plate XVI, was published in the Report of this Station for 1896, from an original photograph.

All others are from original photographs taken in the streets of New Haven and are fair examples of certain present conditions mentioned in the following report.

Causes of the Present Condition of the Shade Trees of New Haven.

The unsatisfactory condition of many of the shade trees in the squares and streets of New Haven is due to a number of causes acting together; no single one of them being chiefly responsible for the damage. A brief statement of these causes follows:

1. *Old Age.*

Many of the trees in New Haven are of very great age. For example, the sycamore near the corner of College and Elm Streets, the last of a row which once bordered the Green, was set in 1759 and many of the elms on the Green were planted in the year 1787.

While under favorable conditions some of these trees may last for many years longer, their age must necessarily tell against them in their struggle for life under any circumstances.

2. *Lack of Water and Air about the Roots.*

All trees need to stand in ground which is sufficiently open to the air and suitably watered. The exclusion of either air or water from the soil is surely and quickly fatal. It is a matter of common observation that a filling of earth two or more feet deep about thrifty, mature trees will damage or kill them. The covering of earth works this injury simply by excluding air from the active rootlets.

The conditions of city life seem to require that streets and sidewalks should be made hard and as nearly impervious to water—and incidentally to air,—as may be. As a result, the trees standing on or close by the streets are greatly limited in their supply of both water and air by the water-tight and air-tight covering above their roots.

3. *Lack of Plant Food.*

The soil in a large part of the city is a light leachy sand, naturally unfertile and for more than a hundred years the tree roots have been constantly taking the available plant food out of it. A part of this matter assimilated by the trees remains permanently in the wood and by far the larger part goes into

the leaves. These leaves, as well as much of the grass growing under the trees, are crops which have been gathered annually for more than a century from our streets and parks; a crop which is rich in mineral matter and hence impoverishes the soil on which it grows, as our field and garden crops exhaust the fertility of land. Just as no market gardener thinks of success in farming without a yearly dressing of the land with fertilizers of some sort, so in our city parks the best success with trees cannot be expected on a soil which has supported their life for more than a hundred years, unless the supply of plant food in the soil is supplemented by the use of fertilizers.

The soil is further exhausted by the removal of a part of the grass whenever it is cut in our parks.

It is true that trees have the power to gather food enough to support life and make some growth even from soils which are, agriculturally speaking, almost barren. It is also true that the wastes of the community which pass into the soil help to feed the trees standing upon it. Moreover, from time to time, some fertilizing material has been put on our public squares with the object of improving the grass. But these various things do not fully meet the requirements of the trees. The yearly application of some suitable fertilizer to the soil about shade trees, is of the highest importance to increase their growth and—what is more vital—their thrift and their power of resisting unfavorable conditions.

4. *Mutilations of Trees.*

A very large number of the trees on the streets of New Haven, not only such as are newly planted, but also those of the larger sizes, have been and are now being injured and even ruined by the gnawing of horses, which contrary to city ordinances are hitched to them or left unhitched to bite and tear the tree trunks.

The damage done in this way is well shown in figures 1 and 2 of Plate VIII following page 338.

To show the extent of damage by horses, the following statement, based on personal observation, gives the total number of trees on the streets named, the number of such trees damaged by the gnawing of horses and collisions of vehicles, and the percentage of mutilated trees.

MUTILATION OF TREES BY HORSES AND VEHICLES.

	Whole number of trees.	Number mutilated.	Percentage injured.
Orange St., Canner to Court.....	260	82	31
Wall St., State to York.....	44	24	55
Ashmun St., York to Munson.....	107	59	55
Orchard St., Munson to Davenport Ave.	244	86	35
Chapel St., Day to College.....	86	38	44
Charles St., Orchard to Dixwell Ave...	18	8	44
Howe St., Whalley Ave. to Oak.....	130	41	31
George St., Temple to Winthrop Ave...	254	70	28
	1143	408	36

Another very destructive mutilation is the necessary cutting of large roots in digging for water and gas mains or sewers, and worse than this the cutting of main roots close to the tree or the cutting of the trunk itself in order to lay a curb-stone to line or make a cobble gutter. An illustration of such mutilation is given in figure 3, Plate IX.

While this Report was in preparation, one of the finest elms in the city was blown down by a sudden squall, carrying to the ground a number of electric trolley wires, maiming a horse so that it had to be killed and doing injury to the building opposite. Had it fallen a few minutes earlier or later it would certainly have demolished street cars and destroyed human life. The tree was perfectly sound five feet above the ground, but at the surface it was a mere shell, the heart wood being entirely destroyed. The primary cause of this decay was quite certainly a mutilation of the root which had not healed and in which decay had started, spreading till the whole was gone. Figure 4, Plate IX shows the decayed trunk seen from the bottom and is a striking example of the damage which may result from a mutilation.

Another mutilation which has destroyed many trees or greatly marred them is unskillful trimming and neglect of the scars left by it. In many cases large limbs have been sawed off, leaving bare wounds almost horizontally exposed, to catch and hold the rain and entirely unprotected by anything like paint to keep the water out. Naturally decay soon begins here, and spreads into the body of the tree.

Figure 5 of Plate X gives an illustration of this kind of damage.

A further mutilation, less extensive than those just named, but very evident in some places, is the chafing of the bark by electric light or trolley feed wires. In some cases the bark has been wholly destroyed on one side and the limb killed. And lastly, each year some trees or parts of trees are broken off by severe gales, the injury usually occurring to trees which are not in a very thrifty condition.

5. *Poisoning by Illuminating Gas.*

Illuminating gas is extremely poisonous as well to the roots as to the leaves of trees. A considerable leak from a gas main, under repair, during a single night has killed trees standing near, and a very slight leak for a longer time will also infallibly kill them.

Many trees have been killed by this cause, the damage often being done before the leak was discovered.

6. *Insect Injuries.*

The insects which commonly injure street trees in New Haven may be grouped as (a) leaf-eating insects, (b) sucking insects, and (c) borers.

(a) *Leaf-eating Insects.*

Elm Leaf-Beetle.—*Galerucella luteola,* Müll. The adults appear in the first half of May, when the leaves are unfolding, and perforate them with small round holes. The females lay their yellow eggs on the under sides of the leaves in irregular clusters. Each female is said to deposit about six hundred eggs, and the egg-laying period extends over several weeks. The eggs hatch in about a week and the young larvae or grubs feed upon the under surface of the leaves, eating off the green portion and leaving only the skeleton covered with the upper epidermis. Such leaves soon turn brown and fall.

The English elm suffers greater injury than our American species.

The larvae or grubs do much more damage than the adults, and in from fifteen to twenty days, when full grown, descend the body of the tree or drop from the branches in search of a place to pupate. Large numbers transform at the base of the tree, where, partially covered with fallen leaves or rubbish, they

may often be gathered by the quart. Many, however, crawl into crevices of the rough bark of the trunk and larger branches and there undergo this change. In from six to ten days the adult beetle comes forth, feeds for a time upon the leaves and then retires to winter quarters in some building or almost any sheltered place. In New Haven some of the beetles lay eggs for a second brood, but usually there is but one complete generation in a season.

The full grown larva or grub is about one-half inch long, with a broad black band along each side of the body and is covered with short tubercles bearing hairs. The pupa is about one-quarter inch long, naked and light yellow. The adult beetle is about one-quarter inch long, with head, chest and margins of the wing-covers, brownish yellow. Each wing-cover is also marked lengthwise with a more or less obscure black stripe. Plate XVI, fig. 17, shows this insect in its various forms.

Canker Worms.—Fall Canker Worm, *Anisopteryx pometaria,* Harr. Spring Canker Worm, *Paleacrita vernata,* Peck.

Both these species injure elms in New Haven by eating the leaves during May and June. The eggs are laid on the bark of the trunk or branches by the wingless females; those of the fall species during warm days in November and December, those of the spring species in March and April.

The adult males are grey moths, having a wing expanse of about an inch, while the females are wingless and must creep up the trunks of the tree to lay their eggs in them. See Plate XVI, fig. 16.

The larva or caterpillar becomes full grown in about four weeks after hatching, and is then about an inch long, of a dark brown color, with lighter stripes running lengthwise of the body. The color, however, varies considerably. The caterpillars "loop" in crawling, and when disturbed "spin down" from the branches on a fine thread by means of which they afterwards ascend.

They pupate in the ground. Much of the damage done by canker worms in the city has been wrongly attributed to the elm leaf-beetle; but the work of the two insects may be readily distinguished. The adult elm leaf-beetle makes "shot-holes" through the leaf and its larva or grub eats away the under

surface; while the canker worm eats any portion of the leaf except the principal veins, but does not puncture the leaf. The White-Marked Tussock Moth, *Notolophus leucostigma,* Sm. and Abb.; the Forest Tent Caterpillar, *Clisiocampa disstria,* Hübn.; the Fall Web Worm, *Hyphantria cunea,* Drury, and the Bag Worm, *Thyridopteryx ephemeraeformis,* Steph., all of them pests in other places, are also found in New Haven, but up to the present have not been so abundant as to be troublesome.

(b) *Sucking Insects.*

Elm Scale.—*Gossyparia ulmi,* Geoff.

This insect, shown in figure 6, Plate X, was introduced from Europe and is now distributed over the United States. It collects in clusters at the forking of the twigs and in the crevices of the bark, mostly on the under side of the branches, from which it sucks the sap for its food. The females, dark brown in color, with margins of a white woolly substance, are oval in outline, about an eighth of an inch long and bring forth their young alive instead of laying eggs. They exude a sweet sticky substance, known as "honey-dew," in great abundance and this often drips upon the ground and walks, under badly infested trees. The young appear about the middle of June. The branches which they attack generally die and the whole tree is weakened.

The Cottony Maple Scale.—*Pulvinaria innumerabilis,* Rathv.

This insect may be found on nearly every street in this city where there are maples. One of the worst infested trees stands on the corner of Wall and Orange Streets. White masses of a waxy material, resembling cotton, are seen in the crevices of the bark and on the under sides of the leaves and branches. The impregnated females live over winter on the under sides of the twigs and produce eggs under the cottony substance. They then shrivel and die. The eggs hatch in early summer, the young lice crawl about for a few hours, then settle along the mid-ribs of the leaves, where they continue to suck the sap, until mature, when they migrate to the twigs and there pass the winter.

Much damage has been done in various places by this insect, but it is easily controlled by remedial treatment.

(c) *Borers.*

Maple Borer.—*Plagionotus speciosus,* Say.

Maple trees in New Haven are more seriously injured by the maple borer than by any other species of insect.

The adult is a beautiful black beetle about an inch long, ornamented with cross-bands of bright yellow. The eggs are laid on the trunks of the maples in July and August and the young borers, as soon as hatched, tunnel in the bark or wood, where they remain through the winter. The appearance of these beetles is shown in figure 7, Plate XI. Usually the main tunnel is between the wood and bark, and sometimes passes nearly around the trunk in a spiral and upward course, girdling it. Examples of the injuries are shown in Plate XI, figure 10 and Plate XII, figure 11. The "sawdust" or castings are thrown outside the burrow and serve as a guide to trees which have been attacked. The burrows often run deep into the solid wood and the larva doubtless passes the winter in these more protected chambers.

The life-history of this borer is not fully known, but it is supposed that two years are required for its full development.

Elm Borer.—*Saperda tridentata,* Oliv.

This enemy of the elm often causes great injury before its presence is suspected, and makes numerous galleries in the inner bark, so that the bark will sometimes separate from the wood in large sheets. The beetle is about half an inch in length, slate-colored, with orange markings. Its appearance is shown in figure 8, and the characteristic injuries caused by it in figure 9 of Plate XI.

The Pigeon Tremex.—*Tremex columba,* L.

Injured and dying elms are often attacked by this and many other species, which seldom attack healthy trees.

The Leopard Moth.—*Zeuzera pyrina,* Fabr., is exceedingly injurious to elms and maples about New York City. The adult is a large white moth, spotted with black, and the larva makes deep burrows into the wood.

7. *Lack of Knowledge and Care in Planting.*

The statements in the preceding pages have mainly to do with the life and health of the trees. A further consideration, which is of great importance and which is often overlooked, is

the failure to produce trees of symmetrical proportions. The purpose of planting trees in our streets and parks is not only to furnish shade but also to beautify the city. When trees are planted, the question should always be considered, whether the right varieties have been chosen, whether the individuals are perfect, and whether the location of each tree is such that it can develop symmetrically.

It requires only a short walk in the New Haven streets and parks to see trees which are misshapen because they have been crowded by one or more of their neighbors, and to see young trees which will never develop into beautiful individuals because they were not properly treated in the nursery.

The failure to produce symmetrical trees in city streets and parks can usually be attributed to the following causes:

(a) *Poor nursery stock.* It is as true of trees, as of our field and garden crops, that, to secure good results, the seed must be selected with care and from the right sources. Trees run into varieties as readily as other plants and these varieties differ greatly in beauty. Therefore, the seed for producing ornamental trees should be gathered from trees of known stock as to symmetry and hardiness. Often this is not done, however, and those who gather seed to supply the trade do not take into consideration the quality of the trees which produce it. Commercial stock is, therefore, liable to be (in part at least) from trees belonging to the less desirable varieties. It is safer that the seed used be from trees of known excellence. As a rule those who select young stock for street planting are not qualified to judge what individuals are likely to develop into well-shaped trees. With the system now in use, it is inevitable that a certain number of trees are planted which ought never to have left the nursery. Members of the Committee have noticed, in numerous instances in New Haven streets, young trees which can never be beautiful specimens because they were not properly handled in the nursery.

(b) *Poor judgment in selecting the species.* Hitherto the selection of the varieties of trees to be planted has been left entirely to the private citizens who purchase them. The result is that there is no uniformity among the trees on many streets, and frequently varieties have been set out which are not suitable for street purposes. A case in point is on lower Prospect

Fig. 1.—Tree ruined by gnawing of horses. Decay started from the injury and only a shell of living wood remains on one side of the tree. This tree is liable to be broken over by a strong wind and probably will fall upon the adjacent building.

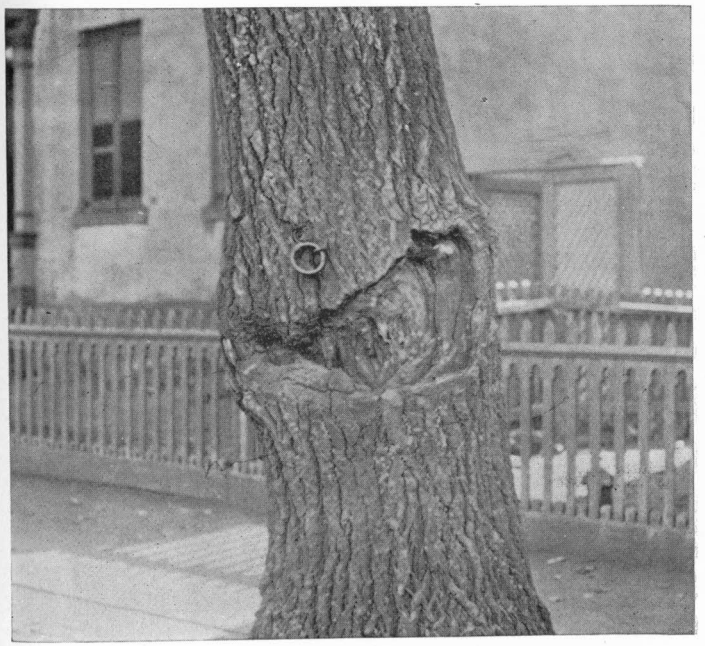


Fig. 2.—Tree injured by use as a hitching post.

Fig. 3.—Trees mutilated in laying curb and gutter.

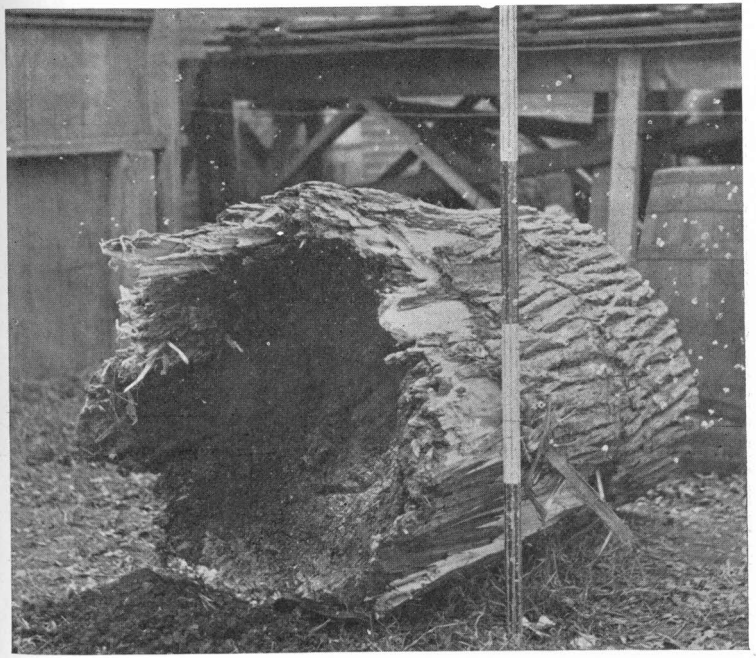


Fig. 4.—Trunk of an Elm which was thrown over in a squall, Oct. 15, 1900.

Fig. 5.—Decay following unskillful pruning.

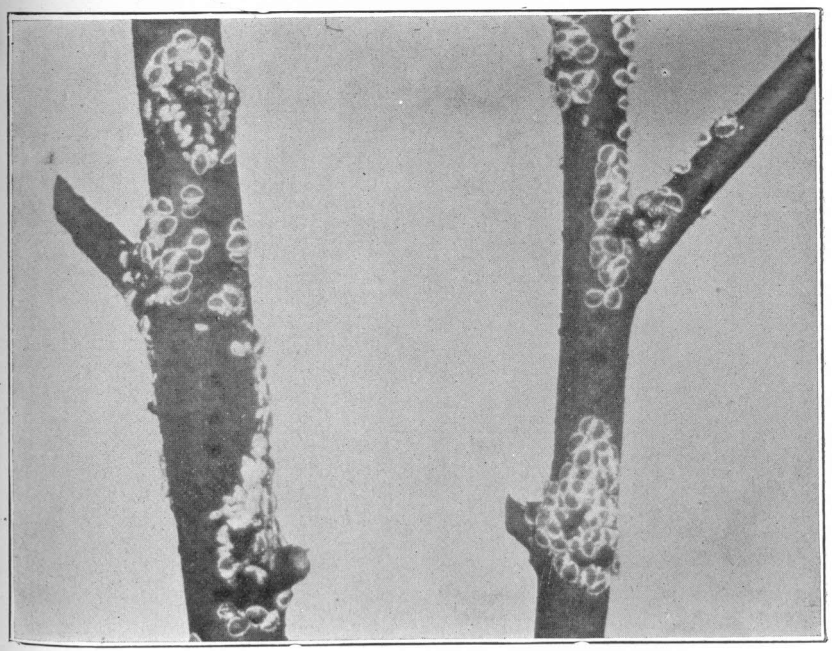


Fig. 6.—The Elm Scale on Twigs.

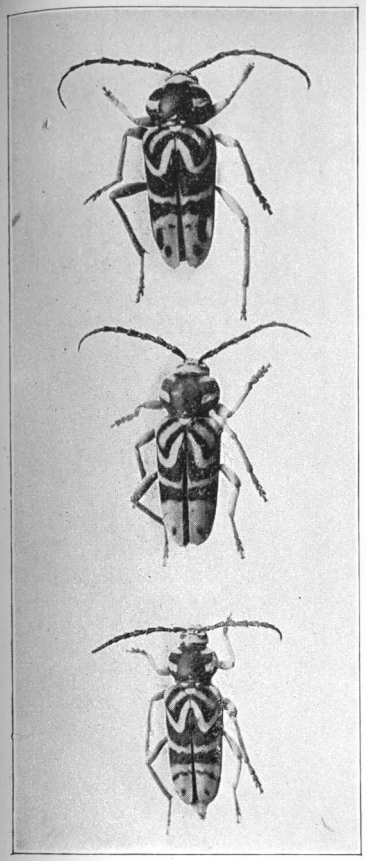


Fig. 7.—Adult Maple Borers.
(After Felt.)

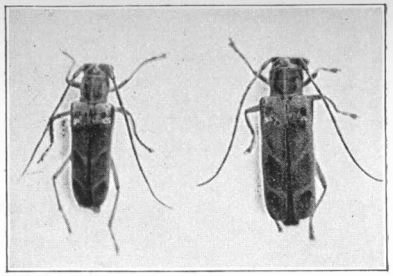


Fig. 8.—Adult Elm Borers.
(After Felt.)

Fig. 9.—Work of Elm Borer.
(After Felt.)

Fig. 10.—Work of Maple Borer nearly girdling the tree.

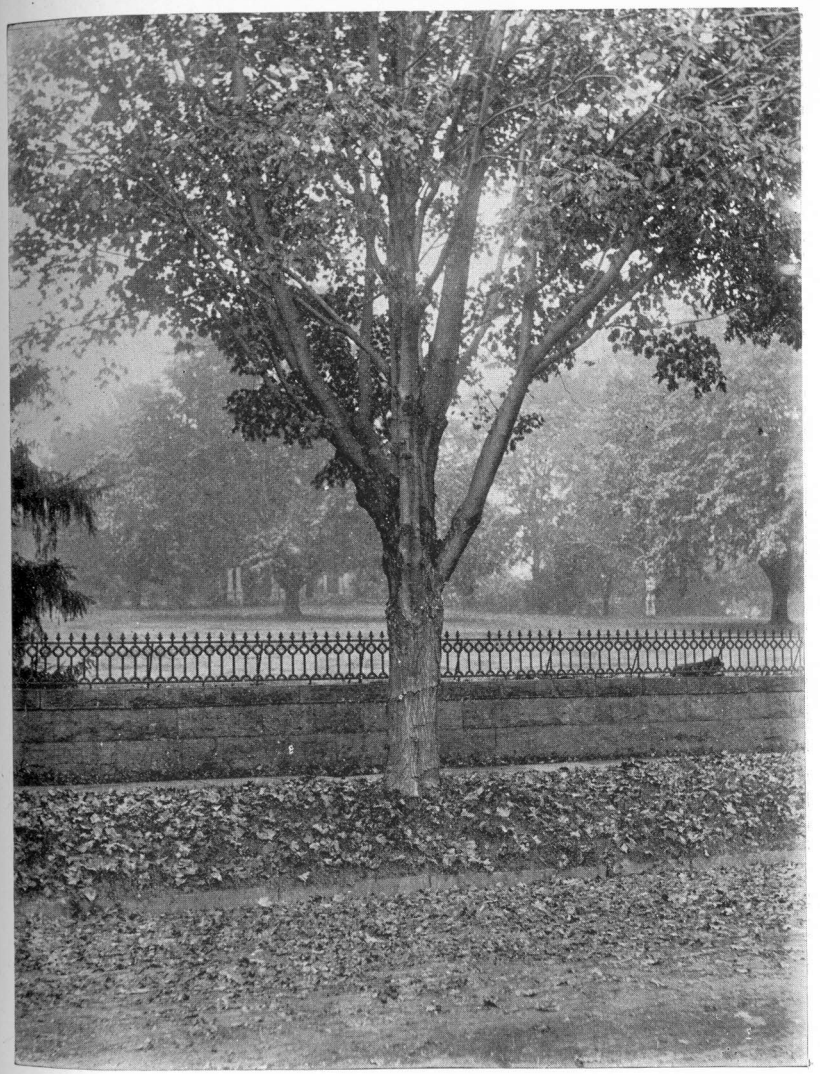


Fig. 11.—Damage by Maple Borers showing tunnels cut spirally around the trunk.

Fig. 12.—Trees set near the property line away from the curb.

Fig. 13.—Damage by Borers, following unskillful pruning.

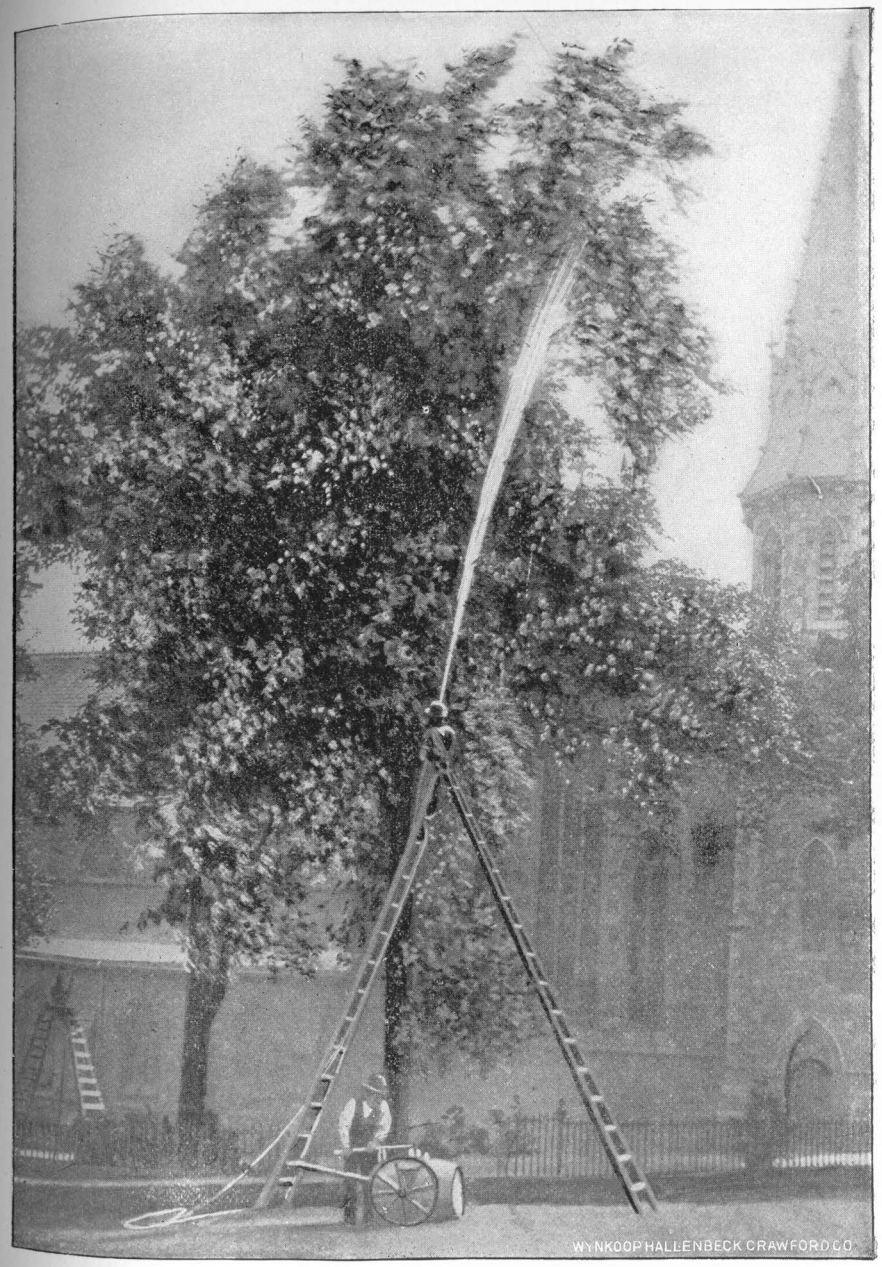


Fig. 14.—Hand Spraying-Pump in Operation.
(After Felt.)

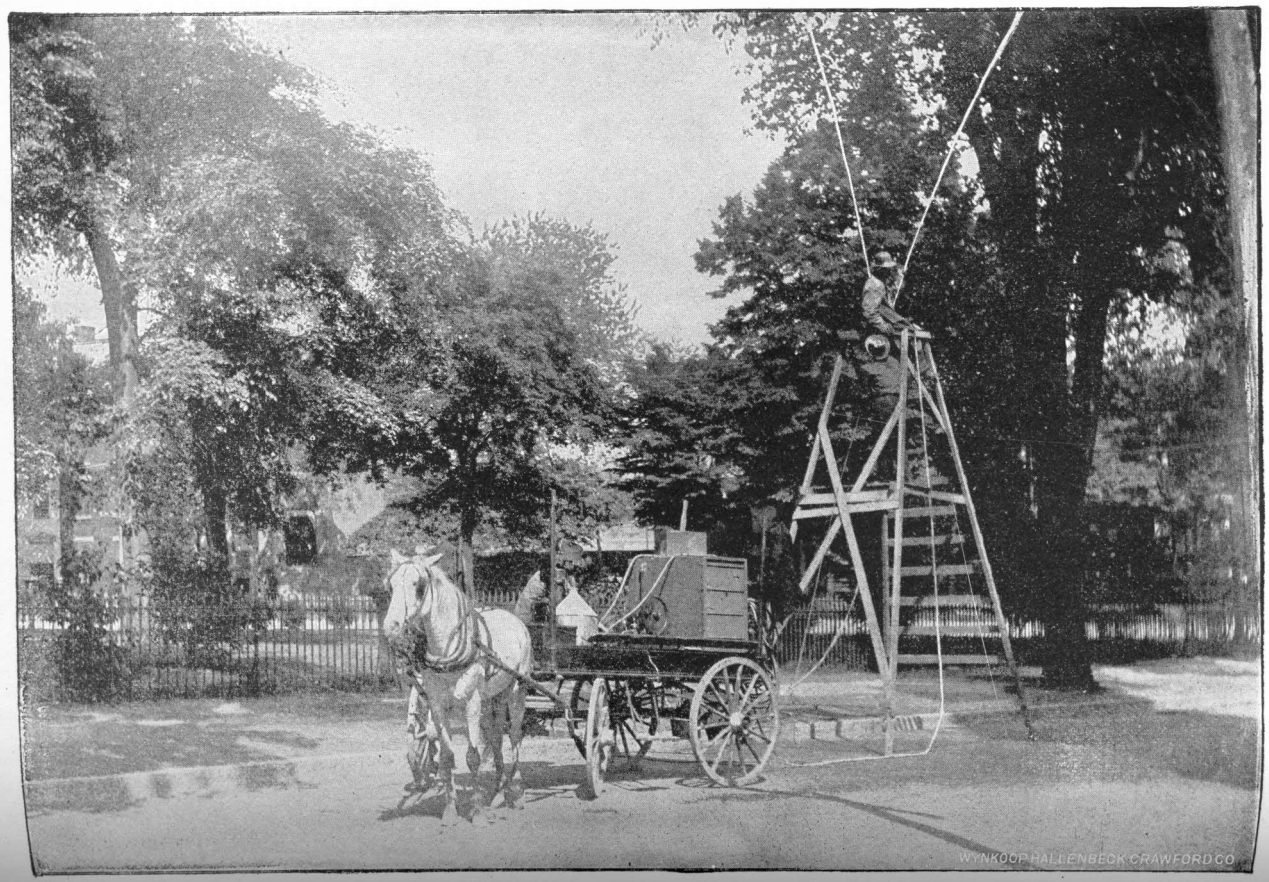


Fig. 15.—Power Sprayer in Operation.
(After Felt.)

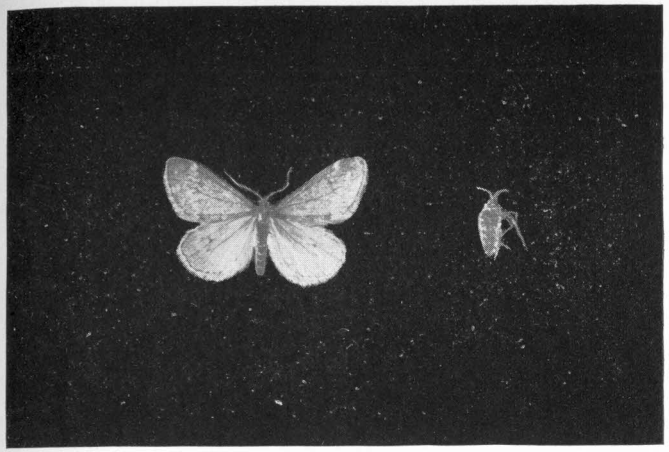


Fig. 16.—Fall Canker Worm Moths. Male and Female.

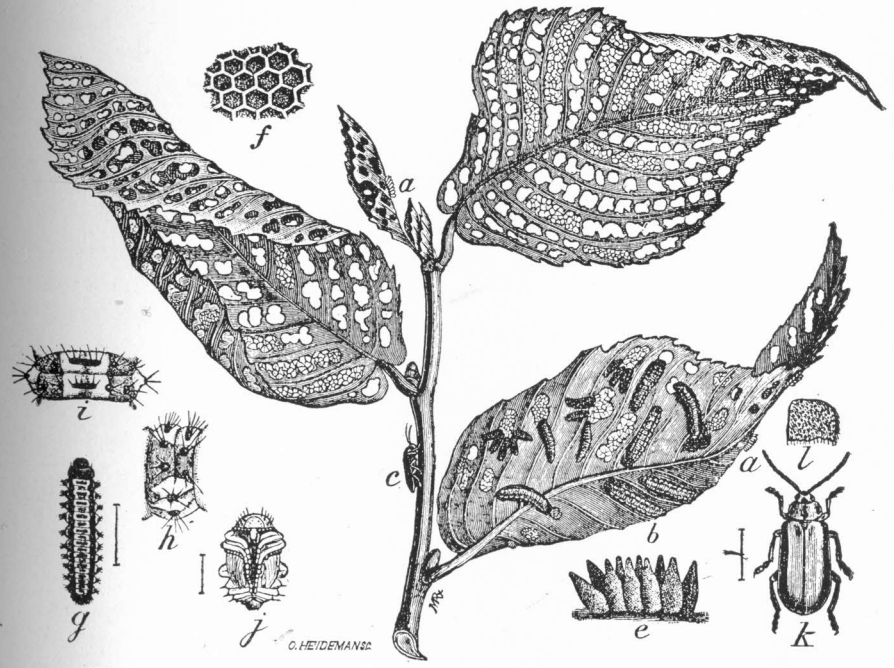


Fig. 17.—Elm Leaf-Beetle.—*a*, eggs; *b*, larvæ; *c*, adult: *e*, eggs, enlarged; *f*, sculpture of eggs; *g*, larva, enlarged; *h*, side view of greatly enlarged segment of larva; *i*, dorsal view of same; *j*, pupa, enlarged; *k*, beetle, enlarged; *l*, portion of elytron of beetle, greatly enlarged. *(After Riley.)*

Street, where, in about two blocks, Norway maple, sugar maple, red maple, basswood, white ash, elm, tulip tree, locust and cherry can be found jumbled together entirely without system. Without a systematic plan for the arrangement of street trees, the result can never be satisfactory.

(c) *Unwise location of trees.* In order to produce the best results, each tree should be given enough space for the development of its normal form. As a rule the trees in New Haven are planted too closely together, with the result that many individuals become one-sided or otherwise misshapen.

There is also a tendency to set young trees under old specimens which may die in a few years. This has been done in several places on the Green. The old trees have, however, not died and the young specimens have been crowded for room and light and have become distorted.

(d) *Improper planting.* This cause for failure in city planting is less common than the causes discussed in the preceding pages. Nevertheless, the members of the Committee have noted in the newly-planted streets a number of small trees, dead or dying, which should have lived if they had been properly planted.

(e) *Lack of care after planting.* Hitherto no attention seems to have been given to the young trees after they have been planted, except, in some instances, to trim off the dead limbs. Often young specimens require a certain amount of trimming in order to develop well-shaped crowns, but, so far as the Committee is informed, this is seldom done. Furthermore it frequently happens that young trees are injured so severely that there is no hope of their complete recovery. Even if they live, they cannot become perfect specimens, whereas if they are removed and replaced at once, the new trees will have the benefit of growth during the time the old ones would linger along before death.

8. *Electric Currents from Feed Wires.*

Whether or not the electric currents—which sometimes leak into trees from electric light, or trolley wire—damage the trees, has not been certainly determined; there can be no doubt, however, that they are of no benefit and prudence will dictate that such exposures should be carefully avoided.

What Can be Done to Protect and Improve the Shade Trees?

We have thus set forth the main causes of the present unsatisfactory condition of the city shade trees. To abate or remove these causes we make the following notes and recommendations:

1. *Age of the trees.* For old age there is no remedy! Nevertheless the recommendations given below will certainly lengthen the life of the trees by abating those attacks which weaken the vital forces and thus hasten decay and death.

2. *Lack of Water and Air about the Roots.* This lack is not very severely felt by trees standing in the squares with some green sward about them. In times of extreme and protracted drought these trees suffer in common with all vegetation and would of course be helped by watering once a month while the drought lasts, with a large volume of water equal to at least one-half the normal average rainfall.

On narrow paved streets in the center of the city little can be done, and it is a question how long the trees in such situations can survive. On residential streets conditions are better.

Lawns next the street, which are well watered, give access of air and water to the tree roots under them and thus greatly help to support the trees on the street adjoining.

The conditions for growth would be still better if the trees were on the lawn side of the walk instead of near the curb. With such an arrangement the trees would have more space for the growth of their roots, and there would be less damage if it were necessary to cut the roots in lowering the foundation of the road. Furthermore they would be out of the reach of horses and would thus escape one of the most serious sources of damage. Such a plan would improve the general appearance of the street by giving it a broader effect. There would be an advantage also in having the walks drain directly into the street and thus the possibility of standing water on or beside the walk would be avoided. Such a plan would be practical only where no trees have already been planted, and where the building lots are deep enough to leave some air space between trees and buildings. Figure 12, Plate XIII, gives an idea of the general effect of this system of planting.

3. *Lack of Plant Food.* This may be supplied by a regular annual dressing with a moderate amount of fertilizer put on the surface. It is not practicable or necessary to dig it in. If the surface is enriched, the feeding rootlets of the trees will quickly find it out and develop most where they find most nourishment.

It is desirable, however, that experiments should be made in the use for shade trees of liquid fertilizers poured into holes, an inch in diameter, made for the purpose about the trees.

To avoid complaints, not always quite reasonable, a fertilizer for use in city squares should be nearly or quite odorless and not offensive to the sight.

We recommend for present use a mixture of

	Cost.
50 pounds nitrate of soda @ $45 per ton	$1.13
300 pounds cotton seed meal @ $27 per ton	4.05
100 pounds acid phosphate @ $15 per ton	.75
100 pounds muriate of potash @ $42.50 per ton	2.13
550 pounds costing	$8.06

The mixture is to be made by shoveling the ingredients together *just before use* and should be sown broadcast on each acre of land which is directly under the tree branches, as soon as the leaves begin to open in the spring.

In addition to such fertilization, we recommend an application of slaked lime to be made yearly, for some years, between December 1st and April 1st.

Five hundred pounds of stone lime, *which is moderately free from magnesia,* should be sown broadcast per acre, after being slaked with water. This quantity of lime will cost about $2.50.

For stone lime may be substituted 700 pounds of slaked oyster-shell lime. This can be bought here, ready for use, for 12½ cents per bushel of about 48 pounds in bulk, making the cost per acre $1.80.

The cost of mixing the fertilizer and slaking the lime—if stone lime is used—should not exceed $1.50 per ton, so that the total cost of fertilizing all the squares annually in the way recommended would be between $11.30 and $12.00 per acre annually, exclusive of the teaming and labor of applying the fertilizer to the land.

It may be added that the fertilizer and lime above recommended are an excellent dressing for grass and lawns, and that a well fertilized and well watered lawn greatly helps the trees which stand on the street bordering it.

4. *Mutilation of trees by horses, by street work and by electric wires.* Our present city ordinances forbid "any person to cut, bruise, injure or destroy any tree or shrub for shade, ornament, or use in any street or public square," also "to fasten any horse or other animal to any shade tree in any street or who shall place or leave any horse or other animal in such a manner that it may injure any shade tree," also "to mischievously injure or remove any fixture placed around any tree for its protection," or "to attach any guy rope, show bill, advertisement or other thing upon any tree without the permission of the Board of Public Works."

These regulations are suitable and sufficient for the protection of our trees if they were thoroughly enforced, which they manifestly are not and perhaps practically cannot be. Nevertheless more might be done in this direction, and we would suggest that the police be instructed to take notice of all infractions which come to their knowledge and that the offenders be vigorously prosecuted.

The regulation of stringing electric wires is a delicate and difficult matter and it might be advisable to require that this should always be done under the supervision of an inspector furnished by the Board of Public Works at the expense of the Company doing the work.

As to the cutting of roots in the laying of curb stones, gutters, sidewalks and street mains, we know of no way to prevent it. The liability of our trees to damage from these causes seems inseparable from the necessity of properly constructed streets, and from the existence of heat, light and water systems which are indispensable municipal requirements. The Board of Public Works, however, rather than a contractor, should in all cases decide when and where mutilation of the trunk or roots of a tree is necessary.

All trees near the curb and within reach of horses should be so protected that they cannot be bitten or gnawed. Young trees should be surrounded by a frame or by wire netting so adjusted that it will not bind or cut the bark as the tree grows. For large trees netting fastened on the street side will usually be sufficient.

Mutilation by unskillful trimming. When the limbs of a tree are amputated, extreme care should be taken to make the cuts close to, and perfectly even with, the trunk. If the pruning is done in this manner, the wounds heal more quickly than if stubs of the branches remain, and after healing there are no unsightly bulges at the point of cutting. Care should further be taken that no bark is torn from the trunk, as often occurs when a heavy branch is removed. In order to avoid this evil, a cut should first be made on the under side of the branch at a distance of a foot or more from the trunk, and then the branch should be cut off just above the notch. The stub can then be safely removed and a perfectly smooth cut made.

After the removal of a branch the wound should be painted with a coat of coal tar.* The painting of wounds of living branches may be done best after the activity of the sap has ceased, for at this season the coal tar will adhere most perfectly to the wood.

The trimming of dead limbs may be carried on at any season of the year, but extensive pruning of living branches should preferably be done when the trees are not in sap, for it has been shown by experiments that wounds made in the fall and winter tend to resist decay better than those made during the period of growth.*

No recommendations can be made regarding the trimming of trees to improve the shape of their crowns, for this operation can only be carried out by a skilled forester or landscape gardener, who must treat each tree according to its individual requirements.

Mutilation by Wind Storms. Nothing can be done to protect our trees against the wind other than to keep them in as strong and thrifty condition as may be, thus giving them greater power of resistance.

5. *Poisoning by Illuminating Gas.* We have nothing at present to recommend other than that the police should report at once any suspected leakage of gas in the streets, both to the Board of Public Works and to the Gas Company, and that the latter should be required by the Board of Public Works *at once* to examine and repair if necessary.

* See note on page 351.

All citizens should coöperate in giving timely notice of suspected leaks, which, if not stopped, may soon kill valuable trees. In some cities, when a tree has been killed by gas leaks, the Company is required to pay the expense of removing it and planting a new one under the direction of the City authorities. Such a regulation seems eminently just, and its adoption in New Haven is well worth considering.

6. *Insect Pests. Means of destroying Leaf-eating Insects.* Trees can be protected against all leaf-eating insects if the foliage is kept well covered with poison during the early part of the summer. A thorough spraying should be given the trees as soon as the leaves have unfolded, for if the elm leaf-beetles can be poisoned before laying eggs the battle is won. Another application should be made about two weeks later or as soon as the young larvae begin to hatch out from the eggs. The second spray should be directed against the under surface of the leaves. In a dry season like the past, probably no other spraying would be necessary, but if rains were frequent four applications might be required to keep the foliage well poisoned up to the first of July.

Arsenate of lead is perhaps the best poison to use for this purpose. It has been employed during the last five or six years, has given entire satisfaction and is considered superior to Paris green by several competent and experienced men in charge of street trees.

It may be prepared as follows:

Arsenate of Soda	4 oz.
Acetate of Lead	11 oz.
Water	100 gallons.

The arsenate of soda and the acetate of lead should each be dissolved in four quarts of water and then poured into the spraying tank containing the required amount of water. This mixture will not injure the foliage even if a much larger proportion of poison is used. It should be stirred constantly to insure uniformity in the mixture applied, though most spraying outfits are provided with an agitator for this purpose.

If trees cannot be sprayed, however, some good may be accomplished by destroying the pupae of the Elm Leaf-Beetle as they congregate at the base of trees. They may be gathered and burned, or drenched with a mixture of 1 lb. of whale-oil soap dissolved in 5 gallons of water, or with kerosene (10 per cent.) and water mixed and applied with a pump made especially for the purpose.

In the winter the belfries and towers of all public buildings should be searched and the beetles found in them carefully gathered up and burned. Vast numbers of them are often found in such places.

As the females of the canker worm and of the white-marked tussock moth are wingless, trees may be protected against them by putting sticky bands around the trunks of the trees. A strip of tarred paper five inches wide, tacked around the tree and covered with a quarter-inch layer of printers' ink, makes a serviceable band. Cotton batting should be placed under the paper to prevent insects from crawling beneath it. The ink will harden after a few weeks, but may be kept soft and sticky by brushing it over occasionally with black Virginia oil such as is used for lubricating the axles of freight cars. The ink and oil should not be spread on the bark of the trees.

Several forms of metal protectors are on the market, but all need frequent attention to keep them in good condition. All forms of bands and protectors are unsightly and are not needed where spraying is practiced.

Remedies for Sucking Insects. All the sucking insects that have been named above or that are liable to injure shade trees must be destroyed by something that will kill by contact, as they do not take the arsenical poisons into their system. The cheapest and most efficient of these insecticides is kerosene oil and water, but a pump of special pattern is necessary to apply it. A mixture containing fifteen per cent. of kerosene will kill most sucking insects without injury to the foliage of the trees. One pound of whale-oil soap in five gallons of water is also an efficient remedy.

Remedies for Borers. Borers are more liable to attack trees which have been weakened or injured than healthy and vigorous specimens and often attack that portion of a tree where large branches have been cut off in a careless way and decay has begun. This form of attack is shown in Plate XIII, figure 13. The maple borer, however, sometimes attacks strong trees. Constant watchfulness will detect the borers when they begin their work and they may then be destroyed by injecting carbon-

bisulphide into the tunnel which they make and plugging it tight with putty. Sometimes they can be killed by running a wire into the burrow, but it is often necessary to dig them out and properly dress the wound with paint. The very best preventive is to keep all trees in a perfectly healthy and vigorous condition.

We advise that the elm trees on the "Green" and on other centrally located public squares of New Haven be sprayed for a few years to reduce as much as possible the injury sure to be caused by the elm leaf-beetle, canker-worm and other leaf-eating insects. It does not seem practicable to attempt to spray all street trees, but suitable equipment should be procured so that at a day's notice any tree in any street of the city can be sprayed when it is found that any insect pest is threatening serious damage.

Such equipment should contain at least one power spraying outfit for large trees, and three hand barrel pumps, of which two are of the special form for mixing kerosene and water, together with plenty of ½ inch hose, couplers, extensions, nozzles, etc.,* constructed especially for spraying purposes. The cost of such an outfit would be not far from $500.00.

Though the members of this committee have not had opportunity to test the various power sprayers on the market, we believe that an outfit such as devised for use in the parks of New York City by Dr. E. B. Southwick, Entomologist of the Park Commission, is the best and most economical equipment for New Haven. This outfit consists of a "Daimler" gasoline motor operating a Gould's force pump. Motor and pump together weigh but 300 lbs. and may be placed on a spring wagon with the tank containing the insecticide. This motor requires very little attention and is economical, as a gallon of gasolene per day, it is stated, is all that is required for fuel.

Hand barrel pumps with the kerosene attachment are made by the Deming Co., Salem, Ohio, and The Gould's Mfg. Co. of Seneca Falls, N. Y. The kerosene attachment may be removed and the pumps can then be used to apply any mixture.

Such pumps (without the kerosene attachment) made by Morrill & Morley of Benton Harbor, Mich. and The Gould's Mfg. Co. of Seneca Falls, N. Y., have been in use for several years at the Experiment Station and have given satisfaction.

*The city of Springfield is equipped with two power sprayers and twelve barrel pumps. See Report of City Forester for 1899, p. 4.

One of the best nozzles for spraying trees is the "McGowen," made by J. J. McGowen, Ithaca, N. Y. For small trees or shrubs, the "Vermorel" is excellent and may be obtained from any pump manufacturer.

The general appearance of the spraying apparatus mentioned above is well shown in Plates XIV and XV, figures 14 and 15, which were kindly supplied by Dr. E. P. Felt, Entomologist of the State of New York.

In reference to the cost of spraying trees, we cite the following from page 21, Bulletin No. 20, Vol. 5, of the New York State Museum, "On the Elm Leaf-Beetle in New York State," prepared by Dr. Felt, the State Entomologist:

"*Cost of Spraying Elms.* I have taken some pains to ascertain the precise cost of spraying per tree in the hope of encouraging those to whom this would be a serious item. It is pleasant to record that the expense is much lower than I had supposed. Dr. Smith, of the New Jersey Agricultural Experiment Station, has kindly supplied the following data. The elms on the college campus at New Brunswick are 50 to 75 feet high and were sprayed at odd times by the janitors, it requiring about an hour or two with force pump, tank and ladders to treat one tree. The poison necessary for each spraying was worth about six cents. It will thus be seen that the cost per tree would be between 36 and 56 cents, varying with the price of labor. In the city of New Brunswick the trees were sprayed at a contract price of one dollar for the season, the understanding being that they were to receive three treatments if necessary. The contractor prepared the outfit, furnished the material, did the spraying at the price mentioned and had a neat margin remaining.

Mr. Kirkland, Assistant State Entomologist of Massachusetts, has kindly supplied me with the following figures. A grove of over 200 red and white oaks ranging in height from 40 to 70 feet were sprayed once at an expense of 49 cents per tree. In this instance arsenate of lead was used at the rate of 20 lbs. to 150 gallons of water, a considerably stronger mixture than would be necessary for the larvae of the elm-beetle. In addition, he estimated the expense of spraying smaller trees, 20 to 40 feet high, at 15 to 20 cents per tree.

The cost of spraying the elms in Albany this season, aside from wear and tear of the apparatus, is considerably less than the figures above given. The trees present a wide range in size, although the majority are from 50 to about 70 feet in

height. Taking them as they come, Mr. Lewis has succeeded in spraying them once at the low cost of about 15 cents per tree. This is largely due to the excellent apparatus, to be described later, and is a most encouraging feature of the work.

"It is hoped that these figures will induce private individuals to provide protection for their trees, either by doing the spraying themselves or else by hiring some capable party."

We are informed by Mr. Wirth, Park Superintendent of Hartford, that the cost of spraying in Bushnell Park last summer averaged $1.00 per tree and that the benefit to the trees was well worth the outlay.*

Varieties of Trees Suitable for Street Planting.

In conclusion, we desire to say a few words regarding the kinds of trees which it is desirable to plant on city streets.

New Haven, the "Elm City," has for many years been noted for the beauty of its elms, and it seems eminently proper that this character should be preserved. It is, therefore, recommended that when the old elms die, they be replaced by the same species. If the newly set trees are properly cared for, there should be no difficulty in producing specimens of as fine proportions as those now standing.

Next to the elm, the most popular tree for street planting in New Haven has been the sugar maple. In youth it forms a compact, oval, or egg-shaped crown of remarkable symmetry. With advancing age the top becomes broad and often nearly flat, giving the tree an expression of dignity, which it altogether lacks when young. It is transplanted with ease and thrives well in the unfavorable conditions of large cities. It grows rapidly, being surpassed in this respect among the maples only by the silver variety.

The red maple seems to thrive admirably in New Haven. Although it is surpassed by the other maples in grace of form, it will always be a favorite street tree on account of its scarlet flowers, which appear early in spring, and its brilliant autumn foliage. It is recommended for planting in New Haven.

The silver maple has been planted in the New Haven streets only to a limited extent. In its natural habitat it is one of the

* The recommendations contained in the report regarding the method of appointment and duties of a city Forester and regarding the establishment of a city nursery are chiefly of local interest and need not here be reproduced.

most beautiful of all the American trees. Unfortunately, however, it is fastidious as to soil and situation, and the specimens planted in cities do not usually do justice to the capabilities of the tree. It grows with great rapidity and in early life develops a spreading crown with long drooping branches. The wood is soft and brittle, especially when the tree does not find congenial soil, and often the slender trunks are unable to support the long branches, which are broken by their own weight. Wind and ice storms do considerable damage to the silver maple, and the soft wood, when exposed, is quickly attacked by fungus diseases which eventually kill the tree. In the judgment of the Committee it should take a subordinate place among the trees recommended for planting in streets.

The Norway maple is an admirable tree for street planting. It forms a large, compact, round head and casts a very heavy shade. It grows more slowly than the trees already mentioned, but it has the advantage of requiring but little care after planting. It is perfectly hardy in New Haven.

Of the trees which have been but little planted in New Haven, the Committee would specially recommend the pin oak, tulip tree and sycamore.

The pin oak is rapidly coming into popularity in a number of cities. It is distinguished by a graceful pyramidal form with drooping lower branches which often sweep the ground. It is easily transplanted and thrives peculiarly well as a street tree. Its growth is apt to be slow directly after transplanting, but in a few years it is able to keep pace with most other trees. It is recommended for trial in New Haven.

There are a number of other oaks which might well be tried in our streets, as the red, white and scarlet varieties. If frequently transplanted in the nursery and severely pruned before removal, they may be successfully planted in cities.

The tulip tree grows naturally in the woods near New Haven, and will doubtless thrive as a street tree. It grows rapidly and during the period of its principal height growth forms a conical crown, which in old age becomes more or less irregular. It is a tree of great dignity and should be given a trial in New Haven.

For broad streets the sycamore is a beautiful and appropriate tree. Both the American and Oriental varieties are used, and

both develop large spreading crowns and grow with great rapidity. The American sycamore is, as a rule, more subject to disease than the Oriental variety, and in consequence the latter is usually given the preference.

There are a number of American lindens (basswood) planted in the streets and parks of New Haven. This species grows rapidly and develops a large, round crown which casts a deep shade. With proper care the American linden makes an excellent avenue tree, but it is liable to be injured by storms and, if it is neglected, disease is apt to attack the wounds, eventually killing the tree.

The European varieties of linden are to be recommended on account of the perfect symmetry of their compact crowns. They thrive admirably in this climate.

Ash is often planted as a street tree, but its tendency to fork and to become straggling makes it less desirable than those already mentioned.

To summarize what has been discussed above, we make the following

RECOMMENDATIONS.

1. The rigid enforcement of those city ordinances which forbid the bruising, injuring, or destruction of trees, and the fastening of animals to trees in such a way as to injure them.

2. That all trees standing within reach of horses in the street be protected by frames or wire netting, so that they cannot be mutilated.

3. That when limbs are removed from trees, greater care be exercised to cut them smoothly, close to, and even with, the trunk and without tearing the trunk bark. The exposed wood should be painted with coal tar.

4. That the stringing of electric wires be done only under the supervision of the Board of Public Works, and that this supervision be paid for by the company doing the work.

5. That when trees are killed by gas leakage from the mains, the owners of the mains be required to pay to the city the cost of the removal of the trees killed and of planting new trees in their places.

6. That the land under trees in the city parks be annually dressed with lime and with odorless fertilizer of the composition named, at a cost of from $11.00 to $12.00 per acre.

7. That on new streets, when the building line is far enough from the street line, it is desirable to plant just in front of the property line, rather than just back of the curb.

8. That the elm trees on the Green and other interior parks of the city be sprayed regularly for a few years, and thereafter as seems necessary, in the way prescribed.

For this purpose the city should buy a spraying outfit of approved construction, such as has been described, costing about $500.00.

9. That in winter systematic search be made in all belfries and towers of public buildings, and that the elm leaf-beetles, which winter in great numbers in such places, be gathered up and destroyed.

10. We also recommend the permanent employment of a City Forester, who should have charge of the trees in all respects.

11. That, in case such an officer be employed, the city have a nursery of from three to five acres at Springside Farm, where trees suitable for planting on the streets and interior parks can be grown.

Since the foregoing report was printed and issued as Bulletin 131, we have been favored with the comment and friendly criticism of tree wardens, city foresters and others who had special knowledge of the subject.

There is much difference of opinion as to the best season for pruning trees. Mr. Christopher Clarke, City Forester of Northampton, Mass., strongly recommends that shade trees be pruned in New England between May 15th and June 15th. He states that the sugar maple, as well as the birches, certainly will bleed excessively if winter pruning is practiced.

For covering the wounds made by cutting off branches, it is noted that coal tar injures the cambium of certain kinds of trees and small trees are especially liable to be hurt by it. Lead paint, colored like the bark of the trees, is perfectly safe and is perhaps as efficient as any substance used as a dressing. Prof. L. H. Bailey, in The Pruning Book, page 113, says: "My conclusion is, after having had the question in mind for a decade, that a heavy application of lead paint is the best all-round dressing for common pruning wounds."

OBSERVATIONS ON THE FERTILIZATION OF PEACH ORCHARDS.

By E. H. Jenkins.

For several years the Station has carried out experiments on this subject. One of them is here described as matter of record, although of course no decisive result can be looked for until after a considerable term of years. The peach is particularly unsatisfactory as an experiment crop because the fruit, which alone furnishes a numerical expression of the effects of fertilizers, tillage or other factors of growth, cannot be expected each year and sometimes fails for a number of years.

The experiment here described is on land of Mr. A. E. Plant in Branford. The orchard is on a high hill, some miles from the shore of Long Island Sound. The soil is a gravelly loam of fairly good quality. The history of the field is as follows:

After lying several years in grass, the lot was plowed in the fall of 1894, was dressed during the winter with from 75 to 100 bushels of unleached Canada ashes per acre, and was planted to peach trees in the Spring of 1895, the varieties being Mountain Rose, Champion and Early Rivers. Twelve hundred pounds of Mapes' corn manure were applied per acre, and the orchard planted to corn.

The following winter, 1895-96, 75 to 100 bushels of unleached ashes per acre were again put on the land.

In the Spring of 1896, there were laid off on the south end of the orchard eight plots or blocks of trees. Each of these plots covered about one-third of an acre and had 48 trees standing on it. The number of trees of the three varieties named was the same on each plot. To the northern half of each plot, 3⅓ bushels or 167 pounds of slaked oyster shell lime were applied.

The plots, beginning at the west end, were marked and fertilized as follows:

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.

These fertilizers, and the lime, have been applied each Spring, since 1896, in April or very early in May.

In August of each year, crimson clover has been sown on plots C, D, E, F, and has always grown well and lived through the winter. It is plowed under in May. 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.	Total.
Plot A.....	2	12	2	1	10	27
B.....	3	6	1	1	2	13
C.....	2	3	1	1	7	14
D.....	0	1	2	0	8	11
E.....	0	1	0	0	0	1
F.....	0	0	0	0	0	0
	7	23	6	3	27	66

Plot A has suffered most, losing more than one-half of the trees on it in five years. This we believe, is partly due to the excess of water in the soil. Plot B has lost 13 trees, less than one-fourth of the whole number; D and E a smaller number, and on F not a single tree had died.

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. As illustrating the vagaries of the peach crop and the New England winter, it is worth noting that in another part of Mr. Plant's orchard, more than 900 trees which blossomed fully in April soon showed signs of trouble and died before the leaves came out. They had been killed by the winter near the ground as effectually as if girdled with a knife.

The Early Rivers peaches, 95 baskets in all, were picked in our absence and no note is made of them. The other two varieties were picked and measured under the supervision of one of the Station staff. 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 tree 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:

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 yellows.

Discussion of the experiment is reserved till further results have been obtained.

CONDIMENTAL AND MEDICINAL CATTLE AND POULTRY FOODS.

While collecting commercial feeding stuffs for analysis, there were bought by our agents samples of all the brands of Condimental and Medicinal Cattle and Poultry Foods, which were found in the State.

These have been analyzed by the Station staff and have also been carefully examined microscopically by Mr. Winton to identify the materials of which they are compounded.

The results of both the chemical and microscopic analyses appear in the table on pages 356 and 357, and may be summarized as follows:

Of the cattle feeds, three have 24 per cent. and more of protein,—as much as is found in the gluten feeds,—four others have about the same quantity of protein as wheat bran, and one has less than corn-meal of average quality.

No one of them is a "concentrated feed" in the common acceptation of that word.

Five of the number have considerable quantities of salt, amounting in one case to more than 16 per cent., and four contain sulphur, an old-fashioned "spring medicine." The largest quantity of sulphur found was 3.90 per cent. Charcoal is an ingredient of five of the cattle foods.

The poultry foods are not very different from the cattle foods, either in composition or in the materials of which they are made.

The table also gives in detail the materials out of which these condimental foods are prepared. The list comprises the common feeds, cotton-seed meal, linseed meal, wheat feed, corn meal and malt sprouts, and the old-time remedies; sulphur, salt, Epsom salts, charcoal, cayenne, gentian, ginger, turmeric and fenugreek, to which are added mustard hulls and cocoa shells.

The poultry foods are made up of these same things (some of them containing considerable quantities of salt), and in addition, iron oxide, carbonate of lime (shells), and ground bone.

Condimental and Medicinal

Station No.	BRAND.	DEALER.	Price per package, cents.	Approximate weight of package, pounds.
	Cattle Foods.			
3013	Baum's Stock Food. Baum's Castorine Co., Syracuse, N. Y.	*Middletown.* Meech & Stoddard		
1912	Benjamin's Food for Horses and Cattle. Benjamin's Food Co., Danbury, Conn.	*Danbury.* F. C. Benjamin & Co.	25	2
1902	International Stock Food. Int. Food Co., Minneapolis	*New London.* A. C. Rogers	25	2
1905	Myer's Royal Horse and Cattle Spice. Niagara Falls, N. Y.	*Norwich.* J. P. Holloway	25	2
1906	Nutriotone. Thorley Food Co., Chicago	*Willimantic.* A. E. Buck & Co.	50	2
1909	Orange Electric Food. G. E. Vincent, Catskill, N. Y.	*Rockville.* Edward White	50	3
1901	Pratt's Animal Regulator. Philadelphia	*New London.* Beebe & Bragaw	25	1⅝
1907	Medicated Meal. F. C. Sturtevant, Hartford, Conn.	*Hartford.* W. H. Toby	25	1¼
	Poultry Foods.			
1908	Baum's Poultry Food. Baum's Castorine Co., Syracuse	*Thompsonville.* H. K. Brainard	25	2
1911	Benjamin's Poultry Food	*Danbury.* F. C. Benjamin	25	2
1910	Dr. Hess' Poultry Panacea. Dr. Hess & Clark, Ashland, O.	*South Norwalk.* G. C. Stillson	25	1½
1903	International Poultry Food. Int. Food Co., Minneapolis	*Norwich.* Norwich Grain Co.	25	2
1914	Myer's Royal Poultry Spice. Niagara Falls, N. Y.	*East Hartford.* W. J. Cox	35	2
1904	Pratt's Poultry Food. Philadelphia	*Norwich.* A. A. Beckwith	25	1⅝
1913	Triplex Poultry Food. Triplex Food Co., New Brunswick, N. J.	*Waterbury.* Spencer & Pierpont	25	1½

Cattle and Poultry Foods.

Station No.	Water.	Ash. Total ash.	Ash. Common salt.	Free sulphur.	Protein.	Crude fiber and charcoal.	Nitrogen-free extract.	Fat.	PRINCIPAL INGREDIENTS.
3013	9.28	12.27*	3.59	3.90	25.84	19.37	25.19	4.15	Linseed meal, charcoal, salt, Epsom salts, sulphur.
1912	6.92	5.52	----	----	27.82	7.57	45.92	6.25	Linseed meal, wheat feed, fenugreek.
1902	6.13	12.50	8.38	----	14.31	14.51	47.88	4.67	Wheat feed, cayenne, a bitter drug,¶ salt, charcoal.
1905	6.10	20.34	16.52	----	17.81	5.84	47.86	2.05	Linseed meal, corn meal, wheat feed, mustard hulls, cocoa shells, malt sprouts, fenugreek, turmeric, salt.
1906	5.94	21.49	13.10	.83	18.97	5.10	42.23	5.44	Linseed meal, corn meal, wheat feed, cotton seed meal, fenugreek, salt, charcoal, sulphur.
1909	6.80	4.00	----	.40	15.03	7.81	58.92	7.04	Corn meal, linseed meal, charcoal, sulphur.
1901	6.67	12.40	10.11	----	9.69	3.12	63.75	4.37	Corn meal, fenugreek, a bitter drug,¶ salt, charcoal.
1907	6.34	8.94	----	2.93	24.10	10.98	39.08	7.63	Linseed meal, corn meal, ginger, fenugreek, a bitter drug, sulphur.
1908	6.95	16.68†	4.88	6.73	19.53	15.40	32.62	2.09	Linseed meal, wheat feed, cayenne, charcoal, salt, Epsom salts, iron oxide, sulphur.
1911	7.05	5.42	----	----	29.19	8.44	42.92	6.98	Linseed meal, wheat feed, corn meal, cotton seed meal, mustard hulls.
1910	6.98	35.67‡	11.65	----	11.94	5.17	37.80	2.44	Wheat feed, charcoal, salt, lime carbonate, iron oxide.
1903	6.79	7.87	2.26	----	14.88	13.97	49.69	6.80	Wheat feed, cayenne, a bitter drug, charcoal, salt.
1914	6.17	17.00	12.88	----	18.19	7.93	45.42	5.29	Linseed meal, corn meal, wheat feed, mustard hulls, cocoa shells, fenugreek, turmeric, cayenne, salt.
1904	7.01	6.28§	----	.81	14.87	6.04	56.94	8.05	Corn meal, wheat feed, a bitter drug, iron oxide, sulphur.
1913	5.76	40.87‖	----	.93	18.03	4.57	25.38	4.46	Linseed meal, wheat feed, charcoal, ground bone, lime carbonate, iron oxide, sulphur.

* Of which, magnesia 1.57, sulphuric acid 2.03, lime 0.80 and carbonic acid 0.85 per cent.

† Of which, magnesia 0.66, sulphuric acid 1.82, lime 0.63, carbonic acid 1.62, phosphoric acid 1.22, oxide of iron 1.89 and sand 1.50 per cent.

‡ Of which, lime 6.00, carbonic acid 5.98, phosphoric acid 1.09, oxide of iron 2.97 and sand 0.88 per cent.

§ Of which, oxide of iron 1.12 per cent.

‖ Of which, lime 19.29, magnesia 0.54, phosphoric acid 11.67, and carbonic acid 5.33 per cent.

¶ Corresponds with gentian in microscopic structure.

In the condimental foods examined no injurious drugs have been found. They are for the most part old-time simple remedies which most farmers buy very cheaply at the village grocery or drug store and keep in the house for use.

There are only two things which call for further notice.

The Claims made for these Feeds. The special claims made for these feeds in advertisements and on the containing packages are very numerous and are of two rather distinct kinds: First, that they are appetizers, giving an agreeable odor and taste to the feed, thus inducing stock to eat more of it, and also making them digest it better than they otherwise would. Secondly, that the foods have great medicinal value.

The claims made under this latter head are as extravagant as those made for patent medicines sold for human use and are supported in some cases by testimonials about as valuable. For example:

One, "cures hog cholera, makes pigs grow quickly, dairy cows produce more butter and milk, stops slinking of calves . . . and regulates horses."

This takes the place of another article made by the same firm and is "much more highly concentrated." This highly concentrated feed, which cures hog cholera, contains less protein than any other of the condimental foods and consists of corn meal, salt, charcoal, fenugreek and a bitter drug, probably gentian.

Another, which "is the most effectual and economical remedy known for diseases of cattle," guaranteed to cure "scowers" in calves, consists of corn meal, linseed meal, charcoal and sulphur.

Still another "is composed of laxatives and tonics in abundance, aromatics in just proportion, diuretics, expectorants and alteratives."

This beneficial mixture is made of linseed meal, corn meal, ginger, fenugreek, a bitter drug and sulphur.

Other brands of condimental food with less remarkable claims for medicinal value are advertised as food "auxiliaries," "appetizers," and flesh and milk producers.

It is interesting to note that the Poultry Feeds are very like the Cattle Feeds, both in chemical composition and in materials used, so that were the claims of the manufacturers all valid, a condimental feed which would cure gapes in chickens might

be expected to increase the flow of milk of cows and also to cure hog cholera.

The mildly curative properties of the various drugs used in these feeds are well understood by most dairy farmers, as well as their limitations.

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 cost about 12½ cents per pound, the most expensive 20 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.

Methods of Analysis of Condimental Foods.

Water, ash, protein, crude fibre (including charcoal), total ether extract and *phosphoric acid* were determined by the methods of the Association of Official Agricultural Chemists.

Common salt was calculated from the chlorine, determined volumetrically, in a water solution, by standard silver nitrate.

Carbonic acid was determined gravimetrically by absorption in soda lime.

Iron, lime and *magnesia.* The ash was dissolved in hydrochloric acid and the acid nearly neutralized with ammonia. Iron (including a trace of alumina) was precipitated by addition of ammonium acetate and a little acetic acid, heating for some time at 50° C. The weight of the precipitate was corrected for phosphoric acid determined gravimetrically. Lime was precipitated in the filtrate by ammonium oxalate, and magnesia in the filtrate from the lime, by sodium phosphate.

The presence of free sulphur was indicated by yellow crystalline scales in the ether extract. In each case it was demonstrated that the first extraction of sixteen hours was complete, by a second extraction with ether and a subsequent extraction with purified carbon bisulphide.

Free sulphur was determined in the ether extract, after transferring with the aid of alcoholic sodium hydrate solution to a nickel crucible, by fusion with sodium hydrate, oxidation with sodium peroxide and precipitation with barium chloride.*

Fat was obtained by difference, subtracting the percentage of free sulphur from the total ether extract.

* The details of this process were kindly furnished by Dr. Osborne, who has used it extensively in the determination of sulphur in proteids.

THE COMPOSITION OF COMMERCIAL FEEDING-STUFFS SOLD IN CONNECTICUT.*

During the autumn of 1900, agents of this Station collected in twenty-five towns and villages of the State, one hundred and eighty-six samples of commercial feeding-stuffs, exclusive of the condimental foods referred to in a previous bulletin.

The analyses of these feeds appear in Table I on pages 372 to 387. 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 average of all the analyses of each kind of feeding-stuff, which have been made at the Experiment Stations of the New England States, and published within the past year.

(4) The digestible nutrients of these feeds. These are calculated from the average composition of the samples found in this State, by the use of the digestion coefficients given in Bulletin 77 of the Office of Experiment Stations.

The results of the analyses are summarized as follows:

Cotton Seed Meal.

The four samples analyzed were of usual quality; the percentage of protein ranging from 41.00 to 45.87, and of fat from 8.38 to 8.81. These percentages are considerably lower than the average of 179 analyses recently made in other New England states.

Guarantees.

Three of the samples were guaranteed to contain 43 per cent. of protein and 9 per cent. of fat. In all of them the percentage of fat was a fraction of 1 per cent. below the guarantee and in one case the percentage of protein was also below.

* The microscopic work referred to in this paper was wholly done by Mr. A. L. Winton. The analyses were made by Messrs. Winton, Ogden and Langley. The discussion of the results is by the Director.

Linseed Meal.

Of the six samples examined, two were apparently "new process" and four were "old process" meals.

The average percentages of protein and fat in the two kinds were as follows:

	Average per cent. of protein.	Average per cent. of fat.
New Process	38.43	2.35
Old Process	31.33	6.72

Sample 2402, sold as old process meal, is, quite evidently, new process.

Guarantees.

Three of the samples, Nos. 1798, 2402, and 2378, bore guarantees and contained substantially what was guaranteed.

Red Dog Flour.

This is the poorest grade of flour, off color, and often sold as a cattle food and for making paste.

Wheat Feeds.

In the following table 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.
Stott'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.
Bay State Milling Co., Winona, Wis.
Berger, Anderson Co., Milwaukee.
Daisy Roller Mill Co., Milwaukee, Wis.
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.
Minkota Milling Co., Superior, Wis.
Moseley & Motley Milling Co., Rochester, N. Y.
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.
Washburn-Crosby Co., Minneapolis.
Whitney & Wilson, Rochester, N. Y.
Woodworth & Co., E. S., Minneapolis.

The differences between the several wheat feeds in the percentages of protein and fat which they contain are shown in the following statement, compiled from all available analyses of these products made at the New England Agricultural Stations during the last twelve months.

Average Composition of Bran, Middlings and Mixed Wheat Feed.

	Bran.		Middlings.		Mixed Wheat Feed.	
	Winter.	Spring.	Winter.	Spring.	Winter.	Spring.
Protein	16.46	15.80	17.51	18.68	17.03	16.90
Fat	4.53	5.00	4.70	5.45	4.58	5.12

The percentages of protein and fat are very nearly alike in Winter and Spring mixed feed. Winter wheat bran shows a higher percentage of protein, but winter wheat middlings a lower percentage of protein than the corresponding spring wheat products.

All the wheat products analyzed were of good quality and apparently free from any adulteration. With three exceptions, none of them had any guarantee of composition. Three samples of mixed feed, made by the American Cereal Co., were guaranteed to contain 18.21 per cent. of protein and 4.48 per cent. of fat. The amounts of protein and fat found by analysis agreed with this guarantee.

Corn Meal.

Of the two samples examined, one was low grade, containing only 8.81 per cent. of protein, nearly three-fourths of 1 per cent. below the average.

Gluten, Gluten Meal, Gluten Feed.

These are all by-products of the manufacture of corn starch and glucose.

The process of manufacture was quite fully described in our last report.

Atlantic Gluten, made by the Atlantic Starch Works, Westport, is sold under a guarantee of 38 per cent. of protein and 2 per cent. of fat. Only one of the six samples examined contained the percentage of protein guaranteed, and only one contained 2 per cent. of fat. The per cent. of protein ranged from 25.25 to 39.75, the average being 32.88.

Last year this feed was the most concentrated of any on the market.

Cream Gluten, made by the Chas. Pope Glucose Co., Chicago, Ill., is guaranteed to contain 34.12 per cent. of protein and 3.20 per cent. of fat. The average protein found by analysis is 35.10 per cent. and the average fat 2.92 per cent.

Chicago Gluten Meal, made by the Glucose Sugar Refining Co., Chicago, Ill., is guaranteed to contain 36 per cent. of protein and 3.37 per cent. of fat, in the water-free material. All of the samples examined contained more than these percentages, the average of all being 38.70 per cent. of protein and 3.23 per cent. of fat, with 8.65 per cent. of water. This is equivalent to 42.3 per cent. of protein and 3.5 per cent. of fat in the water-free material.

Waukegan Gluten Feed, made by the U. S. Sugar Refining Co., is guaranteed to contain 27.38 per cent. of protein and 3.39 per cent. of fat. The four samples analyzed were quite uniform in composition, containing an average of 27.04 per cent. of protein and 3.89 per cent. of fat; being in substantial agreement with the guarantee.

Davenport Gluten Feed. The three samples analyzed showed wide differences in protein, the highest percentage being 34.94, as high as gluten meal, the lowest being 25.87.

The manufacturer's guarantee of 25.50 was made good in every case, but no one of the samples contained 4 per cent. of fat as guaranteed.

Buffalo Gluten Feed, made by the Glucose Sugar Refining Co., Chicago, is guaranteed to contain 25.50 per cent. of protein and 4 per cent. of fat.

Protein, in the three samples examined, ranged from 24.75 to 27.06, the average being 25.88, and the fat ranged from 3.40 to 4.17 and averaged 3.67 per cent.

Glen Cove Gluten Feed, made by the National Starch Manufacturing Co., Glen Cove, L. I., is guaranteed to contain 28.4 per cent. of protein and 4.3 per cent. of fat. The average of four analyses shows 28.76 per cent. of protein and 3.73 per cent. of fat.

Germ Oil Meal.

Of the four samples analyzed, two are of unknown manufacture. One, made by the Glucose Sugar Refining Co., Chicago, Ill., contains 22.50 per cent. of protein and 9.39 per cent. of fat. In the *dry substance* this is equivalent to 24.7 and 10.3 per cent. respectively. The guarantee on dry substance is 25.5 and 10.5.

The sample made by the American Cereal Co. contains 22.06 per cent. of protein and 16.23 per cent. of fat. The guaranteed percentages are 23.0 and 19.5 respectively.

Hominy Chop.

The samples examined have been of quite uniform quality, the percentage of protein ranging from 10.69 to 12.69, averaging 11.67, and that of fat ranging from 6.50 to 10.4 and averaging 8.71.

Only three of the samples bore guarantees, as follows:

	Chapin & Co. 1888	Hunter Bros. 2364	Miner-Hillard Milling Co. 2403
Protein found	11.94	11.69	11.62
" guaranteed	11.0	11.02	10.87
Fat found	9.48	10.04	8.12
" guaranteed	8.0	7.70	8.46

Ground Oats.

Of the two samples of the same brand, "Magnolia Ground Oats," given in the table, one has an exceptionally high percentage of protein, with a low percentage of fiber; the other has a large amount of fiber (light oats, hulls), and in consequence a low per cent. of protein.

Provender.

This name formerly applied strictly to a ground mixture of corn and oats in equal weights. The product of local mills is still made in the same way, but the commercial article too often contains an undue proportion of light-weight oats or of oat hulls, which reduces the percentage of protein.

Of the three samples analyzed, two are from local mills and one presumably ground elsewhere. The former contain on the average 10.85 per cent. of protein, while the latter contains only 9.50 per cent.

Corn and Oat Feeds.

Here belong a number of feeds, all of them of very inferior feeding value to farmers, sold at a relatively high price.

Victor Corn and Oat Feed is made by the American Cereal Co. and guaranteed to contain 8.23 per cent. of protein and 3.0 per cent. of fat. Each of the five samples examined fully met this guarantee.

Lenox Feed, sold without guarantee, has about the same average composition as the Victor.

Oat Feed "Vim," made by the American Cereal Co., Chicago, is guaranteed to contain only 6.30 per cent. of protein and 2.38 per cent. of fat. The sample analyzed contains more of each constituent than is guaranteed, but cannot be economically used by the dairyman.

Friend Concentrated Dairy Food, sold without guarantee, contains a large proportion of oat hulls and is the lowest grade feed which has been found in the Connecticut market this year. To call it "Concentrated Dairy Food," is the grossest kind of misrepresentation.

Corn, Oats and Barley.

A mixture with this name is made by the American Cereal Co., and guaranteed to contain 10.78 per cent. of protein and 3.29 per cent. of fat. Each of the three analyses made were fully up to this guarantee.

"Rye Feed"

is a material which shows a very considerable range of composition, depending on the process of manufacture. The sample whose analysis is given shows a much higher percentage of protein, 16.12, than is usually found in this feed.

Buckwheat Bran.

Attention is called to this article because of its very high percentage of protein, 33.37 per cent. Only a very limited amount of it is made, but some who have used it consider it unsurpassed as a concentrated feed for dairy stock.

Factory Mixed Feeds.

H-O Dairy Feed, made by the H-O Co., Buffalo, N. Y., is a mixture of corn and oat feeds with a little wheat and some cotton seed meal, and is guaranteed to contain 18 per cent. of protein and 4.5 per cent. of fat. The three samples analyzed contained, on the average, 1 per cent. more of protein and one-half per cent. less of fat than was guaranteed.

H-O Poultry Feed, made by the same firm, is essentially a mixture of hulled oats, cracked corn and wheat bran or middlings, for which $29 and $30 per ton are charged. The average percentages of protein and fat found by analysis were 16.70 and 5.31 respectively; the percentages guaranteed are 17 and 5.50.

H-O Horse Feed, also made by the H-O Co., is essentially a mixture of cracked corn, oats, some wheat product with a little linseed meal, and costs from $21 to $23. It is guaranteed to contain 12 per cent. of protein and 4.50 per cent. of fat. Five samples contained an average of 12.73 per cent. of protein and 4.04 per cent. of fat.

Quaker Dairy Feed, made by the American Cereal Co., Chicago, Ill., is a mixture of ground oats, wheat and a little corn, sold for $18 to $22 per ton, and guaranteed to contain 12.03 per cent. of protein and 2.50 per cent. of fat. The percentages found by analysis were considerably higher, 13.77 and 3.38 respectively.

American Poultry Food, made by the American Cereal Co., is essentially a mixture of corn and wheat products, guaranteed to contain 13.96 per cent. of protein and 5.49 per cent. of fat. The average of two analyses gave 13.12 per cent. of protein and 6.95 per cent. of fat.

Blatchford's Calf Meal, made by John W. Barwell, Waukegan, Ill., is essentially 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 extract as the gluten feeds.

THE COMPOSITION OF COMMERCIAL FEEDING-STUFFS COMPARED WITH THEIR PRICES.

In the last Report of this Station, it was shown 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 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 cheaper than he can 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 principal commercial feeding-stuffs 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, containing over 40 per cent. of protein, and costing $27.60 per ton.

TABLE II.—COMMERCIAL FEEDING STUFFS, ARRANGED ACCORDING TO THEIR PERCENTAGE OF PROTEIN.

	Protein. %	Fat. %	Cost per ton.
Cotton Seed Meal	42.8	8.5	$27.60
Chicago Gluten Meal	38.7	3.2	27.60
New Process Linseed Meal	38.4	2.4	32.00
Cream Gluten Meal	35.4	2.9	28.00
Atlantic Gluten Meal	32.9	2.0	----
Old Process Linseed Meal	31.3	6.7	31.00
Davenport Gluten	29.3	3.1	24.50
Glen Cove Gluten Feed	28.8	3.7	22.00
Waukegan Gluten Feed	27.0	3.9	22.50
Buffalo Gluten Feed	25.9	3.7	25.75
Blatchford's Calf Meal	25.0	4.7	55.00
Spring Wheat Middlings	19.1	5.5	21.50
Winter Wheat Mixed Feed	18.1	4.7	21.00
H. O. Dairy Feed	18.1	4.0	22.00
Winter Wheat Middlings	17.7	4.7	21.75
Spring Wheat Bran	16.5	5.0	20.00
Winter Wheat Bran	16.2	4.6	21.00
Quaker Dairy Feed	13.5	3.1	19.50
H. O. Horse Feed	12.2	3.5	22.00
Hominy Chop	11.7	8.7	20.00
Corn, Oats and Barley	11.6	4.7	21.00
Ground Oats	11.5	5.5	17.00
Provender	10.9	4.6	19.00
Corn Meal	9.4	4.0	20.00
"Victor" Corn and Oat Feed	9.1	4.2	20.00
Oat Feed "Vim"	8.6	2.5	16.00
Lenox Feed	8.4	3.4	17.00
Concentrated Dairy Feed	6.6	3.1	14.20

2. Gluten Meals and Linseed Meals, containing 30 to 40 per cent. of protein, and costing $27.60 to $32.

3. Gluten Feeds, containing 25 to 30 per cent. of protein, and costing $22 to $26.

4. The Wheat Feeds, containing 15 to 20 per cent. of protein, and costing $20 to $22.

5. Corn Chop, Oats, Corn, Provender, containing 9 to 12 per cent. of protein, and costing $17 to $20.

6. Oat Feeds, Oat Hulls and various worthless wastes, containing 6½ to 9 per cent. of protein, and costing $14.20 to $20.

It will also be noted that the percentages of fat in these feeds are not very unlike, ranging between 2.4 and 5.5 per cent., with exception of cotton seed meal, old process linseed meal and hominy chops, 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 twenty pounds of protein in	Cotton Seed Meal cost	$0.64
Then	"	"	Gluten Meals cost about	0.85
	"	"	Gluten Feeds cost about	0.88
	"	"	Wheat Feeds cost about	1.20
	"	"	Oats, Corn, Provender, Corn Chop, etc., cost	1.77
	"	"	Oat Feeds and other trash cost...	2.10

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 classes 5 and 6. Home-grown corn meal makes anything in these two groups 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.

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

TABLE I.—ANALYSES OF COMMERCIAL FEEDS.

Station No.	Name of Feed.	Manufacturer or Jobber.	Retail Dealer.
1793	Cotton Seed Meal	American Cotton Oil Co.	Hartford, Smith, Northam & Co.
2387	" Owl Brand	F. W. Brode & Co., Memphis, Tenn.	Suffield, Spencer Bros.
2845	"	Chapin & Co., Boston, Mass.	Putnam, Bosworth Bros.
3019	"		New Milford, Ackley, Hatch & Marsh
			Average of the above 2 analyses
			Average digestible
			Average of 179 recent analyses
1798	Oil Meal, "Old Process"	American Linseed Co., Chicago	Hartford, Smith, Northam & Co.
2373	Linseed Meal, "		Naugatuck, Grant Grocery Co.
2402	" "		Bristol, G. W. Eaton
2432	Oil Meal "	Douglass & Co., Minneapolis	West Winsted, Balch & Platt
2378	Linseed Meal		Derby, Peterson, Hendee Co.
262	"		Bridgeport, Wheeler & Howes
			Average of the above 3 analyses of Old Process Linseed Meal
			Average digestible
			Average of the above 2 analyses of New Process Linseed Meal
			Average digestible
			Average of 41 recent analyses of Old Process Linseed Meal
			Average of 43 recent analyses of New Process Linseed Meal
123	"Patent Flour Stock" No. 1	Pillsbury-Washburn Flour Mills Co., Minneapolis	Sent by manufacturer
124	"Patent Flour Stock" No. 2	Pillsbury-Washburn Flour Mills Co., Minneapolis	" "
125	"Patent Flour Stock" No. 3	Pillsbury-Washburn Flour Mills Co., Minneapolis	" "
126	"Patent Flour Stock" No. 4	Pillsbury-Washburn Flour Mills Co., Minneapolis	" "
112	"Red Dog Flour"	Northwestern Consolidated Milling Co.	Boston, C. M. Cox & Co.
			Average of 8 recent analyses
	Bran from Winter Wheat.		
1796	Bran, Winter Wheat	Voigt Milling Co., Grand Rapids	Hartford, Smith, Northam & Co.
1866	" Choice	Hecker-Jones-Jewell Milling Co., N. Y.	South Norwalk, Manuel T. Hatch
1872	" Canadian	C. M. Cox & Co., Boston	" " "
2370	" Winter Wheat	Valley City Mill. Co., Grand Rapids	Naugatuck, Grant Grocery Co.
2396	" "	Abner Hendee, Agent, New Haven	Southington, Southington Lumber & Feed Co.

SAMPLED IN 1900.

Station No.	Analyses. Water.	Ash.	Protein.	Fiber.	Nitrogen-free Extract. (Starch, gum, etc.)	Ether Extract.	Price per ton.
1793	7.74	5.49	44.50	9.66	24.23	8.38	$30.00
2387	7.79	6.89	41.00	8.83	26.93	8.56	27.00
2845	----	----	45.87	----	----	----	----
3019	6.41	----	44.19	----	----	8.81	26.00
	7.76	6.19	42.75	9.25	25.58	8.47	
	----	----	37.79	5.13	15.50	7.90	
	----	----	**45.13**	----	----	**10.20**	
1798	9.74	5.19	33.62	9.40	35.19	6.86	32.00
2373	8.95	5.38	31.75	8.23	39.16	6.53	30.00
2402	8.65	5.38	39.00	8.40	36.33	2.24	33.00
2432	9.74	5.45	28.62	8.77	40.64	6.78	40.00
2378	9.12	4.90	37.87	8.92	36.73	2.46	32.00
262	----	----	33.75	----	----	----	----
	9.48	5.34	31.33	8.80	38.33	6.72	
	----	----	27.82	5.02	29.74	5.95	
	8.89	5.14	38.43	8.66	36.53	2.35	
	----	----	34.13	4.94	28.35	2.08	
	----	----	**33.06**	----	----	**7.27**	
	----	----	**38.09**	----	----	**2.59**	
123	11.47	1.63	15.06	1.19	67.38	3.27	----
124	12.16	0.69	12.44	0.22	73.42	1.07	----
125	12.09	0.53	13.00	0.38	72.48	1.52	----
126	11.97	0.48	13.31	0.35	72.52	1.37	----
112	9.18	3.58	19.31	2.69	59.74	5.50	----
	----	----	**18.69**	----	----	**4.88**	
1796	10.37	5.68	16.50	7.37	55.60	4.48	22.00
1866	8.36	3.58	16.50	10.01	56.78	4.77	20.00
1872	8.44	6.01	15.19	10.21	55.67	4.48	23.00
2370	9.35	5.33	16.25	9.00	55.39	4.68	20.00
2396	8.58	7.05	15.75	11.07	52.18	5.37	20.00

TABLE I.—*Continued.* ANALYSES OF COMMERCIAL FEEDS.

Station No.	Name of Feed.	Manufacturer or Jobber.	Retail Dealer.
2419	Bran, Coarse		Torrington, G. W. Green
			Average of the above 6 analyses
			Average digestible
			Average of 38 recent analyses
	Bran from Spring Wheat.		
1797	Bran, Spring	Pillsbury, Minneapolis	Hartford, Smith, Northam & Co.
1875	" "	" "	Stamford, Ingersoll Bros.
1881	" "	" "	Danbury, F. C. Benjamin & Co.
2357	" "	Harder & Son, Agt., Boston	Waterbury, Spencer, Pierpont & Co.
2362	" "	Northwestern Consolidated Mill. Co., Minneapolis	Watertown, C. W. & T. F. Atwood
2374	" "		Derby, Peterson-Hendee Co.
2393	" Coarse	Washburn-Crosby Co.	Plantsville, Atwater's Mill
2425	" "A"	J. S. Wolf, Agt., Pittsfield, Mass.	Canaan, Ives & Pierce
			Average of the above 8 analyses
			Average digestible
			Average of 45 recent analyses
	Bran, unclassified.		
2354	Bran, Michigan	Agt., Smith, Northam & Co., Hartford	Waterbury, Platts Mills Co.
2391	"	Agt., Abner Hendee, New Haven	Suffield, Spencer Bros.
2429	" Choice Clean	J. G. Davis Co., Rochester, N. Y.	West Winsted, Balch & Platt
			Average of the above 3 analyses
			Average digestible
	Middlings, Winter Wheat.		
1792	Choice	Voigt Milling Co., Grand Rapids	Hartford, Smith, Northam & Co.
2355	" White	Voigt Milling Co., Grand Rapids	Waterbury, Spencer, Pierpont & Co.
2369	"	Valley City Mill Co., Grand Rapids	Naugatuck, Grant Grocery Co.
2397		Kane Mill Co., Atchison, Kan.	Southington, Southington Lumber & Feed Co.
2416	B	Agt., C. M. Cox & Co., Boston	Torrington, E. H. Talcott
2420			" G. W. Green
			Average of the above 6 analyses
			Average digestible
			Average of 18 recent analyses
	Middlings, Spring Wheat.		
113	Standard	Northwestern Consolidated Milling Co.	Boston, C. M. Cox & Co.
114	Improved	Northwestern Consolidated Milling Co.	" " "
115	Standard	Washburn-Crosby Co.	" " "
116	Fancy	" "	" " "
1794	A	Pillsbury, Minneapolis	Hartford, Smith, Northam & Co.
1800	Daisy	" "	" " "
1861	Badger Flour	Berger, Anderson Co., Milwaukee	Norwalk, Holmes, Keeler & Selleck Co.

SAMPLED IN 1900.

Station No.	Analyses. Water.	Ash.	Protein.	Fiber.	Nitrogen-free Extract. (Starch, gum, etc.)	Ether Extract.	Price per ton.
2419	9.41	5.88	16.69	8.82	55.41	3.79	$21.00
	9.09	5.59	16.15	9.41	55.17	4.59	
	----	----	12.56	2.69	38.29	3.12	
	----	----	**16.46**	----	----	**4.53**	
1797	9.48	6.34	16.25	10.66	52.13	5.14	22.00
1875	9.10	5.96	16.19	10.17	53.60	4.98	20.00
1881	8.27	6.15	16.50	**11.33**	52.98	4.77	19.00
2357	8.84	5.85	16.62	9.95	53.62	5.12	19.00
2362	8.50	6.22	16.50	10.40	53.11	5.27	19.00
2374	8.71	6.57	17.75	7.74	54.58	4.65	20.00
2393	8.43	6.08	16.06	11.45	53.54	4.44	20.00
2425	8.33	6.46	16.12	11.43	52.37	5.29	19.00
	8.71	6.20	16.50	10.39	53.24	4.96	
	----	----	12.84	2.97	36.95	3.37	
	----	----	**15.80**	----	----	**5.00**	
2354	8.81	5.33	16.12	7.51	58.24	3.99	21.00
2391	8.98	6.19	17.00	8.31	54.57	4.95	20.00
2429	9.02	6.06	16.81	8.99	53.88	5.24	21.00
	8.93	5.86	16.65	8.27	55.56	4.73	
	----	----	12.95	2.37	38.56	3.22	
1792	10.42	4.25	17.00	5.11	58.78	4.44	23.00
2355	11.09	3.71	16.37	4.69	60.13	4.01	21.00
2369	10.54	4.32	16.31	5.42	59.12	4.29	22.00
2397	9.65	4.72	19.37	4.78	56.08	5.40	21.00
2416	10.28	4.52	19.25	6.00	54.86	5.09	22.00
2420	9.98	4.13	17.94	4.82	58.29	4.84	21.50
	10.33	4.28	17.70	5.14	57.87	4.68	
	----	----	14.12	1.70	47.05	4.04	
	----	----	**17.51**	----	----	**4.70**	
113	9.22	5.44	17.06	5.50	56.97	5.81	----
114	9.89	3.91	20.31	4.65	55.08	6.16	----
115	9.52	4.46	18.06	9.03	53.70	5.23	----
116	9.76	3.95	17.81	6.26	57.46	4.76	----
1794	9.87	4.63	19.37	6.47	53.59	6.07	23.00
1800	10.62	3.30	20.00	2.34	58.22	5.52	23.00
1861	10.39	4.07	20.50	5.55	53.42	6.07	20.00

TABLE I.—*Continued.* ANALYSES OF COMMERCIAL FEEDS.

Station No.	Name of Feed.	Manufacturer or Jobber.	Retail Dealer.
1862	Snow's Cream Flour	E. S. Woodworth & Co., Minneapolis	Norwalk, Holmes, Keeler & Selleck Co.
1869	Fancy	Andrews & Co., Minneapolis	South Norwalk, Manuel T. Hatch
1877	A	Pillsbury, Minneapolis	New Canaan, C. H. Fairty
1892	Flour	Washburn-Crosby Co.	New Milford, F. R. Green
1896	"	Sheffield Milling Co., Faribault, Minn.	" Ackley, Hatch & Marsh
1900	Snow's Cream Flour	E. S. Woodworth & Co., Minneapolis	Waterbury, Platts Mills Co.
2379		Bay State Milling Co., Winona, Minn.	Ansonia, Ansonia Flour & Grain Co.
2382	B	Pillsbury, Minneapolis	Hartford, Smith, Northam & Co.
2386	Standard	Washburn-Crosby Co.	East Hartford, G. M. White & Co.
2388	Flour	" "	Suffield, Spencer Bros.
2394	A	Pillsbury, Minneapolis	Plantsville, Atwater's Mill
2426	A	Pillsbury, Minneapolis	Canaan, Ives & Pierce
2430		Northwestern Consolidated Mill Co.	West Winsted, Balch & Platt
			Average of the above 20 analyses.
			Average digestible
			Average of 69 recent analyses
	Middlings, unclassified.		
1885	Dexter	Chapin, Boston	Danbury, F. C. Benjamin
2375			Derby, Peterson, Hendee Co., (Caroline St.)
2377			Derby, Peterson, Hendee Co., (Main St.)
2405	H		Bristol, G. W. Eaton
2412		Agt., Hollister, Chase & Co., N. Y.	" W. O. Goodsell
			Average of the above 5 analyses
			Average digestible
	Mixed Feed from Winter Wheat.		
147	Snow Flake	Lawrenceburg Roller Mills Co., Lawrenceburg, Ind.	East Hartford, G. M. White & Co.
1799	Sunshine	Hunter Bros., St. Louis, Mo.	Hartford, Smith, Northam & Co.
1871	Buckeye Wheat Feed	American Cereal Co.	South Norwalk, Manuel T. Hatch
1879	" " "	" "	Danbury, F. C. Benjamin & Co.
1894	Snow Flake	Lawrenceburg Roller Mills Co.	New Milford, Ackley, Hatch & Marsh
2351	Acme Feed	Acme Milling Co., Indianapolis	Waterbury, Platts Mill Co.
2356	Mixed Feed	Rex Mill Co.	" Spencer, Pierpont & Co.
2363	"	Isaac Hunter Co., Toledo, Ohio	Watertown, C. W. & T. F. Atwood
2366	Buckeye Wheat Feed	American Cereal Co.	" " "
2368	Farmers' Favorite Mixed Winter Wheat	Valley City Mill Co., Grand Rapids	Naugatuck, Grant Grocery Co.
2380	Snow Flake	Lawrenceburg Roller Mills Co.	Ansonia, Ansonia Flour & Grain Co.
2381	Hoosier Mill Feed	Geo. F. Evans, Indianapolis	Ansonia, Ansonia Flour & Grain Co.

SAMPLED IN 1900.

Station No.	Analyses. Water.	Ash.	Protein.	Fiber.	Nitrogen-free Extract. (Starch, gum, etc.)	Ether Extract.	Price per ton.
1862	10.75	3.11	20.25	2.61	58.09	5.19	$21.00
1869	10.34	3.21	19.87	2.73	58.98	4.87	22.00
1877	10.10	4.49	19.50	6.43	53.31	6.17	21.00
1892	10.00	4.51	19.85	6.81	53.49	5.34	21.00
1896	9.60	4.62	19.44	5.98	54.39	5.97	20.00
1900	10.52	3.23	19.31	2.30	59.77	4.87	22.00
2379	9.40	4.74	19.50	6.59	53.94	5.83	20.00
2382	10.73	4.97	18.00	7.82	53.17	5.31	22.00
2386	9.97	4.53	18.81	7.51	53.94	5.24	21.00
2388	9.53	4.62	17.94	7.02	55.47	5.42	22.00
2394	9.56	4.30	19.37	6.21	54.84	5.72	20.00
2426	9.93	4.38	19.44	6.55	54.15	5.55	21.00
2430	9.69	4.67	18.12	8.80	53.44	5.28	22.00
	9.97	4.25	19.12	5.85	55.28	5.52	
	----	----	15.27	1.94	44.94	4.76	
	----	----	18.68	----	----	5.45	
1885	10.80	4.62	18.87	5.91	55.36	4.44	21.00
2375	10.36	4.19	18.12	5.57	57.06	4.70	21.00
2377	10.19	3.41	19.19	2.12	59.73	5.36	21.00
2405	9.08	5.08	17.25	7.30	56.24	5.05	23.00
2412	9.84	4.05	18.62	6.78	55.63	5.08	21.00
	10.05	4.27	18.41	5.54	56.80	4.93	
	----	----	14.69	1.83	46.18	4.25	
147	----	----	17.06	----	----	4.01	----
1799	9.26	5.82	16.50	8.16	55.81	4.45	23.00
1871	9.09	5.50	18.56	8.08	54.15	4.62	21.00
1879	9.23	5.37	18.12	6.79	55.76	4.73	20.00
1894	8.84	5.61	17.94	7.84	54.72	5.05	20.50
2351	8.77	5.53	17.94	6.95	56.13	4.68	22.00
2356	8.63	5.92	17.75	7.18	55.78	4.74	20.00
2363	9.64	5.57	16.75	7.74	55.48	4.82	21.00
2366	9.63	5.09	18.12	7.38	54.92	4.86	20.00
2368	9.58	5.05	19.75	7.95	53.18	4.49	21.00
2380	8.23	5.86	20.31	7.26	53.42	4.92	20.00
2381	9.10	4.22	18.19	6.85	56.91	4.73	20.00

TABLE I.—*Continued.* ANALYSES OF COMMERCIAL FEEDS.

SAMPLED IN 1900.

Station No.	Name of Feed.	Manufacturer or Jobber.	Retail Dealer.	Water.	Ash.	Protein.	Fiber.	Nitrogen-free Extract. (Starch, gum, etc.)	Ether Extract.	Price per ton.
2390	Acme Feed	Acme Mill Co., Indianapolis	Suffield, Spencer Bros.	9.03	5.42	18.00	6.92	56.04	4.59	$21.00
2411	"	Acme Mill Co., Indianapolis	Bristol, W. O. Goodsell	8.95	5.25	18.75	7.10	55.48	4.47	20.00
2414	Sunshine Mixed Feed	Hunter Bros., St. Louis, Mo.	Torrington, E. H. Talcott	8.89	5.27	18.50	7.58	55.29	4.47	21.00
2422	Farmers' Favorite Mixed Winter Wheat, Cow Feed	Valley City Mill Co., Grand Rapids	Canaan, Ives & Pierce	10.06	5.19	16.56	7.43	56.37	4.39	20.00
			Average of the above 15 analyses	9.13	5.37	18.12	7.41	55.31	4.66	
			Average digestible	----	----	14.46	2.45	44.97	4.02	
			Average of 68 recent analyses	----	----	**17.03**	----	----	**4.58**	
	Mixed Feed from Spring Wheat.									
1791	Fancy Mixed Feed	Pillsbury, Minneapolis	Hartford, Smith, Northam & Co.	8.52	5.31	17.75	7.00	56.02	5.40	23.00
1891	Superior "	Washburn-Crosby Co., Minneapolis	New Milford, F. R. Green	8.73	5.60	17.78	9.08	53.72	5.09	20.00
2367	Hiawatha "	Wm. Listman Mill Co., Superior, U. S. A.	Watertown, C. W. & T. F. Atwood	8.92	5.13	17.12	8.86	54.66	5.31	20.00
2392	Fancy "	Pillsbury, Minneapolis	Plantsville, Atwater Mills	9.69	4.96	18.37	7.06	54.59	5.33	20.00
2400	" "	" "	Bristol, Geo. W. Eaton	8.70	5.42	17.50	6.40	56.69	5.29	22.00
2410	Boston "	Imperial Mill Co., Duluth, Minn.	" W. O. Goodsell	8.60	5.21	17.00	7.60	56.35	5.24	20.00
			Average of the above 6 analyses	8.86	5.27	17.58	7.67	55.34	5.28	
			Average digestible	----	----	14.03	2.54	44.99	4.56	
			Average of 36 recent analyses	----	----	**16.90**	----	----	**5.12**	
	Mixed Feed, unclassified.									
1893	N. E. Mixed Feed	U. S. Flour Milling Co.	New Milford, Ackley, Hatch & Marsh	8.90	5.39	17.00	8.51	54.89	5.31	20.00
2352	N. Y. "	Agt., Hollister, Chase & Co., N. Y.	Waterbury, Platts Mills Co.	9.50	5.03	14.37	7.90	58.46	4.74	20.00
2365	Boston "	Imperial Mill Co., Duluth, Minn.	Watertown, C. W. & T. F. Atwood	9.16	4.88	16.69	8.32	55.75	5.20	21.00
2395	Kauffman's "	Agt., Chapin, Boston	Southington, Southington Lumber & Feed Co.	8.43	4.49	17.94	6.21	58.73	4.20	20.00
2421	Mixed Feed	----	Torrington, G. W. Green	8.00	5.83	17.69	8.66	55.47	4.35	21.00
			Average of the above 5 analyses	8.79	5.12	16.74	7.92	56.67	4.76	
			Average digestible	----	----	13.36	2.62	46.07	4.11	
2409	Corn Meal	W. O. Goodsell, Bristol	Bristol, W. O. Goodsell	10.71	1.20	9.94	1.65	72.53	3.97	20.00
3056	" "	Berkshire Mills, Bridgeport	W. I. Lobdell, Stratford	----	----	8.81	----	----	----	----
			Average of 15 recent analyses	----	----	**9.54**	----	----	**3.83**	
			Average digestible	----	----	6.75	----	68.61	3.66	
734	Atlantic Gluten Meal	Atlantic Starch Works, Westport, Ct.	Middletown, Sent by F. B. Ashton	9.40	1.90	25.25	----	----	1.55	----
1002	Atlantic Gluten Meal	----	" Meech & Stoddard	----	----	34.75	----	----	1.70	----
1003	Atlantic Gluten Meal	----	" " "	----	----	33.44	----	----	1.40	----
1786	Atlantic Gluten Meal	----	" F. B. Ashton	----	----	36.31	----	----	1.77	----
1787	Atlantic Gluten Meal	----	" "	----	----	27.75	----	----	3.78	----
1840	Atlantic Gluten Meal	----	Sent by manufacturer	8.23	----	39.75	----	----	1.82	----
			Average of 6 analyses	----	----	32.88	----	----	2.00	

TABLE I.—*Continued.* ANALYSES OF COMMERCIAL FEEDS.

Station No.	Name of Feed.	Manufacturer or Jobber.	Retail Dealer.
1790	Cream Gluten Meal	Chas. Pope Glucose Co., Chicago, Ill.	Hartford, Smith, Northam & Co.
2359	" " "	Chas. Pope Glucose Co., Chicago, Ill.	Waterbury, D. L. Dickinson
2903	" " "		Hartford, C. A. Pease & Co.
			Average of 3 analyses
			Average digestible
			Average of 48 recent analyses
1795	Chicago Gluten Meal	Glucose Sugar Refining Co., Chicago	Hartford, Smith, Northam & Co.
1856	" " "	Glucose Sugar Refining Co., Chicago	Norwalk, Holmes, Keeler & Selleck Co.
1889	" " "	Glucose Sugar Refining Co., Chicago	New Milford, F. R. Green
2361	" " "	Glucose Sugar Refining Co., Chicago	Watertown, C. W. & T. F. Atwood
2415	" " "	Glocose Sugar Refining Co., Chicago	Torrington, E. H. Talcott
			Average of the above 5 analyses
			Average digestible
			Average of 60 recent analyses
3020	Atlas Gluten Meal	Made at Peoria, Ill.	Sent by F. S. Truesdell, Naugatuck
3071	King Gluten	Nat'l Starch Mfg. Co., Indianapolis	S. E. Brown, Collinsville
			Average of 22 recent analyses
118	Waukegan Gluten Feed	U. S. Sugar Refinery Co., Waukegan, Ill.	Sent by manufacturer
2371	" " "	U. S. Sugar Refinery Co., Waukegan, Ill.	Naugatuck, Grant Grocery Co.
2372	" " "	U. S. Sugar Refinery Co., Waukegan, Ill.	" " " "
2401	" " "	U. S. Sugar Refinery Co., Waukegan, Ill.	Bristol, Geo. W. Eaton
			Average of the above 4 analyses
			Average digestible
			Average of 14 recent analyses
1852	Davenport Gluten Feed	Glucose Sugar Refg. Co., Chicago, Ill.	Bridgeport, Standard Feed Co.
2418	" " "	Glucose Sugar Refg. Co., Chicago, Ill.	Torrington, G. W. Green
2428	" " "	Glucose Sugar Refg. Co., Chicago, Ill.	W. Winsted, Balch & Platt
			Average of the above 3 analyses
			Average digestible
			Average of 8 recent analyses
1863	Buffalo Gluten Feed	Glucose Sugar Ref'g Co., Chicago, Ill.	So. Norwalk, Manual T. Hatch
2353	" " "	Glucose Sugar Ref'g Co., Chicago, Ill.	Waterbury, Platts Mills Co.
2404	" " Meal	Glucose Sugar Ref'g Co., Chicago, Ill.	Bristol, G. W. Eaton
			Average of the above 3 analyses
			Average digestible
			Average of 17 recent analyses

SAMPLED IN 1900.

Station No.	Analyses. Water.	Ash.	Protein.	Fiber.	Nitrogen-free Extract. (Starch, gum, etc.)	Ether Extract.	Price per ton.
1790	9.25	1.02	35.94	2.49	48.87	2.43	$29.00
2359	9.03	0.97	34.87	2.44	49.27	3.42	27.00
2903	8.77	----	34.50	---	----	2.91	----
	9.14	1.00	35.10	2.46	49.08	2.92	
	----	----	31.22	----	44.07	2.76	
	----	----	**35.50**	----	----	**2.70**	
1795	8.77	0.93	37.25	1.80	48.01	3.24	29.00
1856	9.02	0.94	39.50	1.87	44.47	4.20	25.00
1889	8.10	1.14	39.56	2.11	46.08	3.01	27.00
2361	9.13	0.95	38.00	1.97	46.90	3.05	27.00
2415	8.24	0.97	39.19	2.08	46.87	2.65	30.00
	8.65	0.98	38.70	1.97	46.47	3.23	
	----	----	34.13	----	41.73	3.06	
	----	----	**36.97**	----	----	**2.98**	
3020	----	----	33.75	----	----	14.06	----
3071	----	----	25.94	----	----	----	----
	----	----	**33.70**	----	----	**3.70**	
118	8.59	1.23	27.75	7.15	50.88	4.40	----
2371	8.99	0.99	26.75	7.37	51.99	3.91	23.00
2372	8.55	0.96	26.06	5.90	55.06	3.47	23.00
2401	9.14	1.13	27.62	6.38	51.97	3.76	21.00
	8.82	1.08	27.04	6.70	52.47	3.89	
	----	----	23.15	5.22	46.80	3.28	
	----	----	**26.46**	----	----	**3.41**	
1852	8.81	1.68	34.94	6.53	44.60	3.44	22.50
2418	9.21	0.86	27.00	6.95	52.52	3.46	24.00
2428	10.06	1.57	25.87	5.53	54.48	2.49	27.00
	9.36	1.37	29.27	6.33	50.54	3.13	
	----	----	25.05	4.94	45.08	2.54	
	----	----	**25.77**	----	----	**3.48**	
1863	8.52	3.46	25.81	6.56	52.25	3.40	24.00
2353	8.27	2.60	24.75	6.68	54.27	3.43	22.00
2404	7.85	2.24	27.06	6.32	52.36	4.17	21.00
	8.21	2.77	25.88	6.52	52.95	3.67	
	----	----	22.15	5.09	47.23	2.10	
	----	----	**25.66**	----	----	**2.73**	

TABLE I.—*Continued.* ANALYSES OF COMMERCIAL FEEDS.

Station No.	Name of Feed.	Manufacturer or Jobber.	Retail Dealer.
63	Glen Cove Gluten Feed	Nat'l Starch Mfg. Co., Glen Cove, L. I.	Sent by A. Cullen & Co., N. Y.
1851	" " "	Nat'l Starch Mfg. Co., Glen Cove, L. I.	Bridgeport, Taylor & Clark
1853	" " "	Nat'l Starch Mfg. Co., Glen Cove, L. I.	" Wm. M. Terry Co.
1854	" " "	Nat'l Starch Mfg. Co., Glen Cove, L. I.	" Berkshire Mills
			Average of the above 4 analyses
			Average digestible
3062	Marshalltown Gluten Feed	Chapin & Co., Boston, Mass.	
2904	Gluten Meal		Middletown, Cowles Co.
2376	Gluten Feed		Derby, Peterson, Hendee Co., Main St.
146	Oil Cake Germ Meal		Sent by J. W. Beers, Hamden
541	Oil Germ Meal		" E. A. Bradley, "
2406	Germ Oil Meal	Glucose Sugar Rfg. Co., Chicago	Bristol, G. W. Eaton
2849	" " "	American Cereal Co., Chicago	Putnam, Bosworth Bros.
	Hominy Chop.		
137	Yellow Hominy Chop	Miner, Hillard Milling Co., Wilkesbarre, Pa.	New Haven, R. G. Davis
1867	Hominy Feed	Diamond Elevator Milling Co., Minneapolis	So. Norwalk, Manuel T. Hatch
1873			Stamford, E. E. Scofield
1874			" Ingersoll Bros.
1888	Hominy Feed	Chapin & Co., St. Louis, Mo.	Danbury, O. A. Meeker
1895	" "	Diamond Elevator Milling Co.	New Milford, Ashley, Hatch & Marsh
1899	" "	Miner, Hillard Milling Co.	Waterbury, Platts Mills Co.
2364	" "	Hunter Bros., St. Louis, Mo.	Watertown, C. W. & T. F. Atwood
2403	" Meal	Miner, Hillard Milling Co.	Bristol, G. W. Eaton
2433			W. Winsted, Balch & Platt
			Averages of the above 10 analyses
			Average digestible
			Average of 33 recent analyses
1883	Cerealine Feed No. 2	Cerealine Mfg. Co., Indianapolis	F. C. Benjamin, Danbury
59	"Magnolia" Ground Oats	R. J. Hardy & Sons, Boston	
62	"Magnolia" Ground Oats	R. J. Hardy & Sons, Boston	
			Average of the above 2 analyses
			Average digestible
			Average of 6 recent analyses
1836	Provender		Sent by Smith, Northam & Co., Hartford
2408	"	W. O. Goodsell, Bristol	Bristol, W. O. Goodsell
2427	"	Ives & Pierce, Canaan	Canaan, Ives & Pierce
			Average of the above 2 analyses
			Average of 14 recent analyses

SAMPLED IN 1900.

Station No.	Analyses. Water.	Ash.	Protein.	Fiber.	Nitrogen-free Extract. (Starch, gum, etc.)	Ether Extract.	Price per ton.
63	8.17	0.36	27.12	4.49	56.00	3.86	----
1851	9.07	0.68	29.69	3.78	53.86	2.92	$22.00
1853	9.00	0.65	28.50	4.43	53.30	4.12	22.00
1854	9.65	0.62	29.75	4.08	51.88	4.02	21.50
	8.97	0.58	28.76	4.19	53.77	3.73	
	----	----	24.62	3.26	47.96	3.15	
3062	----	----	28.75	----	----	----	----
2904	8.97	----	27.87	----	----	4.68	22.00
2376	8.32	1.14	25.31	6.83	55.26	3.14	23.00
146	----	----	25.87	----	----	----	24.00
541	----	----	25.25	---	----	9.16	----
2406	9.02	2.34	22.50	10.70	46.05	9.39	25.00
2849	6.34	----	22.06	----	----	16.23	23.00
137	9.37	2.50	11.56	4.84	62.83	8.90	18.50
1867	9.11	2.08	11.06	4.24	66.45	7.06	21.00
1873	8.75	2.69	12.69	4.83	61.90	9.14	20.00
1874	8.18	2.80	11.87	4.66	63.13	9.36	20.00
1888	7.90	2.84	11.94	6.50	61.34	9.48	20.00
1895	10.60	1.95	10.69	3.40	66.86	6.50	20.00
1899	8.55	2.53	11.56	5.20	63.31	8.85	20.00
2364	8.25	3.17	11.69	6.00	60.85	10.04	20.00
2403	8.61	2.57	11.62	4.59	64.49	8.12	20.00
2433	7.24	2.88	12.00	5.46	62.72	9.70	20.00
	8.66	2.60	11.67	4.97	63.39	8.71	
	----	----	7.92	----	59.96	8.02	
	----	----	**11.19**	----	----	**8.39**	
1883	8.50	2.77	12.31	3.44	63.51	9.47	----
59	7.75	4.35	9.62	17.16	56.25	4.87	17.00
62	8.10	2.47	13.37	7.17	62.70	6.19	17.00
	7.92	3.41	11.49	12.17	59.48	5.53	
	----	----	8.96	8.51	45.20	4.59	
	----	----	**11.31**	----	----	**4.69**	
1836	----	----	9.50	----	----	4.07	----
2408	9.58	2.06	10.75	3.91	69.08	4.62	----
2427	9.73	2.07	10.94	4.20	68.51	4.55	----
	9.65	2.07	10.85	4.06	68.79	4.58	
	----	----	**9.73**	----	----	**3.74**	

TABLE I.—*Continued.* ANALYSES OF COMMERCIAL FEEDS.

Station No.	Name of Feed.	Manufacturer or Jobber.	Retail Dealer.
58	Star Chop	Miner, Hillard Co., Wilkesbarre, Pa.	So. Norwalk, Manuel T. Hatch
67	Mixed Feed		Sent by Crow & Williams, Sing Sing, N. Y.
	Corn and Oat Feed.		
1868	Victor	American Cereal Co., Chicago	So. Norwalk, Manuel T. Hatch
1878	"	American Cereal Co., Chicago	New Canaan, C. H. Fairty
1882	"	American Cereal Co., Chicago	Danbury, F. C. Benjamin & Co.
1898	"	American Cereal Co., Chicago	Waterbury, Platts Mills Co.
2385	"	American Cereal Co., Chicago	E. Hartford, W. J. Cox
			Average of the above 5 analyses
			Average digestible
			Average of 21 recent analyses
60	"Lenox Feed"	R. G. Hardy & Sons, Boston	
61	" "	R. G. Hardy & Sons, Boston	
			Average of the above 2 analyses
			Average of 6 recent analyses
1880	Oat Feed—"Vim"	American Cereal Co., Chicago	Danbury, F. C. Benjamin & Co.
			Average of 4 recent analyses
144	Friends Concentrated Dairy Food	Muscatine Oat Meal Co., Muscatine, Iowa	Hartford, The Blodgett & Clapp Co.
1876	Barley Feed	Agt., Chapin & Co., N.Y.	New Canaan, C. H. Fairty
			Average of 4 recent analyses
2417	Rye Feed	A. D. Stone & Co., Rochester, N. Y.	Torrington, E. H. Talcott
1845	Buckwheat Bran	Quinnebaug Mill, Danielson	Danielson, Quinnebaug Store
1887	Corn, Oats and Barley	American Cereal Co., Chicago	Danbury, O. H. Meeker
1897	Corn, Oats and Barley—Kiln Dried	American Cereal Co., Chicago	Waterbury, Platts Mills Co.
2384	Corn, Oats and Barley	American Cereal Co., Chicago	E. Hartford, W. J. Cox
			Average of the above 3 analyses
			Average of 10 recent analyses
	Factory Mixed Feeds.		
1857	H-O Dairy Feed	H-O Co., Buffalo, N. Y.	Norwalk, Holmes, Keeler & Selleck Co.
1864	" " "	" " "	So. Norwalk, Manuel T. Hatch
2398	" " "	" " "	Southington, Southington Lumber & Feed Co.
			Average of the above 3 analyses
			Average of 9 recent analyses
1859	H-O Poultry Feed	H-O Co., Buffalo, N. Y.	Norwalk, Holmes, Keeler & Selleck Co.

SAMPLED IN 1900.

Station No.	Analyses. Water.	Ash.	Protein.	Fiber.	Nitrogen-free Extract. (Starch, gum, etc.)	Ether Extract.	Price per ton.
58	9.98	2.63	8.25	11.52	63.94	3.68	$19.00
67	----	----	10.37	----	----	4.92	----
1868	7.88	3.84	9.00	12.72	61.66	4.90	20.00
1878	9.01	2.80	8.75	9.44	66.67	3.33	20.00
1882	7.93	3.11	8.50	11.26	66.20	3.00	19.00
1898	7.90	3.63	9.50	10.12	64.10	4.75	20.00
2385	8.67	3.72	9.81	9.99	62.89	4.92	22.00
	8.28	3.42	9.11	10.71	64.30	4.18	
	- --	----	6 45	5.17	53.37	3 63	
	----	----	**8.86**	----	----	**3.06**	
60	9.23	2.75	8.37	8.67	67.72	3.26	17.00
61	10.24	2.37	8.50	6.93	68.46	3.50	17.00
	9.73	2.56	8.43	7.80	68.10	3.38	
	----	----	**8.66**	----	----	**2.90**	
1880	5.93	5.65	8.62	23.32	54.02	2.46	16.00
	----	----	**6.01**	----	----	**2.16**	
144	----	----	6.62	----	----	3.06	14.20
1876	7.36	5.36	13.37	15.12	54.87	3.92	19.00
	----	----	**13.20**	----	----	**3.37**	
2417	10.79	3.02	16.12	3.63	63.41	3.03	21.00
1845	13.50	----	33.37	----	----	8.49	18.00
1887	7.02	4.39	11.44	10.77	61.53	4.85	21.00
1897	7.48	4.11	11.87	10.53	60.94	5.07	21.00
2384	7.51	4.27	11.75	10.27	61.14	5.06	22.00
	7.34	4.26	11.68	10.52	61.21	4.99	
	----	----	**11.61**	----	----	**4.69**	
1857	8.52	3.69	18.75	12.65	52.80	3.59	21.00
1864	7.31	4.05	19.31	12.69	52.03	4.61	23.00
2398	8.02	3.73	19.00	12.12	53.42	3.71	23.00
	7.95	3.82	19.02	12.49	52.75	3.97	
	----	----	**18.06**	----	----	**4.01**	
1859	9.28	2.52	16.50	5.14	61.07	5.49	29.00

TABLE I.—*Concluded.* ANALYSES OF COMMERCIAL FEEDS.

Station No.	Name of Feed.	Manufacturer or Jobber.	Retail Dealer.
1870	H-O Poultry Feed	H-O Co., Buffalo, N. Y.	So. Norwalk, Manuel T. Hatch
2407	" " "	" " "	Bristol, G. W. Eaton
			Average of the above 3 analyses
			Average of 8 recent analyses
1855	H-O Horse Feed	H-O Co., Buffalo, N. Y.	Bridgeport, Berkshire Mills
1858	" " "	" " "	Norwalk, Holmes, Keeler & Selleck Co.
1865	" " "	" " "	So. Norwalk, Manuel T. Hatch
2399	" " "	" " "	Southington, Southington Lumber & Feed Co.
			Average of the above 4 analyses
			Average of 12 recent analyses
1860	Quaker Dairy Feed	American Cereal Co., Chicago	Norwalk, Holmes, Keeler & Selleck Co.
1884	" " "	American Cereal Co., Chicago	Danbury, F. C. Benjamin & Co.
1890	" " "	American Cereal Co., Chicago	New Milford, F. R. Green
2358	" " "	American Cereal Co., Chicago	Waterbury, Spencer, Pierpont & Co.
2383	" " "	American Cereal Co., Chicago	Hartford, Smith, Northam & Co.
2389	" " "	American Cereal Co., Chicago	Suffield, Spencer Bros.
2424	" " "	American Cereal Co., Chicago	Canaan, Ives & Pierce
			Average of the above 7 analyses
			Average of 28 recent analyses
2360	American Poultry Food	American Cereal Co., Chicago	Waterbury, D. L. Dickenson
2423	" " "	American Cereal Co., Chicago	Canaan, Ives & Pierce
			Average of the above 2 analyses
			Average 9 recent analyses
1886	Gem Poultry Feed	F. C. Benjamin & Co.	Danbury, F. C. Benjamin & Co.
2431	Blatchford's Calf Meal	E. W. Blatchford, Chicago, Ill.	W. Winsted, Balch & Platt
			Average of 6 recent analyses
1916	Animal Meal	Bowker Co., Boston, Mass.	New Haven, C. J. Benham
2413	" "	Bowker Co., Boston, Mass	Bristol, W. O. Goodsell
			Average of the above 2 analyses
			Average of 10 recent analyses
122	Corn Feed	The Marsden Co., Owensboro, Ky.	Sent by manufacturer

SAMPLED IN 1900.

Station No.	Analyses. Water.	Ash.	Protein.	Fiber.	Nitrogen-free Extract. (Starch, gum, etc.)	Ether Extract.	Price per ton.
1870	9.26	2.66	16.87	5.13	61.10	4.98	$29.00
2407	8.52	2.70	16.75	4.45	62.11	5.47	30.00
	9.02	2.63	16.70	4.91	61.43	5.31	
	----	----	**16.96**	----	----	**5.36**	
1855	8.93	3.35	12.75	9.30	61.69	3.98	23.00
1858	9.38	3.23	13.06	9.69	60.90	3.74	21.00
1865	8.25	3.58	13.12	10.58	59.76	4.71	23.00
2399	8.44	3.36	12.00	9.39	63.08	3.73	22.00
	8.75	3.38	12.73	9.74	61.36	4.04	
	----	----	**12.19**	----	----	**3.48**	
1860	7.00	4.79	13.87	15.02	55.58	3.74	20.00
1884	6.88	5.30	13.75	15.84	54.66	3.57	19.00
1890	7.19	3.99	12.62	15.34	58.03	2.83	18.00
2358	7.55	5.31	13.50	14.93	54.91	3.80	19.00
2383	7.09	4.33	13.62	15.28	56.65	3.03	21.00
2389	7.45	4.73	14.50	15.14	55.04	3.14	22.00
2424	6.95	5.02	14.50	15.62	54.37	3.54	18.00
	7.16	4.78	13.77	15.31	55.60	3.38	
	----	----	**13.53**	----	----	**3.13**	
2360	9.41	2.67	13.06	4.33	63.47	7.06	27.00
2423	8.93	2.80	13.19	4.91	63.33	6.84	25.00
	9.17	2.74	13.12	4.62	63.40	6.95	
	----	----	**13.20**	----	----	**6.20**	
1886	6.82	27.00*	12.12	7.55	43.02	3.49	20.00
2431	9.15	4.45	25.00	4.30	52.45	4.65	55.00
	----	----	**24.45**	----	----	**4.62**	
1916	4.64	43.54	38.50	----	----	10.25	----
2413	5.95	41.76	38.87	----	----	9.79	40.00
	5.29	42.65	38.69	----	----	10.02	
	----	----	**42.55**	----	----	**9.63**	
122	6.52	5.28	4.37	37.03	46.06	0.74	----

* Chiefly shells, with a little sand.

A HYDROLYTIC DERIVATIVE OF THE GLOBULIN EDESTIN AND ITS RELATION TO WEYL'S ALBUMINATE AND THE HISTON GROUP.

By Thomas B. Osborne.

It is well known that globulins after precipitation from salt solutions, either by dilution or dialysis, usually do not redissolve completely in solutions of a neutral salt.

Weyl (Zeit. f. Physiol. Chem., I, **72**, 1877) states that, on long contact with water, globulins gradually become insoluble in neutral sodium chloride solutions of every concentration, and designates the substance thus formed as "albuminate." Very recently Starke (Starke, Zeit. f. Biologie, n. f. **22**, 425) calls attention to the action of water on globulin and states that the precipitated globulin, when washed but a few times with water, always becomes nearly, or quite, insoluble in saline solutions, whereas globulin, which is precipitated by saturating its solution with neutral salts, can be kept for months in the saturated brine without losing its solubility.

In the presence of a very little acid this change from a soluble to an insoluble state appears to take place more rapidly. Thus a globulin thrown down by carbonic acid from a salt solution very soon becomes, to a large extent, insoluble in neutral solutions of sodium chloride. Myosin is rapidly changed into an insoluble form by the acid which develops in the muscle substance after death, and legumin extracted from leguminous seeds is soon converted into a form insoluble in salt solutions, unless the acid is neutralized as soon as the extract is made.

The following investigation makes it probable that the insoluble product, in the case of edestin at least, results from the hydrolytic action of hydrogen ions, and that this change in the protein molecule is the first of a series which leads to the formation of "acid albumin."

In the case of edestin and other proteins of the endosperm, this change from a soluble to an insoluble form takes place much less readily than in proteins from physiologically active animal tissues. It is also true that the proteins of the wheat *embryo,* which is likewise capable of great physiological activity, are also much more prone to become insoluble, in the way

described, than those of the *endosperm* of wheat and other seeds. (Cf. Martin, Jour. of Physiology, **8**, viii, 1887.)

Since this derivative of edestin is a definite substance, well characterized by its properties and reactions, I propose to call it *edestan,* and if, as seems probable, the other protein bodies yield similar derivatives, these may be named in a like manner by changing the termination *in,* usually applied to the protein substance, to *an.* The group of substances belonging to this class may be called proteans, thus following the practice whereby the more altered and basic hydrolytic protein derivatives are designated proteoses, and the individual members albumose, caseose and so forth.

It is important that a distinction should be made between these proteans and those products which result from a more profound change in the protein molecule, caused by the action of stronger acids and alkalies, and which are now known as acid and alkali albumin.

a. *Action of water on edestin.*

Pure water, because it is but slightly ionized, has little effect on pure edestin* at the room temperature. If, however, carbonic acid is present, edestan is formed in decidedly larger amount.

Gram portions of pure and perfectly neutral edestin were suspended in water, agitated frequently and exposed to different temperatures for definite periods of time. An equal volume of 20 per cent. sodium chloride solution was then added to each, and the solution made neutral to phenolphthalein, by which the unaltered edestin was at once dissolved and the formation of edestan was stopped. The edestan was allowed to settle over night and was then easily collected on a filter and thoroughly washed with 10 per cent. sodium chloride brine, until the washings showed no trace of the xanthoproteic reaction.

Nitrogen was determined in the residue and the amount of edestin calculated by multiplying the nitrogen by 5.4,

* For the properties of edestin, and its relations to acids and alkalies, the paper following this should be consulted, in which will be found in detail the evidence on which are based many of the statements made in this paper, concerning edestin and its compounds. Also, Osborne, "On some definite compounds of protein bodies," Jour. Amer. Chem. Soc., **21**, 486.

since, as will be shown later, edestan contains 18.5 per cent. of nitrogen. The results obtained were the following:

TABLE I.—PERCENTAGE OF EDESTAN FORMED BY CONTACT WITH WATER.

	Treated with Sodium Chloride solution after 6 hours.			
10 per cent. NaCl at 20°.	Water + CO_2 at 20°.	Pure Water at 20°.	Pure Water at 30°.	Pure Water at 50°.
2.16	6.75	4.32	7.11	29.00

The portion which was treated with sodium chloride solution stood exactly as long as the others before filtration. The insoluble matter which this contained consisted of a little edestan which was originally present in the preparation and of edestan which was formed by treatment of the edestin with the salt solution. The above figures show that even at 20° a notable quantity of edestan is formed by water alone and that the quantity is decidedly greater if the water contains carbonic acid. At 50° about four times as much edestan was formed as at 30°, and nearly eight times as much as at 20°, which agrees with the fact that the velocity of such a reaction is about doubled by each increase of 10° in the temperature.

b. *Action of acids on edestin.*

Edestin combines with small, but definite quantities of acid to form salts in which the edestin molecule is unchanged. In the presence of an excess of acid, above that required to form these salts, edestin is converted by the free hydrogen ions into edestan, as the following experiments show.

Gram portions of pure, neutral edestin were suspended in water enough to make a final volume of 20 cc., and to the different portions the quantity of centinormal acid stated in the following table was added. After being frequently agitated during the times indicated, the acid was neutralized by an equivalent quantity of decinormal potassium hydrate solution and the amount of edestan that had formed was determined, as in the preceding experiments with water.

TABLE II.—PERCENTAGE OF EDESTAN FORMED BY ACIDS AT 20°.

9 cc. $\frac{HCl}{100}$		14 cc. $\frac{HCl}{100}$		18 cc. $\frac{HNO_3}{100}$	19 cc. $\frac{HNO_3}{100}$	20 cc. $\frac{HNO_3}{100}$
3 hours.	20 hours.	3 hours.	20 hours.	24 hours.	24 hours.	24 hours.
9.01	12.15	29.80	33.55	68.38	75.20	79.02

These figures, compared with those of Table I, show that edestin yielded much more edestan in contact with acids than in contact with water, and also that the percentage of edestan produced increased with the amount of acid.

One gram of this air-dry edestin preparation (equivalent to 0.9300 gram of water-free edestin) can combine with 13 cc. of centinormal hydrochloric acid, so that in the portion containing 9 cc. only that amount of acid was free which was produced by the hydrolytic dissociation of the compound formed, whereas the portion with 14 cc. of acid contained, in addition, a small amount of free acid, the effect of which is shown by the greater amount of edestan formed in it. That, in both cases, only a little more edestan was formed during 20 hours than during 3 hours is explained by the fact that edestan unites with a larger proportion of acid than does edestin, and consequently, as the proportion of edestan increases the proportion of free acid diminishes. With 20 cc. of nitric acid 79 per cent. of the edestin was converted into edestan.

From the salts of edestin, such as usually constitute the crystalline preparations as heretofore made by the usual methods, edestan may be prepared just as from the pure and neutral edestin which was used in the preceding experiments. One gram of a preparation consisting of edestin mono- and bichloride, chiefly the latter, and which already contained 6.32 per cent. of edestan, that had been formed during its preparation, was suspended in water and brought into solution by adding 3.0 cc. of centinormal hydrochloric acid. The added acid, as well as that originally combined with the edestin,* was at once neutralized, an equal volume of 20 per cent. sodium chloride solution added, which dissolved the unaltered edestin, and the edestan was determined as described above. Deducting the edestan originally present in the preparation, it appeared that during the very brief action of the acid, 3.49 per cent. of edestan had been formed. In a similar experiment with 3 cc. of acid, which was left in contact with the preparation for 20 hours before neutralization, 29.5 per cent. of edestan was formed. Using 10 cc. of acid, instead of 3 cc., 13.32 per cent.

* One gram of this preparation contained acid equivalent to 11 cc. of $\frac{HCl}{100}$.

of edestan was formed at once, and 70.46 per cent. after 20 hours' contact.

That the amount of edestan formed in a given time depends on the degree of ionization of the acid was shown by suspending gram portions of neutral edestin in 6 cc. of water, adding 14 cc. of centinormal hydrochloric, phosphoric and acetic acids respectively, and, after frequently agitating for about 2 hours at 20°, determining the amount of edestan formed in each.

TABLE III.—PERCENTAGE OF EDESTAN FORMED BY EQUIVALENT QUANTITIES OF DIFFERENT ACIDS UNDER THE SAME CONDITIONS.

HCl	H_3PO_4	$H_4C_2O_2$
19.29	16.02	5.65

The solution of phosphoric acid used in this experiment contained 0.98 gram of H_3PO_4 per liter, being made on the assumption that this acid behaves towards edestin as a monobasic acid. The much smaller quantity of edestan formed by acetic acid, compared with that formed by hydrochloric acid, is in accord with the lesser ionization of this acid.

c. *Composition of edestan.*

Ten grams of a preparation of crystallized edestin chloride were suspended in water, in a glass stoppered bottle and 30 cc. of decinormal hydrochloric acid were gradually added. After the resulting clear solution had stood at the room temperature for about two hours, it was made neutral to phenolphthalein by adding 38 cc. of decinormal potassium hydrate solution, the 8 cc., in the excess of the 30 cc. of added acid being required to neutralize the acid originally combined with the edestin preparation.

The curdy precipitate, that formed on neutralizing, was washed thoroughly with 10 per cent. sodium chloride solution and then with water, until chlorides were removed, and finally with absolute alcohol. Dried over sulphuric acid, this formed preparation **1**, which weighed 6.82 grams.

This experiment was repeated with another preparation of edestin chloride, the acid solution allowed to stand over night, at a temperature below 10° and then 50 cc. of decinormal potassium hydrate solution was added. Although this excess

of alkali was more than sufficient to dissolve the entire quantity of substance which was precipitated by neutralization, had this been unchanged edestin, nevertheless very little protein matter was dissolved by it. The precipitate was filtered out, washed with water, dehydrated with absolute alcohol and found to weigh 8 grams after drying over sulphuric acid. This formed preparation **2**.

Preparations of edestin chlorides, which contain the water-soluble bichloride, yield aqueous solutions, from which the protein matter is precipitated by a little sodium chloride. The precipitate thus formed is never wholly soluble again in stronger solutions of sodium chloride, a part being converted into the so-called "albuminate" of Weyl. In order to establish the relations of this substance with that produced by the action of acids on edestin, under known conditions, a quantity of edestin, that had been obtained as a crystalline precipitate by cooling a warm dilute sodium chloride extract of hemp-seed meal, was washed by decantation with water until the sodium chloride was largely removed, whereupon the edestin began to dissolve.

When most had passed into solution, enough sodium chloride, in substance, was added to the clear aqueous solution containing the edestin to form an 8 per cent. brine. The edestin, at first precipitated by partial solution of the salt, mostly redissolved in the stronger brine that formed when all the salt had gone into solution.

The part that did not dissolve was filtered out and washed thoroughly with salt solution until all the globulin had been removed and then extensively with water. As the salt was washed away, the residue became gelatinous and dissolved slightly, so that it could no longer be washed on a filter. It was therefore suspended in water and made exactly neutral to phenolphthalein with very dilute potassium hydrate solution. This converted it into a curdy precipitate which was easily filtered out and washed. In this condition it resembled, in all respects, the edestan obtained by neutralizing the hydrochloric acid solutions just described. After washing thoroughly with water and dehydrating with absolute alcohol, this preparation, **3**, was dried at 110° and analyzed with the results given below. Preparations **1** and **2** were likewise dried at 110° and analyzed.

TABLE IV.—COMPOSITION OF EDESTAN.

	1	2	3	Edestin.
Carbon	51.48	51.91	51.69	51.50
Hydrogen	6.91	6.96	6.98	7.04
Nitrogen	18.51	18.49	18.49	18.69
Sulphur	1.00	0.99	0.92	0.88
Oxygen	22.10	21.65	21.92	21.89
	100.00	100.00	100.00	100.00
Ash	0.55	0.06	0.14	

Between these analyses and that of edestin no sufficient difference exists to enable us to detect any change in ultimate composition caused by its conversion into edestan. A strict comparison of the reactions of **1** and **2** with those of **3** showed that these were one and the same substance.

d. *Reactions of edestan.*

Edestan prepared as just described is a voluminous, dusty, white powder which swells somewhat in water and forms a colorless, transparent jelly with very dilute hydrochloric acid. Whether a true solution was formed by the dry powder in this extremely dilute acid could not be ascertained since the opalescent fluid that resulted could not be filtered clear.

Dry, neutral edestan is scarcely soluble, even in strong ammonia, but the gelatinous mass, formed by treating the substance with very dilute hydrochloric acid, is slightly more soluble, though in either case the amount dissolved by ammonia is very small. The solution in ammonia yields a precipitate with ammonium chloride, consequently when hydrochloric acid is added to the ammoniacal solution a precipitate forms, even when much of the ammonia is unneutralized. The ammoniacal solution is not precipitated by sodium chloride.

A strong solution of edestan, which, however, probably contains a little unaltered edestin, may be prepared by dissolving edestin in centinormal hydrochloric acid in the proportion of 30 cc. to each gram and allowing the solution to stand for at least 24 hours. One-third of the acid may then be neutralized by adding the requisite quantity of very dilute potassium hydrate solution. An opalescent, unstable, super-saturated solution results, which can be filtered nearly clear and, if abundantly diluted, yields no precipitate within several hours. Such a solution of edestan chloride yields a precipitate with 10 per cent. ammonia, which is soluble in a considerable excess, the resulting solution being readily precipitated by ammonium chloride. By decinormal ammonia solution the substance is precipitated but not redissolved, even by a very large excess of this ammonia solution.

The aqueous solution of edestan chloride yields a precipitate with a very little ammonium or sodium chloride, the latter being readily, the former with difficulty, dissolved by an excess of ammonia.

With nitric acid edestan gives a precipitate completely soluble on warming but reprecipitated on cooling.

With potassium phosphotungstate, sodium phosphomolybdate or sodium picrate, edestan chloride forms slimy precipitates. With a solution of ovalbumin edestan chloride yields an abundant precipitate.

Mercuric chloride forms no precipitate in a dilute solution of edestan chloride, nor in a relatively strong one, unless a considerable amount of this reagent is added.

Very dilute hydrochloric acid does not precipitate edestan, but the strong acid gives a precipitate, which dissolves in a sufficient excess of concentrated acid.

e. *The amount of acid with which edestan combines.*

Edestan exists in preparations of edestin chlorides in combination with acid. The amount of acid with which this substance forms a compound, sparingly soluble in water, appears to be definite, as the following experiments show.

A quantity of a preparation of edestin chloride was dissolved, as far as possible, in 10 per cent. salt solution and the insoluble edestan was allowed to settle. This was first washed thoroughly with salt solution, until the edestin was removed, and then with water, in which a very little dissolved, while the remainder formed a gelatinous mass. The latter was suspended in water and dialyzed until the sodium chloride was removed. The dialyzer then contained an opalescent fluid and a voluminous precipitate. Of this fluid, 25 cc. were made neutral to phenolphthalein by adding 2.5 cc. of a centinormal solu-

tion of potassium hydrate, and by evaporating and drying the residue at 110° was found to contain 0.1165 gram of substance. The same volume drawn from the bottom of the dialyzer, which contained much of the undissolved matter, was made neutral by 11 cc. of the alkali and contained 0.4710 gram of substance. These quantities correspond to an acidity of 21.5 and 23.4 cc. respectively, of a centinormal solution per gram of edestan. A repetition of this experiment gave essentially the same result.

A quantity of the insoluble matter which remained on treating another preparation of edestin chloride with 10 per cent. sodium chloride brine was thoroughly washed with salt solution, once with water and finally with dilute alcohol, until all the salt was removed. A quantity of the still moist substance was then suspended in water, finely divided by straining through fine bolting cloth, and 4.0 cc. of decinormal potassium hydrate solution added, which was decidedly in excess of the quantity necessary to make the mixture neutral to phenolphthalein. After agitating continuously for some time, the excess of alkali was neutralized by 2.1 cc. of decinormal hydrochloric acid, which showed that 1.9 cc. of the alkali had been neutralized by the acid combined with the substance. By evaporating and drying the residue at 110° it was found that 0.9430 gram of edestan was present in the mixture, from which it appears that its original acidity was equal to 20.1 cc. of a centinormal solution per gram.

Another portion of this substance was suspended in water in a finely divided state and brought into solution by adding 2.0 cc. of decinormal hydrochloric acid and shaking for some time. The solution was then made neutral to phenolphthalein, by adding 3.0 cc. of decinormal potassium hydrate solution, and the amount of dissolved edestan found to be 0.5039 gram, from which it is found that its original acidity was equal to 20.0 cc. of a centinormal solution per gram.

This quantity is just three times the acidity of edestin monochloride and one and a half times that of the bichloride, consequently if edestan is formed from edestin without any notable change in molecular weight, this substance occurs in preparations of edestin chlorides as a trichloride, assuming edestin to have a molecular weight of about 14,500.

Bang (Bang, Zeit. f. Physiol. Chem. **27**, 463) has recently

reviewed the reactions of the histons and concludes that for the present these may be defined as follows: In neutral solution the histons are precipitated by the cautious addition of ammonia, the precipitate in the presence of an ammonium salt very soon becoming insoluble in an excess of ammonia. They give a precipitate with nitric acid, which dissolves on heating and reappears on cooling. They are precipitated from neutral solution by heating, if their solutions contain some sodium chloride, not, however, if they are poor in salts. Neutral solutions of histons are precipitated by the alkaloid reagents and by solutions of ovalbumin and other proteins. In this group of bodies Bang includes goose-blood histon, thymus histon, scombron and globin.

I have shown that edestan has all these reactions with the exception of the precipitation of the solution by heat in the presence of moderate quantities of neutral salts. This reaction could not be obtained with edestan as it is insoluble in water, and the aqueous solution of its chloride gives a precipitate with a very little salt which is insoluble in stronger saline solutions.

The most important difference between these histons and edestan is that the former appear to be soluble in water when neutral, whereas neutral edestan is very insoluble in water, the reactions, which I have described, being given by aqueous solutions of its chloride. This combined acid, however, is present in such small proportion that it can be detected only in concentrated solutions by using very delicate litmus paper, so that it might easily be overlooked were its presence unknown. Bang gives no evidence that his solutions did not contain a similar proportion of acid and it seems probable that some of them at least did contain it, since the substances were extracted by dilute hydrochloric acid and the solutions made "neutral" presumably to litmus, this indicator being the one commonly employed by physiologists for such purposes. That any near relation exists between edestan and the bodies enumerated by Bang as histon is not probable, except in the case of globin, which seems to be more nearly related to edestan than to the histons since globin is a true protein substance, obtained from haemoglobin by the action of acids under conditions similar to those leading to the formation of edestan. With thymus histon and with scombron, it would

seem that edestan and globin have little in common, since the two former yield little or no proteoses on pepsin digestion, whereas edestin yields such abundantly and globin doubtless does the same.

From the facts now at our command it is evident that we have two different classes of bodies which conform pretty closely to the reactions characteristic of the histons. It is important to recognize this fact, since otherwise confusion will result if these two classes are not distinguished from one another, and protein derivatives produced by the acid used in preparing these substances may be regarded as actual constituents of the tissues.

Summary.

By the action of water or very dilute solutions of acids, the globulin edestin is converted into a substance insoluble in saline solutions of moderate concentration.

This derivative of edestin is formed by hydrolysis, the amount formed being proportional to time and the concentration of the solution in hydrogen ions. In pure water less is formed in a given time than in water containing carbonic acid. More is formed by a given quantity of hydrochloric acid than by an equivalent quantity of phosphoric acid, and by either of these acids much more is formed than by an equivalent of acetic acid.

This substance is the same as that designated as "albuminate" by Weyl, which is formed in greater or less amount in preparations of crystallized edestin made in the usual manner, and is without doubt the first product of the hydrolytic changes leading to the formation of the so-called acid albumin.

It is probable that the products insoluble in saline solutions which are formed from other globulins, originate from the same cause, and that these form a distinct class of hydrolytic derivatives of the native protein molecules.

For this derivative of edestin the name edestan is proposed.

The ultimate composition of edestan is the same, so far as can be determined by analysis, as that of edestin from which it originates.

Edestan forms salts with hydrochloric acid which react acid toward phenolphthalein to the full extent of the combined acid. One salt, having an acidity equivalent to 20.0 cc. of a centinormal solution per gram, is very sparingly soluble in water. It is this salt which forms the so-called "albuminate" found in edestin preparations. If edestan has a molecular weight near that of edestin, assumed to be about 14,500 (see Osborne, Jour. Amer. Chem. Soc. **21**, 486, 1899; also the paper following), this acidity would correspond to that of a trichloride, being just three times that of edestin monochloride and one and one-half times that of the bichloride.

Edestan is insoluble in water, far less soluble in solutions of potassium hydrate than is edestin and insoluble in ammonia water, unless the solution of the latter is relatively very strong.

The aqueous solution of edestan chloride, when concentrated, reacts acid with litmus. It is precipitated by neutralization, the precipitate being soluble in strong ammonia, yielding a solution which is precipitated by ammonium chloride but not by sodium chloride.

The aqueous solution of edestan chloride gives a precipitate with nitric acid which dissolves on warming and reappears on cooling; a precipitate with ovalbumin solutions, with the alkaloidal reagents and with sufficient mercuric chloride if its solution is concentrated. These reactions agree closely with those given Kossel as characteristic of histons, but with the true histons edestan has little in common.

THE BASIC CHARACTER OF THE PROTEIN MOLECULE AND THE REACTIONS OF EDESTIN WITH DEFINITE QUANTITIES OF ACIDS AND ALKALIES.

By Thomas B. Osborne.

I. INTRODUCTION.

The Basic Character of the Protein Molecule.

That the proteins are ionized and highly reactive bodies is indicated by the rapidity with which they unite with both bases and acids, by the readiness with which, in many cases, they respond to changes in the ionization of their solutions, and also by the fact that they are, chemically, the most active constituents of protoplasm.

That they are neutral bodies, like the carbohydrates, is not in harmony with what is known of them.

Nevertheless, it appears to be generally assumed that a solution containing protein matter, which shows neither acid nor alkaline reaction with litmus, is chemically neutral.

Observations are on record which show that some protein solutions, when neutral to litmus, are acid to phenolphthalein and alkaline to lacmoid. It is also well known that a notable quantity of acid can be added to a protein solution before an acid reaction with tropaeolin, alizarine, or phloroglucin and vanillin appears.

The fact that acids combine with protein bodies is, therefore, well known, and, in making preparations of these substances, the necessity of removing such acids has long been recognized. This has been supposedly accomplished by adding potassium or sodium hydrate or carbonate until the reaction with litmus becomes neutral. I am not aware that anyone has offered any evidence, however, that by this procedure this object is fully accomplished. It is of importance, therefore, to know whether litmus can be used to determine the point when all combined acid has been converted into neutral salts of potassium or sodium and all the protein substance has been set free, or whether, as we know is the case when tropaeolin or lacmoid is used as an indicator, more acid still remains combined.

Solutions in water of preparations of crystallized ovalbumin, in sodium chloride brine of excelsin, amandin, vignin, conglutin, glycinin, corylin, phaseolin and legumin, and in 75-90 per cent. alcohol of zein, gliadin and hordein,* which were either neutral or acid when tested with a strip of sensitive, neutral litmus paper, capable of showing distinctly the presence of 0.25 cc. of centinormal hydrochloric acid in 10 cc. of water, when made neutral to litmus, were, in every case, still acid towards phenolphthalein. With the exception of ovalbumin, these preparations had been made by the methods usually employed and had come in contact with no acid except that contained in the seeds from which they were obtained. The ovalbumin preparations were made both by Hopkins' and by Hofmeister's methods, the acidity of all of them being the same.

* These protein bodies are described in Reports of this Station, 1890 to 1899; also Osborne, Amer. Chem. Jour., **13, 14** and **15**; Jour. Amer. Chem. Soc., **16, 17, 18, 19, 20** and **21**; also Die Proteide, etc., Heidelberg, 1897.

To render gram portions of these several protein preparations neutral to litmus required in a few cases not any, in most cases from 0.1 cc. to 1.5 cc. of decinormal alkali; while to make the same one gram portions neutral to phenolphthelin required the further addition of from 0.7 to 1.0 cc. of decinormal alkali, except for legumin, which required 2.0 cc.

This reaction with phenolphthalein is sharp and definite, like that with strong mineral acids, and is independent of dilution, the same result being obtained in a volume of 10 cc. or in one of 100 cc.

The question now arises, whether complete neutralization of the combined acid is indicated by phenolphthalein or by litmus.

Preparations of edestin, which are neutral or acid to litmus, when suspended in water and made neutral to phenolphthalein by adding potassium hydrate, are not in any perceptible degree dissolved, but yield to the solution potassium salts of simple acids, which may be obtained therefrom by evaporation. When thus freed from these acids, the edestin immediately begins to dissolve if more alkali is added.

Edestin made neutral to phenolphthalein and dissolved in sodium chloride solution reacts distinctly alkaline towards litmus. This alkaline reaction is caused by the edestin itself and not by organic salts of the alkali, since such preparations yield a very small amount of ash, less than 0.05 per cent., which is neutral to both litmus and phenolphthalein.

Crystalline preparations of excelsin, obtained from the Brazil nut, *Bertholetia excelsa,* are undissolved when suspended in water and made neutral to litmus, but are completely dissolved when enough alkali, either potassium or its equivalent of ammonium hydrate, is added to render the solution neutral to phenolphthalein. With less alkali, solution is not complete, the amount of excelsin dissolved depending upon the quantity of alkali added.

Likewise, preparations of legumin from the pea, horse bean, or vetch, when suspended in water, are completely dissolved only when enough potassium, or an equivalent of ammonium, hydrate is added to neutralize their acid reaction to phenolphthalein. It is highly improbable that excelsin and legumin can form soluble compounds with potassium which are neutral to phenolphthalein, and the fact that an exactly equivalent

quantity of ammonium causes solution, is also evidence that this is not so, since a much larger proportion of ammonium hydrate than of potassium hydrate is required to dissolve edestin. Thus, 1 gram of a preparation of edestin, which was completely dissolved by 1 cc. of decinormal potassium hydrate solution, was not entirely dissolved by 13 cc. of decinormal ammonium hydrate. Furthermore, the proteins being very weak acids, it is scarcely possible that these form salts with potassium which are neutral to phenolphthalein. Certainly this is not the case with edestin, as the slightest excess of potassium hydrate above that required to neutralize the combined acid at once turns phenolphthalein red.

Solutions of all the other protein bodies that I have examined, when similarly made neutral to phenolphthalein, react decidedly alkaline with litmus.

From these facts it seems certain that the proteins are true bases, as I have previously pointed out (Osborne, Jour. Amer. Chem. Soc., **21**, 486; Report of this Station for 1899; also Jour. Amer. Chem. Soc., **22**, 402), and that they are not pseudo-ammonium bases, as Cohnheim and Krieger assume. (Cohnheim and Krieger, Zeit. f. Biologie, N. f. **22**, 95.)

II. COMPOUNDS OF EDESTIN WITH ACIDS.

Since edestin, when neutral to phenolphthalein, is insoluble in water, it presents an opportunity for studying the nature of the acidity of its preparations, as obtained by the methods now used, that is offered by no other protein with which I am familiar. I have, therefore, subjected edestin to an extensive study, the details of which are given in the following pages.

This study appeared to be important, as edestin is a true protein substance, presenting all the essential characteristics of these bodies, so that the reactions into which it enters with bases and acids are, without doubt, to a large extent typical of those of the proteins in general.

I. The Degree of Acidity of Edestin Preparations.

To neutralize to phenolphthalein the acid reaction of a sodium chloride solution of one gram of each of twenty different preparations of edestin made by all the various methods usually employed in preparing this substance, it was necessary to add from 0.85 to 1.5 cc. of decinormal potassium hydrate solution.

To neutralize eight of these solutions to litmus required from 0.2 to 0.5 cc., while the remaining twelve were neutral to litmus, the difference in the acidity of the several preparations measured by these two indicators being equal to from 0.85 to 1.10 cc. of decinormal alkali.

The degree of acidity towards phenolphthalein is very easily determined by direct titration, since the end reaction appears promptly. The same result is obtained by titrating the saline solution directly, by dissolving the preparation in an excess of alkali and titrating back, or by suspending the edestin in water in a stoppered bottle and adding the alkali until a red color appears. In the latter case the end point is obtained more slowly, since the reaction takes place with one substance in the solid state.

II. The Nature of the Acids Combined with Edestin.

Air-dried preparations of edestin, when suspended in water and treated with enough dilute potassium hydrate solution to give a just preceptible alkaline reaction with phenolphthalein, do not dissolve, as already said, but form, on standing, dense deposits of disintegrated crystals, above which a voluminous flocculent layer of amorphous matter settles. Some samples, when thus treated, separate completely from the solution, leaving it clear and easily filtered; others form a milky, colloidal semi-solution which cannot be filtered. These latter preparations, when suspended in 50 per cent. alcohol and neutralized to phenolphthalein with alkali, yield clear solutions which are easily filtered. The residue left on evaporating the filtrate and washings of the neutralized edestin, when dried at 110°, usually equals about 1.25 per cent. of the edestin, dried at the same temperature. The proportion of this residue obtained from several preparations was found to be as follows:

Preparation --	4	7	9	10	11	12	13	15	18
Per cent. -----	1.30	1.05	1.27	1.21	1.40	1.26	1.41	1.15	1.44
				1.26	1.41			1.17	

In order to find the composition of these residues, 75 grams of preparation **19*** were exhausted with large quantities of 75

* This was obtained by treating hemp-seed with 3 per cent. brine heated to 60° and cooling the clear extract. The protein which separated wholly in octahedral crystals, therefore constitutes a preparation of crude edestin.

per cent. alcohol until the final washings left on evaporation no notable quantity of solids. The total residue left by evaporating the whole of these washings weighed 0.2833 gram, equal to 0.38 per cent. of the protein. Its solution in water was made neutral to phenolphthalein by 3.4 cc. of decinormal potassium hydrate solution, and yielded a precipitate, chiefly protein, weighing 0.1159 gram. The filtrate from this, when evaporated, left a residue weighing 0.1674 gram, of which 0.0133 gram was potassium that had been added in neutralizing the solution. Deducting this, we find that only 0.1541 gram of nonprotein matter had been removed by washing 75 grams of edestin. On ignition, a residue of mineral matter remained, weighing 0.0600 gram, from which again should be deducted 0.0133 gram, corresponding to the potassium contained in the 3.4 cc. of decinormal solution added, so that the total mineral matter removed by exhaustive washing from the 75 grams of edestin amounted to only 0.0467 gram, or 0.06 per cent. The absence of more than traces of soluble mineral matter remaining in this sample of edestin having thus been demonstrated, it was suspended in pure water, and 90.0 cc. of decinormal potassium hydrate solution, diluted with much water, was gradually added, which sufficed to exactly neutralize the mixture to phenolphthalein. After being shaken in a closed flask for some hours, the undissolved edestin was filtered out and washed by decantation with alcohol of about 65 per cent. by volume, applied in six successive portions of 1,000 cc. each. The filtrate and washings were separately evaporated and left residues, when dried at 110°, which weighed as follows:

TABLE I.—SOLUBLE MATTER FORMED BY NEUTRALIZING EDESTIN 19 WITH POTASSIUM HYDRATE.

1st.	aqueous filtrate	0.2542 gram.
1st.	1000 cc. 65% alcohol	0.1225 "
2d.	" " " "	0.0680 "
3d.	" " " "	0.0750 "
4th.	" " " "	0.0725 "
5th.	" " " "	0.0480 "
6th.	" " " "	0.0308 "
	Total	0.6710 "

These residues were united and extracted with strong alcohol, in which a part dissolved. The part soluble in alcohol was also

soluble in water, forming a yellow solution which required 0.3 cc. of decinormal hydrochloric acid to neutralize it to litmus, and 0.7 cc. to phenolphthalein.

When this alcoholic solution was evaporated and the residue burned at a low temperature, alkaline vapors were evolved in small amount.

The matters soluble and insoluble in strong alcohol weighed respectively 0.1514 and 0.6173 gram, and when analyzed were found to contain the following substances:

TABLE II.—COMPOSITION OF THE POTASSIUM SALTS FORMED BY NEUTRALIZING A CRUDE PREPARATION OF CRYSTALLIZED EDESTIN 19 WITH POTASSIUM HYDRATE.

	Part Soluble in Strong Alcohol.		Part Insoluble in Strong Alcohol.	
	Weight.	Per cent.	Weight.	Per cent.
Organic matter	0.0825 gram.	54.42	0.1429 gram.	23.15
Potassium carbonate	0.0400 "	26.38	0.0600 "	9.72
Potassium sulphate	0.0200 "	13.33	0.0766 "	12.41
Potassium chloride	0.0052 "	3.43	0.2750 "	44.55
Potassium phosphate	--------	----	0.0235 "	3.74
Sodium chloride	--------	---	0.0091 "	1.47
Undetermined and loss	0.0037 "	2.44	0.0302 "	4.96
	0.1514 "	100.00	0.6173 "	100.00

The sum of the mineral matters contained in the two portions is 0.5433 gram, and had the following compositions:

TABLE III.—COMPOSITION OF TOTAL INORGANIC SALTS FORMED BY NEUTRALIZING THE CRUDE PREPARATION OF CRYSTALIZED EDESTIN 19 WITH POTASSIUM HYDRATE.

	Weight.	Per cent.
Potassium carbonate	0.1000 gram.	18.40
Potassium sulphate	0.0966 "	17.81
Potassium chloride	0.2802 "	51.54
Potassium phosphate	0.0235 "	4.32
Sodium chloride	0.0091 "	1.67
Undetermined and loss	0.0339 "	6.26
	0.5433 "	100.00

From these figures we find that the greater part of the soluble substances formed by neutralizing this preparation consists of potassium salts of mineral acids and that 60 per cent. of the potassium in these salts is present as chloride.

We also find that alcohol dissolves a large proportion of the organic matter which consists largely of potassium salts of one or more organic acids, since the quantity of potassium carbonate formed after igniting is equal to about one-half the combustible matter. The sum of this latter and the potassium carbonate is 0.1225 gram, of which 0.0211 gram is potassium and 0.1014 gram organic. From this a maximum mean molecular weight of 188 can be calculated, which shows that no considerable part of the potassium carbonate is formed from potassium compounds of protein.

Owing to the exhaustive washing to which this preparation had been subjected before neutralization, it is improbable that this organic matter was an admixed impurity, nor was it a free organic acid insoluble in water, because the solution of its potassium salt remained clear on adding a little hydrochloric acid, showing the organic acid to be readily soluble in water.

We must, therefore, conclude that this organic matter consists of one or more of the organic acids of the seed, which had combined with the edestin.

In confirmation of these results, this experiment was repeated, with sample **20**, prepared from a sodium chloride extract of hemp-seed, which had been neutralized to litmus with potassium hydrate, and dialyzed until the edestin had precipitated in crystals. This precipitate was redissolved in 10 per cent. sodium chloride brine, heated to 50°, the solution diluted with three volumes of water at the same temperature, filtered perfectly clear and cooled at 12°. The beautifully crystallized deposit which separated was thoroughly washed, first with 1 per cent., then with 0.5 per cent. sodium chloride solution, and finally with 50 per cent. alcohol until all the salt was removed. This method of washing with dilute salt solution and alcohol was necessary, because on washing with water alone a large part of the preparation dissolved, the reason for which is later explained.

Thirty grams of the air-dry preparation were suspended in pure, freshly-boiled water, and 24.0 cc. of decinormal potassium hydrate solution, likewise diluted with water, were added. The mixture, perfectly neutral to phenolphthalein, was allowed to stand some time, filtered, and the insoluble edestin thoroughly washed with dilute alcohol.

The filtrate and washings were evaporated, the residue dried at 110°, weighed and analyzed with the following results:

TABLE IV.—COMPOSITION OF THE POTASSIUM SALTS FORMED BY NEUTRALIZING A RECRYSTALLIZED PREPARATION OF EDESTIN, **20**, WITH POTASSIUM HYDRATE.

	Gram.	In per cent. of the Inorganic Matters.
Organic matters	0.0315	
Potassium carbonate	0.0083	5.7
Potassium sulphate	0.0095	6.5
Potassium chloride	0.1081	73.9
Sodium chloride	0.0108	7.4
Undetermined and loss	0.0095	6.5
Total	0.1777	100.0

These figures in general confirm those previously given, but show a larger proportion of potassium chloride and a smaller proportion of organic salts and sulphate. This is doubtless the result of the recrystallization, whereby this preparation **20** was finally separated from a solution containing a much smaller proportion of negative ions other than those of chlorine than that existing in the solution from which **19** was crystallized.

As already stated, a part of many preparations of edestin dissolves in water when the associated salts are mostly washed out. In order to determine whether or not this solubility is due to a difference in the nature of the acids united to the soluble and to the insoluble parts, 30 grams of preparation **20** were exhausted with pure water and the filtered solution was neutralized with 10.6 cc. of decinormal potassium hydrate solution, whereby the edestin was wholly precipitated. The clear filtrate and washings from this precipitate were evaporated, the residue dried at 110° and analyzed, with results as follows:

TABLE V.—COMPOSITION OF THE POTASSIUM SALTS FORMED BY NEUTRALIZING THE PART OF THE EDESTIN PREPARATION WHICH WAS SOLUBLE IN WATER.

	Gram.	In per cent. of the Inorganic Matters.
Organic matters	0.0902	
Potassium carbonate	0.0021	1.4
Potassium sulphate	0.0096	6.6
Potassium chloride	0.0721	49.8
Sodium chloride	0.0585	40.4
Undetermined and loss	0.0025	1.8
Total	0.2350	100.0

The presence of sodium chloride, which forms so large a part of these salts, is undoubtedly due to incompletely washing the original preparation, which had been recrystallized several times from dilute brine and, in order that the water-soluble edestin compound should not be removed from it, had been washed first with 0.5 per cent. brine and then with 50 per cent. alcohol. The inorganic residue obtained in a similar experiment, described on page 410, contained only 11.41 per cent. of sodium chloride, which shows that in the present case this is to be regarded as an accidental contamination and not as a product of neutralization.

The potassium hydrate used for neutralizing the edestin was equivalent to 0.0791 gram of potassium chloride, of which salt 0.0721 gram appears in the analysis, even after calculating all the other acids as potassium salts. From this, it is evident that the water-soluble edestin was mostly combined with hydrochloric acid. It is to be noted that all the added alkali, in this case, was recovered, whereas in the experiments first described only 70 per cent. was found in solution. This is doubtless due to the fact that in these first experiments the acid neutralized was largely contained within the body of the crystals,* and, as these crystals did not dissolve when neutralized, the potassium salts which formed within them were washed out with great difficulty. In this last experiment the edestin was wholly dissolved at the time the alkali was added, and consequently the potassium salts that formed were easily separated from it.

The part of preparation **20** which did not dissolve on treating with water, was next suspended in pure, boiled water and neutralized to phenolphthalein by carefully adding 16.6 cc. of decinormal potassium hydrate solution. After standing some time, the solution was filtered and the undissolved edestin thoroughly washed with 75 per cent. alcohol. The filtrate and washings, when evaporated, left a residue which, when dried at 110°, was analyzed with the following results:

* Under the microscope the greater part of the undissolved edestin is seen to consist of fragments of crystals, most of which are of relatively considerable size, so that potassium salts formed within these fragments are necessarily extracted with difficulty.

TABLE VI.—COMPOSITION OF THE POTASSIUM SALTS FORMED BY NEUTRALIZING THAT PART OF THE EDESTIN PREPARATION THAT WAS INSOLUBLE IN WATER.

	Gram.	In per cent. of the Inorganic matters.
Organic matters	0.0574	
Insoluble mineral matter	0.0067	5.8
Potassium carbonate	0.0121	10.5
Potassium sulphate	0.0117	10.1
Potassium chloride	0.0710	61.5
Sodium chloride	0.0085	7.4
Undetermined and loss	0.0055	4.7
	0.1729	100.0

In this experiment, 75 per cent. of the potassium added was recovered, of which 76 per cent. is chloride and 11 per cent. sulphate.

In the similar experiment, to be described on page 411, 85 per cent. of the potassium added was recovered, of which 47.6 per cent. was chloride and 52.4 per cent. sulphate. Since the present experiment yielded so small a proportion of sulphate, it is evident that the insolubility of edestin in water is not simply due to combined sulphuric acid, but, as we shall later show, is chiefly due to the *greater proportion* of acid combined with the soluble part.

To make a preparation which, when neutralized, should yield only chloride, 3,000 grams of hemp-seed meal were extracted with 9 liters of brine heated to 60° and containing 3 per cent. of almost chemically pure sodium chloride. The filtered extract was cooled to 8° and allowed to stand over night, until the large crop of crystals had been deposited. These crystals were then collected on a filter, washed once with water, redissolved in one liter of sodium chloride brine, the solution filtered perfectly clear, heated to 55°, diluted with three volumes of water at the same temperature, and rapidly cooled to 0°.

The crystalline deposit which separated was suspended in water, brought on a filter, and this process repeated until all the edestin soluble in water was washed out. The three portions of washings first obtained were almost protein-free, the fourth contained nearly one-half of the original preparation, the fifth much less, and the sixth very little.

To the fourth portion enough pure sodium chloride was added to form a 10 per cent. solution. This caused at first an abund-

ant precipitate, most of which dissolved when more of the salt passed into the solution, which was then filtered and dialyzed for 40 hours, whereby its salt content was reduced to 2 per cent., and the edestin was precipitated in beautiful crystals. These were filtered out, washed with 50 per cent. alcohol and finally with absolute alcohol and dried over sulphuric acid, giving 37 grams of a perfectly crystallized, dazzlingly white preparation, **22**, which was mostly soluble in pure water, and wholly soluble in sodium chloride solution.

To neutralize to phenolphthalein, a quantity of this preparation corresponding to one gram of the water and ash-free substance, 1.22 cc. of decinormal potassium hydrate solution was required, corresponding to an acidity which, as we shall see later, is that of a mixture containing a small proportion of the water-insoluble with a large proportion of the water-soluble, edestin compound.

Twenty grams of this preparation, air-dry, were then treated with 600 cc. of pure water, 220 cc. of centinormal potassium hydrate solution added, and the voluminous precipitate filtered out and washed with 250 cc. of water. The filtrate and washings, when evaporated, left a residue, which had the following composition:

TABLE VII.—POTASSIUM SALTS FORMED BY NEUTRALIZING EDESTIN PREPARATION. **22.**

	Gram.	In per cent. of the Inorganic matters.
Organic matters	0.0185	
Potassium carbonate	0.0020	1.19
Potassium sulphate	0.0065	3.89
Potassium chloride	0.1398	83.51
Sodium chloride	0.0191	11.41
	0.1859	100.00

Although the free edestin had been only superficially washed, we find over 85 per cent. of the added potassium to be contained in these salts, 95 per cent. of which is present as chloride. The proportion of sulphate to chloride in these salts is less than 2 molecules of the former to 100 of the latter. Although this preparation was nearly free from sulphate, nevertheless, a perfectly pure chloride was not obtained in this way.

Twenty grams of that part of the edestin, which, as already described, did not dissolve in water, were suspended in 600 cc. of water and neutralized by adding 12 cc. of decinormal potassium hydrate solution. The solution filtered from the undissolved edestin, together with the washings, was evaporated and the residue analyzed with the following results:

TABLE VIII.—COMPOSITION OF POTASSIUM SALTS FORMED BY NEUTRALIZING THAT PART OF THE EDESTIN PREPARATION THAT WAS INSOLUBLE IN WATER.

	Gram.	In per cent. of the Inorganic matters.
Organic matters	0.0340	
Potassium carbonate	none	
Potassium sulphate	0.0479	49.6
Potassium chloride	0.0373	38.7
Sodium chloride	0.0079	8.2
Undetermined and loss	0.0034	3.5
	0.1305	100.00

In this residue we have a larger proportion of sulphate than in any previously analyzed. We shall later show edestin sulphate to be less soluble in water than the corresponding chloride, and, for this reason, it is probable that the edestin sulphate had accumulated in the fraction insoluble in water. Whether edestin sulphate is a constituent of the seed or results from sulphates contained in the sodium chloride and in the river water in which the solutions were dialyzed was not determined, but the latter seems probable, because, before its final precipitation this substance was wholly soluble in water.

From these results it appears that edestin preparations, obtained by cooling or by dialyzing saline solutions, usually consist of mixtures of several compounds of the protein with acids, the proportion of the different compounds formed depending upon the degree of acidity of the solution and the nature of the negative ions which are present when the edestin crystallizes out.

Owing to the difficulty of obtaining edestin chloride free from sulphate, it seemed possible to obtain the sulphates free from other acid compounds.

Four kilograms of hemp-seed meal were accordingly extracted with 15 per cent. ammonium sulphate solution, the extract saturated with the same salt, and the protein thus precipitated was filtered out and dissolved in the dilute sulphate solution which resulted on adding water. The clear solution, when dialyzed,

deposited relatively large octahedral crystals, which, when washed with water and alcohol and dried, weighed 440 grams, preparation **23**.

Fifty grams of this preparation were suspended in water and made exactly neutral to phenolphthalein by adding 45 cc. of decinormal potassium hydrate solution, diluted with much water. As the neutral edestin did not separate from the solution in a condition to be filtered, an equal volume of alcohol was gradually added. The clear filtrate and washings then obtained were evaporated and the residue analyzed with the following results:

TABLE IX.—COMPOSITION OF THE POTASSIUM SALTS FORMED BY NEUTRALIZING EDESTIN, PREPARATION **23**.

	Gram.	In per cent. of the Inorganic matters.
Organic matters	0.2269	
Potassium carbonate	0.0480	18.98
Potassium sulphate	0.1956	77.34
Potassium chloride	0.0066	2.61
Undetermined and loss	0.0027	1.07
	0.4798	100.00

The effect of substituting sulphate for chloride in extracting edestin is plainly shown by these figures, over 75 per cent. of the recovered potassium being sulphate and less than 3 per cent. chloride. Of the potassium added in neutralizing, 66 per cent. was recovered in the above salts, which agrees well with the 70 per cent. obtained in the previously described experiments in which the edestin crystals did not dissolve but fell into relatively large fragments on neutralizing.

In order to convert, if possible, edestin sulphate into chloride, 50 grams of this preparation **23** were suspended in 70 per cent. alcohol and 50 cc. of decinormal potassium hydrate solution added. The edestin thus made neutral was filtered out, dissolved in 500 cc. of 10 per cent. sodium chloride solution and carefully mixed with an equal volume of the same brine containing 50 cc. of decinormal hydrochloric acid. The solution was filtered clear, dialyzed, the crystalline precipitate washed with water, until all the soluble edestin was removed, the residue suspended in water, neutralized to phenolphthalein, and the potassium salts produced, analyzed with the following results:

TABLE X.—COMPOSITION OF THE POTASSIUM SALTS FORMED BY NEUTRALIZING EDESTIN CHLORIDE OBTAINED FROM EDESTIN SULPHATE.

	Gram.	In per cent. of the Inorganic matters.
Organic matters	0.0192	
Potassium carbonate	0.0016	2.01
Potassium sulphate	0.0130	16.31
Potassium chloride	0.0587	73.65
Undetermined and loss	0.0064	8.03
	0.0989	100.00

These figures show that over 82 per cent. of the potassium was recovered as chloride and less than 16 per cent, as sulphate.

The many experiments here described can leave no doubt that the acidity of edestin preparations is chiefly caused by hydrochloric and sulphuric acids and that by neutralizing to litmus only a part of the combined acids is removed.

As to the nature of the organic acid, which was present in all the salts described, no information has been obtained, too little being present to make its identification possible.

To determine whether this organic acid was in fact an acid combined with the protein substance or was a product resulting from local over-action of the alkali on the edestin molecule, I extracted hemp-seed meal with 10 per cent. sodium chloride solution containing enough baryta to cause the extract to be just neutral to litmus and then precipitated the edestin from the filtered extract by dialysis against distilled water.

The crystalline product thus obtained was thoroughly washed with water, dissolved in brine, again precipitated by dialysis and extensively washed with water. The moist product was then suspended in water, made neutral to phenolphthalein by adding very dilute potassium hydrate solution, filtered out and redissolved in 10 per cent. sodium chloride brine. The resulting solution was mixed with an equal volume of the same brine, containing hydrochloric acid equivalent to the potassium hydrate previously used for neutralizing and the solution dialyzed. The crystalline precipitate was filtered out, washed and neutralized as before and the entire process again repeated. The three solutions filtered from the three successive edestin precipitates caused by neutralization were evaporated and the residues analyzed.

TABLE XI.—COMPOSITION OF SALTS RESULTING FROM THREE SUCCESSIVE NEUTRALIZATIONS OF AN EDESTIN PREPARATION.

	I. Per cent.	II. Per cent.	III. Per cent.
Potassium carbonate	7.4	5.1	0.8
Potassium sulphate	4.4	2.6	23.0
Potassium chloride	82.8	80.6	71.3
Sodium chloride	----	5.2	3.6
Undetermined	5.4	6.5	1.3
	100.0	100.0	100.0

These figures show that the organic potassium compound practically vanished after the third precipitation, and therefore it is highly probable that this is a salt of an organic acid previously combined with the edestin and not a product of the action of the alkali upon the protein molecule.

III. THE PROPORTION OF ACID COMBINED WITH EDESTIN.

On page 402 I have shown that all of a large number of edestin preparations are, without exception, acid to phenolphthalein, and that many of them are also acid to litmus. Some of these preparations are decidedly more acid than others. Most of the more acid contain more substance soluble in water than those less acid. Some, however, of the most acid are wholly insoluble in water. All of these latter were prepared from solutions containing ammonium *sulphate* and, when neutralized with potassium hydrate, yielded chiefly potassium *sulphate*, whereas the others containing substance soluble in water, yielded, on thus neutralizing, chiefly potassium *chloride*.

The difference between the degree of acidity of the part of the preparation which is soluble in water and of that which is insoluble therein is, however, marked. In upwards of a hundred trials, I have invariably found the acidity of the part soluble in water to be equivalent to very nearly 1.4 cc. of decinormal acid per gram of the dissolved edestin, while that of the insoluble part was but half as great, provided the preparation tested was made without using ammonium sulphate. As an illustration of this, the following experiments may be given.

A quantity of an edestin preparation was made by cooling a warm sodium chloride extract of hemp-seed and repeatedly recrystallizing the precipitate from warm, dilute salt solution.

The substance was then washed by decantation with water. The first, second and third solutions decanted contained no edestin, owing to the salts present in them, but the fourth and fifth contained some.

It was necessary to add 0.8 cc. of decinormal potassium hydrate solution to 10 cc. of the fourth decantation in order to obtain a neutral reaction with phenolphthalein, while exactly twice as much was required by 20 cc. By evaporating, and drying the residue at 110°, it was found that 10 cc. contained 0.5777 gram of edestin, so that 1.0 gram of the soluble edestin neutralized 1.39 cc. of decinormal alkali. Similarly, 25 cc. of the fifth washings, containing 0.5320 gram, required for neutralization 0.7 cc. of decinormal alkali, equal to 1.32 cc. per gram.

Eighteen grams of that part of the original preparation which did not dissolve on exhausting with water, when suspended in water, was made exactly neutral to phenolphthalein by 12 cc. of decinormal alkali, or 0.66 cc. per gram,—that is, by just one-half the quantity of alkali required by the soluble part.

Further, another quantity of edestin from which all the compounds soluble in water had been removed and which, when subsequently dried at 110°, weighed 21.27 grams, required when freshly washed and not dried 16.6 cc. of decinormal alkali to render it neutral to phenolphthalein, or 0.78 cc. of decinormal alkali for each gram of protein.

On page 412 the method is described by which a part of preparation **23**, yielding chiefly sulphate when neutralized, was converted into a crystalline preparation yielding chiefly chloride. The product thus obtained was exhausted with water until nothing more was removed from it, and that part which remained undissolved was uniformly suspended in water and 10 cc. drawn out and mixed, in a stoppered bottle, with 1.5 cc. of decinormal potassium hydrate solution and phenolphthalein. A clear red solution was formed at once, which required 0.95 cc. of decinormal hydrochloric acid for neutralization, showing 0.55 cc. of the alkali to have been neutralized by the acid combined with the edestin. By evaporating and drying the residue at 110°, it was found that the 10 cc. contained 0.8152 gram of edestin, from which it is seen that one gram of the compound insoluble in water had an acidity equal to 0.68 cc. of decinormal

acid. Two other similar trials gave exactly the same result. Ten cc. of the mixture were also added to 10 cc. of 20 per cent. sodium chloride solution, phenolphthalein added and then decinormal potassium hydrate solution until a slight pink color formed, for which 0.55 cc. was likewise required.

Edestin preparations suspended in water and treated with an insufficient quantity of hydrochloric acid to dissolve them, yield solutions which have an acidity equal to 1.4 cc. of a decinormal solution per gram of dissolved protein.

From all these facts it is clear that the acidity of the edestin chloride, which is soluble in water, is twice that of the part which is insoluble therein.

If the edestin molecule contains two atoms of sulphur, its weight must be about 7,250, or a multiple of this. If the acidity of the water-soluble edestin is equal to 1.4 cc. of decinormal acid per gram and if one molecule of acid unites with one of edestin to form a water-soluble compound, the molecular weight of edestin would be 7,129. But, since the water-soluble edestin is twice as acid as the water-insoluble, the former must contain at least two molecules of acid, so that the molecular weight of edestin must be about 14,258, or a multiple of this.

We thus have, in these two acid compounds, a rational explanation for the fact, first observed by Ritthausen, that a part of most edestin preparations is soluble in pure water, while the remainder is insoluble therein. That this was due to a chemical difference between these two parts was most probable, although preparations showing this behavior consisted wholly of crystals having apparently the same form.

That these two compounds of different composition, as well as the other salts and the free edestin, should crystallize in the same form is to be expected, since the form of the crystal is determined by the protein molecule, the weight of which is enormous compared with that of the one or two molecules of acid combined with it. The same condition occurs with the compounds of haemoglobin, the crystals of carbon-monoxide haemoglobin being isomorphous to those of oxyhaemoglobin. The same isomorphism also occurs among minerals of high molecular weight, as shown by Penfield and Foote (Penfield and Foote, Amer. Jour. Science, **8**, 122, 1899), who state "In tourmaline we have an isomorphous relation of a very peculiar

nature, for in the acid H_9Al_3 $(BOH)_2$ Si_4O_{19} the nine hydrogens may be replaced to a large extent by the trivalent metal aluminium or by the bivalent metals magnesium and iron without any decided change in crystalline form. This leads to the consideration of a certain phase of isomorphism which, as it seems to us, has not been considered with sufficient care, namely, the mass effect of complex radicals in influencing or controlling crystallization."

If such be the case with a mineral acid containing but $(41)_n$ atoms we certainly should expect the mass influence of a molecule containing approximately $(2{,}000)_n$ atoms to be all-controlling.

IV. Reactions of Edestin with larger quantities of Acid.

It has long been known that protein substances combine with acids, and it is a common practice to determine the amount of acid combined with products of gastric digestion. In these products, however, the combined acid is chiefly held by proteoses and peptones, bodies that are known to have more basic properties than the native proteins from which they originate. (Cf. Conheim & Krieger, Zeit. f. Biologie n. F., **22**, 95.) Panormoff (Panormoff, Jour. d. russ. phys.-chem. Gesellsch., **31**, 556) has recently described definite compounds of ovalbumin with different acids, but these contain a much larger proportion of acid than the salts of edestin just described, and are doubtless compounds of a different order (see preceding paper).

I have, however, obtained evidence that edestin also enters into definite reaction with similar large quantities of acid.

A study of the action of water and acids upon edestin has shown that a hydrolytic change is effected in the edestin molecule, whereby a more basic derivative is formed, which shows an entirely different behavior with alkalies and salt solutions from that exhibited by the original, unchanged edestin. It is probable, therefore, that these more acid compounds are not salts of edestin, but salts of more basic derivatives, which form intermediate steps in a series of changes leading to the so-called "acid albumin." Whether or not these changes are common to the other "native proteids" I have not as yet ascertained with certainty, but it is probable that they are. Gram portions of

the air-dry preparations of edestin, **11**, **12** and **13**, were suspended in water and decinormal hydrochloric acid gradually added, until a drop of the solution, evaporated on porcelain, showed with tropaeolin a distinct red reaction, which in each case appeared with 12 cc. The tests were then repeated by adding to each solution 11 cc. of acid and afterward increasing this quantity by successive additions of 0.2 cc. By testing with tropaeolin after each such addition, it was found that one gram of **11** had reacted with 11.2 cc., **12** with 11.5 cc., and **13** with 11.3 cc. Calculating these figures for the preparation dried at 110° and ash-free, and adding to this the acid originally contained in them, we find that **11** had reacted with 13.9 cc., **12** with 13.7 cc., and **13** with 14.1 cc., which corresponds almost exactly to a compound of one molecule of edestin with 20 molecules of acid, assuming this protein to have a molecular weight of approximately 14,500, or, in other words, to exactly ten times the quantity of acid required to form a soluble compound with one gram of edestin.

Strong evidence of a definite reaction with about 10 molecules of acid was obtained by testing with potassium nitrite and iodide. A series of five one-gram portions of **11** were suspended in water in small, glass-stoppered bottles, and to them were respectively added 4 cc., 5 cc., 6 cc., 6.5 cc. and 7.5 cc. of decinormal hydrochloric acid, and then to each 7.5 cc. of a solution of soluble starch, containing 1 per cent. of potassium iodide and 1 per cent. of potassium nitrate.

The portion containing 7.5 cc. of acid became blue throughout within five minutes, the color first appearing at the top of the solution; that with 6.5 cc. began to turn blue at the top within a minute and a half, and became wholly blue in twelve minutes; that with 6.0 cc. showed a trace of blue on the surface after five minutes, which, even after 30 minutes, was very slight and limited to the upper surface; that with 5.0 cc. showed a trace of blue on the surface after fifteen minutes, which was still slight after an hour and a half; that with 4 cc. behaved like that with 5.0 cc., except that, on adding the nitrite solution, a large, permanent precipitate formed, whereas all the other solutions remained very nearly clear. On standing over night, in the stoppered bottles, the difference between the various portions was much more pronounced, for from those to which

4, 5 and 6 cc. of acid had been added, an opaque yellowish jelly had separated, above which was a clear blue jelly, whereas the portion with 6.5 cc. formed a thin blue jelly containing but little of the opaque substance and presented a wholly different appearance from those with 6.0 cc. and less.

From this it would appear that this edestin preparation combined with the hydrogen ions contained in 6.0 cc. of decinormal hydrochloric acid more firmly than with those contained in the larger quantities. If we add the acid originally combined with the edestin, we may conclude that the hydrogen ions equivalent to 7.0 cc. of the acid were more firmly combined with the edestin than those contained in the larger quantities.

V. Solubility of Edestin in Hydrochloric Acid.

Having found that edestin forms a water-soluble salt with hydrochloric acid, I undertook to determine the amount dissolved by definite quantities of this acid. To do so, it was necessary to make a preparation which should be as neutral as possible to phenolphthalein, free from any of the hydrolytic derivative of edestin, mentioned on page 417, and as free as possible from ash.

This is accomplished by extracting oil-free hemp-seed meal with 3 per cent. sodium chloride brine, previously heated to 60°, to which is added enough saturated baryta solution to render the extract neutral to litmus, the requisite quantity being determined by a preliminary experiment with 100 grams of the meal. It is important to avoid an excess of baryta, since otherwise, compounds of edestin with basic constituents of the seed seem to be formed, which are difficult to get rid of afterwards.

The hot extract is strained on coarse cloth and the residue pressed. The very turbid extract is thrown on large paper filters and allowed to stand at rest for about two hours. During this time a part of the extract filters through and the residue settles in the funnels so that about two-thirds of the solution can be drawn off as a turbid liquid, which, however, contains but little suspended matter. This is filtered by suction on thick felts of filter pulp on perforated porcelain plates placed in large funnels, all being previously washed with 3 per cent. salt solution heated to 70°. By thus filtering, this part of the extract may be readily obtained perfectly clear and the filter be washed

with hot dilute salt solution, within two hours, two liters being passed through each filter. During this time, most of the residual extract passes through the paper filters, so that what remains can be rejected without serious loss. The clear extracts are united in a large glass-stoppered bottle and allowed to stand over night and cool to 5° or less. The edestin separates as a dense deposit of crystals, from which the solution is syphoned and thrown away, since very little more can be obtained from it by further dilution and cooling.

The crystallized edestin is next dissolved in 10 per cent. salt solution, best by adding a volume of 20 per cent. solution equal to that of the mother liquor remaining with the crystals after syphoning off the greater part. Enough 10 per cent. salt solution is then added so that the solution contains about 8 per cent. of edestin, since stronger solutions, under the subsequent treatment, do not, as a rule, yield well crystallized products. This saline solution of edestin is heated to 50° and gradually diluted with two volumes of water, at the same temperature, whereby a perfectly clear solution results. By again cooling to 5° the edestin is recrystallized. By repeating this process a very pure crystalline product is obtained, which is again dissolved in enough 10 per cent. sodium chloride brine, free from carbonic acid, to make an 8 per cent. solution of edestin. An aliquot part of this solution is neutralized to phenolphthalein with decinormal sodium hydrate solution, and the quantity of alkali necessary to neutralize the whole is determined. The edestin solution is then heated to 50° in a glass-stoppered jar, and twice its volume of carbonic acid free water at the same temperature and containing 4 or 5 cc. more than the calculated quantity of the decinormal alkali is gradually added. The mixture, carefully protected from carbonic acid, is allowed to cool during the night to 5°, the nearly clear solution syphoned off, and the crystalline precipitate collected on a piece of Schleicher & Schüll's thick, hardened filter paper placed on a perforated plate. The precipitate, consisting of crystals, is very quickly sucked almost dry and washed two or three times with 1 per cent. sodium chloride solution, cooled to 0°, and free from carbonic acid, then three times with carbonic acid free water, ten times with 70 per cent. alcohol, and many times with absolute alcohol, all the wash water and alcohol being at 0°. It

is necessary that the washing should be complete and the dehydration with absolute alcohol thorough, so that on drying over sulphuric acid no water should be left after the alcohol has gone off, which would convert a part of the edestin into the insoluble edestan.

Owing to the physical state of the crystalline edestin, the filtration, washing and dehydration of 50 to 100 grams can be accomplished within twenty minutes. Preparations made in this way were either neutral or very nearly neutral to phenolphthalein, completely soluble in salt solution, contained not more than 0.02 to 0.03 per cent. of ash, and consisted of fine powders, free from lumps, which can be uniformly suspended in water and almost instantly dissolved by the requisite quantity of acid, alkalies or salts.

It is very difficult to keep the edestin from combining with minute quantities of carbonic acid, since during the final filtration and washing, a brief exposure to the air is unavoidable, without employing elaborate and cumbersome apparatus. As a result, from 1 to 2 cc. of centinormal alkali were required to neutralize one gram of most preparations thus made.

This process is given in detail, as I was unable to prepare edestin suitable for the experiments next to be described, until I had worked out this method of preparation in all its details.

A series of gram portions of preparation **28**, made as above described, were suspended in glass-stoppered bottles, in enough water to make a final volume of 20 cc. with the acid subsequently added. To one portion no acid was added, to the next 2.0 cc. of centinormal hydrochloric acid, to the next 3 cc., and then 1.0 cc. more to each succeeding portion, up to 14.0 cc.

A second, exactly similar series, was also made, commencing with 6.0 cc.

After frequently shaking the contents of the bottles for about two hours, they were allowed to stand at rest for two hours longer until the suspended matter had practically all deposited. From each solution 10 cc. were drawn out with a pipette, the acidity of each such 10 cc. determined with centinormal potassium hydrate solution, and then all separately evaporated to dryness on a water bath and the residues dried to constant weight at 110°. In this way the results given in the following table were obtained.

TABLE XII.—EDESTIN DISSOLVED BY A CENTINORMAL SOLUTION OF HYDROCHLORIC ACID.

	.0 cc.	2.0 cc.	3.0 cc.	4.0 cc.	5.0 cc.	6.0 cc.	7.0 cc.	8.0 cc.
I.	.0104	0.0082	0.0504	0.0526	0.0718	0.1400	0.1876	0.2576
II.	----	----	----	----	----	0.1460	0.1702	0.2458

	9.0 cc.	10.0 cc.	11.0 cc	12.0 cc.	13.0 cc.	14.0 cc.	$\frac{HCl}{100}$
I.	0.3362	0.4358	0.5850	0.6816	0.7650	0.8406	gram.
II.	0.3378	0.4336	0.5636	0.6590	0.7350	0.8080	gram.

The acidity of the solutions and of the residues of Series I was determined by titration with centinormal alkali and phenolphthalein, with the following results:

TABLE XIII.—DISTRIBUTION OF ACID BETWEEN THE DISSOLVED AND UNDISSOLVED EDESTIN IN TERMS OF CENTINORMAL ACID.

0.0 cc.	2.0 cc.	3.0 cc	4.0 cc.	5.0 cc.	6.0 cc.	7.0 cc.	8.0 cc.
0.0 cc.	0.0 cc.	0.0 cc.	0.0 cc.	0.5 cc.	1.8 cc.	2.6 cc.	3.9 cc.
1.3 cc.	2.9 cc.	3.6 cc.	4.5 cc.	5.0 cc.	4.25 cc.	4.4 cc.	4.4 cc.
1.3 cc.	2.9 cc.	3.6 cc.	4.5 cc.	5.5 cc.	6.05 cc.	7.0 cc.	8.3 cc.

9.0 cc.	10.0 cc.	11.0 cc.	12.0 cc.	13.0 cc.	14.0 cc.	$\frac{HCl}{100}$
5.0 cc.	6.8 cc.	8.6 cc.	10.6 cc.	12.2 cc.	13.6 cc.	Dissolved.
4.0 cc.	3.6 cc.	2.4 cc.	1.9 cc.	1.0 cc.	0.8 cc.	Undissolved.
9.0 cc.	10.4 cc.	11.0 cc.	12.5 cc.	13.2 cc.	14.4 cc.	Total.

The degree of acidity of the dissolved and undissolved edestin,—that is, the amount of centinormal alkali neutralized by one gram of the edestin chloride contained in the solution and residues of each of these portions,—is given in the following table:

TABLE XIV.—THE ACIDITY CORRESPONDING TO ONE GRAM OF THE DISSOLVED AND UNDISSOLVED EDESTIN CHLORIDE OF TABLE XIII.

0.0 cc.	2.0 cc.	3.0 cc.	4.0 cc.	5.0 cc.	6.0 cc.	7.0 cc.	8.0 cc.
0.0 cc.	0.0 cc.	0.0 cc.	0.0 cc.	6.0 cc.	11.8 cc.	13.0 cc.	14.4 cc.
1.5 cc.	3.3 cc.	4.3 cc.	5.4 cc.	6.4 cc.	6.8 cc.	6.4 cc.	7.0 cc.

9.0 cc.	10.0 cc.	11.0 cc.	12.0 cc.	13.0 cc.	14.0 cc.	$\frac{HCl}{100}$
14.3 cc.	15.1 cc.	14.0 cc.	15.1 cc.	15.6 cc.	16.0 cc	Dissolved.
7.3 cc.	8.0 cc.	8.0 cc.	9.4 cc.	8.5 cc.	----	Undissolved.

From this table it appears that one gram of the substance in the solutions to which from 7 to 12 cc. of acid had been added neutralized nearly the same quantity of centinormal alkali as that calculated for a compound of one molecule of edestin with two molecules of hydrochloric acid, assuming edestin to have a molecular weight of about 14,500, namely 13.8 cc.

Since the amount of edestin in many of these portions was small, most of these determinations are only approximately correct. As already stated, one-half of each of the solutions in these experiments was drawn out with a pipette and the acidity and quantity of dissolved matter was determined as shown above. In order to more accurately determine the acidity of the dissolved edestin by using a larger proportion of substance, the remainder of those solutions of Series I to which from 7 to 13 cc. had been added, was decanted from the undissolved edestin, united and neutralized by 20 cc. of centinormal potassium hydrate solution. By evaporating, and drying the residue at 110°, this solution was found to contain 1.4459 gram of edestin, corresponding to an acidity equal to 13.8 cc. of centinormal alkali per gram, or exactly that above calculated. Similarly, the remaining solutions from Series II were neutralized by 25.0 cc. of centinormal alkali and contained 1.6941 gram of edestin, corresponding to an acidity equal to 14.7 cc. per gram. From these facts it is evident that the substance brought into solution by the acid has the acidity of a bi-chloride.

The acidity of the undissolved edestin increases with each increase in added acid, until in the portion containing 6.0 cc. it reaches 6.8 cc. per gram, which corresponds to the formation of a mono-chloride. With the larger quantities of added acid, this acidity of the undissolved edestin remains nearly constant, although a slight increase is apparent. This excess of acidity above that of the mono-chloride is caused by the formation of a small proportion of a hydrolytic derivative of edestin, which I have designated *edestan*. Edestan has a higher acid combining power than edestin and forms with acid a salt which is very sparingly soluble in water. The formation and properties of edestan are described in detail in the preceding paper.

Table XII shows that a small quantity of edestin is apparently dissolved by the water to which no acid had been added as well as by that to which 2 cc. were added. This small quantity is due to a little suspended matter, drawn off with the solution, and is not to be considered as dissolved edestin. In the portions containing 3, 4 and 5 cc. of acid, some edestin appears to be dissolved, but as these, in contrast with the others, were

opalescent and neutral, it is most probable that they were colloidal or false solutions caused by edestin bichloride, formed by a local over-excess of acid, which was subsequently reprecipitated on coming into contact with uncombined edestin.

By 6 cc. some edestin was dissolved, but the lower acidity of this portion indicates that the whole of this was not brought into solution by the acid. From 6 cc. upward, a uniformly increasing quantity of edestin passed into solution, until only an insignificant amount remained undissolved by 14 cc. If edestin has a molecular weight of about 14,500 and forms an insoluble chloride with one molecule of hydrochloric acid, about 6 cc. of centinormal hydrochloric acid should convert one gram of an air-dry preparation into this chloride. In Table XII it is seen that the edestin does not dissolve with less than 6 cc. of acid. Strictly, none should dissolve with less than 7 cc., but as this preparation had an acidity of about 1 cc. per gram, the hydrogen ions causing this ought, in so dilute a solution, to contribute equally with those of the hydrochloric acid in reacting with the edestin, and hence a corresponding quantity should be dissolved.

That this soluble acid compound of edestin contains twice as many molecules of acid as the insoluble acid compound, is shown by the rate at which the acidity of the solution of this substance increased in comparison with the rate at which the acid was added in these experiments. Thus, the solution produced by 10 cc. of acid neutralized 1.80 cc. more alkali than that produced by 9 cc., although but 1 cc. more acid had been added; that with 11 cc. also neutralized 1.80 cc. more alkali than that with 10 cc.; that with 12 cc. neutralized 2 cc. more alkali than that with 11 cc.; that is, after the whole of the edestin was converted into the insoluble chloride, each molecule of acid subsequently added brought into solution another molecule of acid which had been previously combined with the edestin as an insoluble chloride.

If edestin has a molecular weight of about 14,500, each cc. of centinormal acid in excess of 7 cc. should dissolve 0.1450 gram. The quantity actually dissolved by each cubic centimeter of acid in excess of 7 cc. falls considerably short of this, chiefly owing to the formation of the more basic derivative, edestan, mentioned on page 417.

Edestan forms sparingly soluble salts with larger quantities of acid than does edestin. In these experiments about 8 per cent. of edestan was formed and consequently the amount of edestin dissolved per cc. of acid was less than that calculated.

From these results it would appear that edestin, like a true base, enters into ionic reactions with hydrochloric acid. That a weak base should enter into such complete reaction with hydrochloric acid is due to the dilution of the solution, for if its molecular weight is 14,500, a solution containing 5 per cent. of this substance is nearly equivalent to a $^1/_{300}$ normal solution.

This method of determining the quantity of edestin brought into solution by hydrochloric acid was next applied to preparations of the chlorides obtained by the methods formerly employed for the preparation of edestin. The only difference in the manipulation of these experiments consisted in filtering the acid solutions on small felts of washed paper pulp, with help of a pump, and washing each filter and residue with 20 cc. of water.

As a part of each of these preparations was soluble in water,—that is, consisted of water-soluble acid compounds of edestin,—the amount dissolved by water alone was deducted from that obtained from each portion to which acid had been added, the difference being the quantity of edestin dissolved by the given quantity of acid. The results thus obtained are given in Table XV.

TABLE XV.—EDESTIN CHLORIDE DISSOLVED BY CENTINORMAL HYDROCHLORIC ACID.

Preparation.	1 cc.	2 cc.	3 cc.	4 cc.	5 cc.	6 cc.
No. 2. I	.1041	.2306	.3291	.4726	.5426	.6301
II	----	.2451	.3279	----	.5301	.6025
No. 4.	.0920	.2300	.3260	.4425	.5681	.6380
No. 11. I	.1194	.2540	.3679	.4445	.4950	.5085
II	.0738	.1968	.3398	.4498	.5369	.6068
No. 15. I	.0916	.2235	.3250	.4332	.5528	.5762
II	.1015	.2291	.3455	.4445	.5365	----
No. 20. I	.1295	.2655	.3761	.4790	.5115	----
II	.1140	----	.3484	----	----	----
III	.0870	.2095	.3335	.5125	.6035	----
IV	.0745	.2055	.2935	.4030	.4625	----

Average of the above figures.

	1 cc.	2 cc.	3 cc.	4 cc.	5 cc.	6 cc.
No. 2	.1041	.2409	.3285	.4726	.5364	.6163
No. 4	.0920	.2300	.3260	.4425	.5681	.6380
No. 11	.0966	.2254	.3539	.4472	.5160	.5577
No. 15	.0966	.2263	.3352	.4388	.5446	.5762
No. 20	.1012	.2268	.3379	.4648	.5258	----

Although notable irregularities occur among these figures, the results, on the whole, are as uniform as perhaps we could expect them to be under the conditions of the experiments. It is to be noted that the greater differences are found for the smaller and for the larger quantities of acid employed, that is, in those cases where slight differences in manipulation would naturally cause the greatest variation in the results.

In the table only 60 per cent. of the edestin is shown to be dissolved by the acid employed. This is due to the fact that the remaining 40 per cent. consisted of moisture, ash, acid compounds of edestin which were soluble in water, and a little of the hydrolytic derivative, edestan, which is insoluble in salt solutions. It was necessary, therefore, to add only about 6 cc. of acid in order to bring into solution all the edestin monochloride contained in each preparation.

The following table gives the average weight, in grams, dissolved per cubic centimeter of centinormal hydrochloric acid in each portion to which the designated quantity of acid was added.

TABLE XVI.—EDESTIN CHLORIDE DISSOLVED PER CC. OF CENTINORMAL HYDROCHLORIC ACID SOLUTION.

Preparation.	1 cc.	2 cc.	3 cc.	4 cc.	5 cc.	6 cc.
No. 2	.1041	.1204	.1095	.1181	.1073	.1027
No. 4	.0920	.1150	.1087	.1106	.1136	.1063
No. 11	.0966	.1127	.1179	.1118	.1032	.0920
No. 15	.0920	.1131	.1117	.1097	.1089	.0960
No. 20	.1012	.1164	.1126	.1162	.1052	.1022

These results, while not so accordant as those obtained with pure and neutral edestin, are nevertheless in harmony with them.

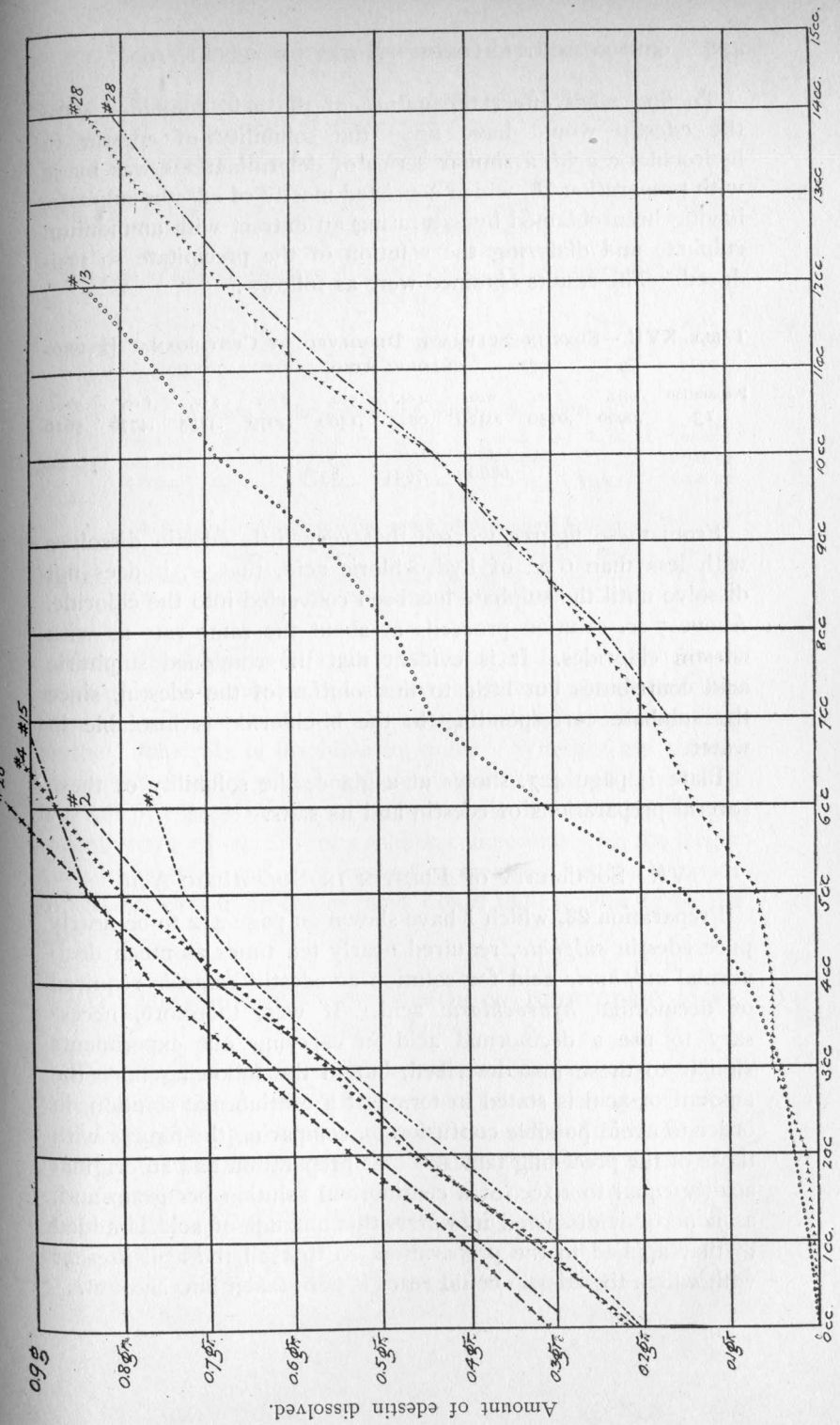


PLATE I.—SOLUBILITY OF EDESTIN IN CENTINORMAL HYDROCHLORIC ACID.

To find what effect the nature of the acid combined with the edestin would have upon the solubility of edestin in hydrochloric acid, a similar series of determinations was made with preparation **13,** which consisted mostly of edestin sulphate, having been obtained by saturating an extract with ammonium sulphate and dialyzing the solution of the precipitate so produced. The results obtained were as follows:

TABLE XVII.—EDESTIN SULPHATE DISSOLVED BY CENTINORMAL HYDROCHLORIC ACID.

Preparation.	0 cc.	2 cc.	3 cc.	4 cc.	5 cc.	6 cc.	7 cc.	8 cc.	9 cc.
13	.0000	.0150	.0420	.0825	.1500	.3070	.4435	.4776	.5616
			10 cc.	11 cc.	12 cc.				
			.6860	.7521	.8378				

From these figures we see that very little edestin dissolves with less than 6 cc. of hydrochloric acid, that is, it does not dissolve until the sulphate has been converted into the chloride. Above 7 cc. solution proceeds at about the same rate as with edestin chlorides. It is evident that the combined sulphuric acid contributes but little to the solution of the edestin, since the sulphate corresponding to the bi-chloride is insoluble in water.

Plate I, page 427, shows at a glance the solubility of these several preparations of edestin and its salts.

VI. SOLUBILITY OF EDESTIN IN SULPHURIC ACID.

Preparation **23,** which I have shown on page 412 to be nearly pure edestin *sulphate,* required nearly ten times as much decinormal *sulphuric* acid for solution as edestin *chloride* required of decinormal *hydrochloric* acid. It was, therefore, necessary to use a decinormal acid in carrying out experiments similar to those just described, but in the following table the amount of acid is stated in terms of a centinormal solution, in order to avoid possible confusion on comparing the figures with those of the preceding tables. This preparation had an original acidity equal to 10 cc. of a centinormal solution per gram and, as none of it dissolved in water, this amount of acid is added to that applied to the preparation, so that all the acid present with which the edestin could react is here taken into account.

TABLE XVIII.—EDESTIN SULPHATE DISSOLVED BY CENTINORMAL SULPHURIC ACID.

Amount in grams of dissolved Edestin Sulphate.

	10 cc.	20 cc.	30 cc.	40 cc.	50 cc.	60 cc.	70 cc.
No. 23.	.0000	.0705	.1750	.4355	.6245	----	.9075
	.0000	.0510	.2280	.4740	.6950	.8680	.9088

Amount of Edestin Sulphate dissolved per cc. of centinormal H_2SO_4 Solution.

	10 cc.	20 cc.	30 cc.	40 cc.	50 cc.	60 cc.	70 cc.
No. 23.	.0000	.0035	.0058	.0109	.0125	----	.0130
	.0000	.0026	.0076	.0118	.0139	.0145	.0130

Acidity of the solution of Edestin Sulphate.

	10 cc.	20 cc.	30 cc.	40 cc.	50 cc.	60 cc.	70 cc.
No. 23.	0.0 cc.	3.0 cc.	6.0 cc.	18.0 cc.	33.0 cc.	------	67.0 cc.
	0.0 cc.	2.0 cc.	8.5 cc.	21.5 cc.	37.5 cc.	57.0 cc.	64.0 cc

Acidity of the solution per gram of dissolved Edestin.

	10 cc.	20 cc.	30 cc.	40 cc.	50 cc.	60 cc.	70 cc.
No. 23.	0.0 cc.	43.0 cc.	35.3 cc.	41.3 cc.	52.9 cc.	------	73.7 cc.
	0.0 cc.	39.2 cc.	37.3 cc.	45.4 cc.	54.0 cc.	65.7 cc.	71.0 cc.

From these figures it is plain that a much larger quantity of sulphuric acid is required to dissolve a given amount of edestin than of hydrochloric acid. The edestin sulphate corresponding to the bi-chloride is insoluble in water. Whether the soluble compound formed with a sufficient quantity of sulphuric acid is a salt of edestin or whether a hydrolytic derivative of edestin is first produced which forms soluble compounds with the larger quantity of sulphuric acid, was not ascertained, but the behavior of edestin with hydrochloric acid would indicate this to be the case.

VII. THE SOLUBILITY OF EDESTIN IN PHOSPHORIC AND ACETIC ACIDS.

Phosphoric acid reacts with edestin as a monobasic acid, in accordance with its dissociation into the ions H and H_2PO_4.

One gram of the air-dry preparation, suspended in 6 cc. of water, was completely dissolved when treated with 14 cc. of a centinormal solution of phosphoric acid. With 13 cc., 0.8920 gram was dissolved, which is very nearly the calculated quantity, namely 0.9230 gram.

Acetic acid likewise reacts with almost the calculated amount

of edestin, since I found that 13 cc. of a centinormal solution dissolved 0.8804 gram.

Both these acids dissolve somewhat more edestin than does an equivalent quantity of hydrochloric acid, 13 cc. of a centinormal solution of which dissolved about 0.7770 gram. This difference appears to be due to the formation of different proportions of the more basic edestan, as the following experiments indicate. To each of three gram-portions of edestin suspended in 6 cc. of water, were respectively added 14 cc. of a centinormal solution of each of these acids. After standing for about two hours at 25°, the acid in each was exactly neutralized, and an equal volume of 20 per cent. sodium chloride solution was added. The amount of the insoluble edestan present in the portion with hydrochloric acid was 0.1786 gram, in that with phosphoric acid 0.1484 gram, and in that with acetic acid 0.0565 gram. These results are approximately in accord with the degree of ionization of these acids and appear to explain the relative incompleteness of the reactions with the respective acids.

VIII. The Solubility of Edestin in Nitric Acid.

Nitric acid dissolves edestin chloride in nearly the same proportion as does hydrochloric acid, but a larger quantity of the former acid is required to dissolve the neutral edestin at about 20° than of the latter. At 35° one air-dry gram of neutral edestin, equal to 0.9300 gram dried at 110°, was completely dissolved by 14 cc. of centinormal nitric acid, but by 12 cc. at this temperature much remained undissolved. At 20° one gram was completely dissolved by 20 cc., all but a very few milligrams by 19 cc., while with 18 cc. much remained undissolved.

This quantity of acid is in such close agreement with that required for the formation of a tri-nitrate that it strongly suggests that such is formed, but it is not safe to assume this without other evidence to confirm it.

That a compound with two molecules of nitric acid should exist which is more soluble in warm than in cold water, is in harmony with the known behavior of this acid with proteoses, some other protein substances and the histons.

A more extended study of this question is necessary, and I shall take it up as soon as possible.

III. COMPOUNDS OF EDESTIN WITH ALKALIES.

It is well known that protein substances react with alkalies as well as with acids, in which respect they closely resemble the purin bases, which, as pronounced bases, form salts with acids and are also able, like weak acids, to form with bases definite compounds, of which the silver salt is one of the best known, since it is used for the separation of these bodies from their ammoniacal solution.

Many unsuccessful attempts have been made to obtain definite compounds of the proteins with bases, especially with the heavy metals. The chief reason that these failed probably lies in the fact that the small quantity of acid which these substances still contain when their solutions are made neutral to litmus has been overlooked, and also to the fact that salts of the heavy metals are hydrolytically dissociated to such an extent as to make it difficult or impossible to maintain suitable conditions for the formation of definite metallic compounds with the proteins.

The experiments next to be described show that edestin enters into definite reaction with potassium and sodium.

I. Solubility of Edestin in Sodium Hydrate Solution.

Preparation **31**, which was strictly neutral to phenolphthalein, was used to determine the solubility of edestin with definite quantities of sodium hydrate, in a manner similar to that employed in determining the solubility of edestin with definite quantities of hydrochloric acid.

Gram portions of the air-dry preparation were suspended, in glass-stoppered bottles, in enough carbonic acid free water to make 20 cc. with the alkali solution to be afterwards added. To the first, 2 cc., to the second 3 cc., and so on up to 7 cc., of centinormal sodium hydrate solution were added. After agitating frequently for an hour, the solutions were allowed to stand at rest for another hour, during which time the undissolved matter settled, leaving the solution nearly clear. From each portion 10 cc. were drawn out with a pipette, evaporated to dryness, and the residues dried to constant weight at 110°. The amount dissolved by each quantity of alkali added is shown in the following table:

TABLE XIX.—AMOUNT OF EDESTIN **31**, DISSOLVED BY A CENTINORMAL SOLUTION OF SODIUM HYDRATE.

2 cc.	3 cc.	4 cc.	5 cc.	6 cc.	7 cc.	$\frac{NaOH}{100}$
0.1244	0.2564	0.4358	0.6086	0.7834	0.8990	Gram dissolved.

The amount, in grams, of edestin dissolved per cubic centimeter with each quantity of alkali added, was the following:

TABLE XX.—AMOUNT OF EDESTIN **31**, DISSOLVED PER CC. OF CENTINORMAL SODIUM HYDRATE.

2 cc.	3 cc.	4 cc.	5 cc.	6 cc.	7 cc.	$\frac{NaOH}{100}$
0.0622	0.0855	0.1090	0.1217	0.1306	0.1283	Gram dissolved.

These figures show that the amount dissolved per cc. steadily rises, until with 6 and 7 cc. it reaches a maximum. This is due to the difficulty with which all of the soluble sodium edestin is separated from the relatively large quantity of edestin remaining undissolved in those portions to which the smaller amounts of alkali had been added, since the great extent of surface presented by the fine crystalline powder strongly adsorbs the soluble sodium edestin and also, to the indiffusibility of the substance, since any sodium edestin formed within the solid particles is removed with difficulty. With increasing quantities of alkali the proportion of undissolved edestin diminishes and the proportion dissolved per cc. correspondingly increases until it reaches a quantity but little less than that calculated for a complete reaction between one molecule of edestin and one of sodium hydrate.

Another series of gram portions of preparation **30**, one gram of which had an acidity requiring 2 cc. of centinormal sodium hydrate solution for neutralization to phenolphthalein, was treated in the same way as the preceding and the following amounts were found to be dissolved:

TABLE XXI.—AMOUNT OF EDESTIN **30**, DISSOLVED BY CENTINORMAL SODIUM HYDRATE SOLUTION.

1 co.	2 cc.	3 cc.	4 cc.	5 cc	6 cc.	7 cc.	8 cc.	9 cc.	$\frac{NaOH}{100}$
0.0490	0.0940	0.1636	0.3208	0.4800	0.6060	0.7120	0.8188	0.8782	Gram dissolved.

In this case the effect of the carbonic acid contained in this preparation is plainly manifested, since 9 cc. of the alkali were required to dissolve the same amount that 7 cc. dissolved of the perfectly neutral preparation, **31**. The small quantity appearing to be dissolved by 1 and 2 cc. consisted mostly of suspended matter unavoidably drawn off with the solution. The agreement between these results and those obtained in the first experiment is best shown by the solubility curves given on page 435.

II. SOLUBILITY OF EDESTIN IN POTASSIUM HYDRATE SOLUTION.

Preparation **28**, one gram of which required 2 cc. of centinormal alkali for neutralization to phenolphthalein, was treated with a centinormal solution of potassium hydrate in the way described for experiments with sodium hydrate. Table XXII shows the weight in grams dissolved by the several quantities of alkali.

TABLE XXII.—AMOUNT OF EDESTIN **28**, DISSOLVED BY CENTINORMAL POTASSIUM HYDRATE SOLUTION.

1 cc.	2 cc.	3 cc.	4 cc.	5 cc.	6 cc.	7 cc.	8 cc.	$\frac{KOH}{100}$
0.0000	0.0150	0.0938	0.1944	0.3294	0.4772	0.7592	0.8500	Gram dissolved.

The amount dissolved per cc. above 2 cc. was as follows:

TABLE XXIII.—AMOUNT DISSOLVED PER CC. OF CENTINORMAL POTASSIUM HYDRATE.

3 cc.	4 cc.	5 cc.	6 cc.	7 cc.	8 cc.	$\frac{KOH}{100}$
0.0938	0.0972	0.1098	0.1193	0.1518	0.1417	Gram dissolved.

In this, as in the experiments with sodium hydrate, the proportion of dissolved edestin increased as the proportion of undissolved edestin diminished, the amount dissolved by 8 cc. being nearly equal to that calculated for a complete reaction between equal numbers of molecules of each substance. The somewhat higher figure found for 7 cc. is doubtless due to a slight error of manipulation, as indicated by the rise in the curve given on page 435, showing the results of this experiment.

Another similar series of gram portions of edestin, **30**, treated with centinormal potassium hydrate in the same way as **28** had been treated, gave the following results:

TABLE XXIV.—AMOUNT OF EDESTIN **30**, DISSOLVED BY CENTINORMAL POTASSIUM HYDRATE SOLUTION.

1 cc.	2 cc.	3 cc.	4 cc.	5 cc.	6 cc	7 cc.	8 cc.
0.0586	0.0574	0.1146	0.2496	0.3984	0.5220	0.6292	0.7726

9 cc.	10 cc.	$\frac{KOH}{100}$
0.8120	0.8558	Gram dissolved.

These results are nearly the same as those obtained with preparation **28**, the amount dissolved by less than 7 cc. being slightly more than in the first series, while that dissolved by more than 7 cc. is slightly less.

Assuming that true solution begins only with 3 cc., we have the following quantities, in grams, dissolved per cc. with each quantity of alkali added:

TABLE XXV.—EDESTIN, **30**, DISSOLVED PER CC. OF CENTINORMAL POTASSIUM HYDRATE SOLUTION.

3 cc.	4 cc.	5 cc.	6 cc.	7 cc.	8 cc.	9 cc.	10 cc.	$\frac{KOH}{100}$
.1146	.1248	.1328	.1305	.1258	.1288	.1160	.1060	Gram dissolved.

As this table shows, with from 5 to 8 cc., the amount dissolved per cc. is about 15 milligrams less than that calculated for a complete reaction between equal numbers of molecules of the protein and alkali. The rate at which this preparation dissolved is more uniform than that at which **28** dissolved, the effect of adsorption being much less in these experiments with **30** than in those with **28**. Probably this is due to the fact that the crystals of **30** were much larger than those of **28**, and therefore a much smaller surface was exposed by the former on which the soluble edestin could be adsorbed than by the latter preparation.

A similar experiment with another preparation, **25**, was also made, with the following results:

TABLE XXVI.—AMOUNT OF EDESTIN, **25**, DISSOLVED BY A CENTINORMAL SOLUTION OF POTASSIUM HYDRATE.

2 cc.	3 cc.	4 cc.	6 cc.	8 cc.	9 cc.	10 cc.	12 cc.	13 cc.	$\frac{KOH}{100}$
.0058	.0048	.1380	.1588	.2694	.3594	.5044	.7790	.8678	Gram dissolved.

This preparation, which, when first precipitated, was perfectly neutral to phenolphthalein, became so acid, after washing and drying without precautions to exclude carbonic acid, the necessity of which was not recognized at the time the preparation was made, that 4 cc. of centinormal alkali were required to neutralize one gram of it.

From the solutions, to which 2 and 3 cc. of alkali had been added, the insoluble edestin settled out, leaving the solution very nearly clear and showing no opalescence whatever. Unlike **28**, this preparation at first dissolved slowly, only .0200 gram more

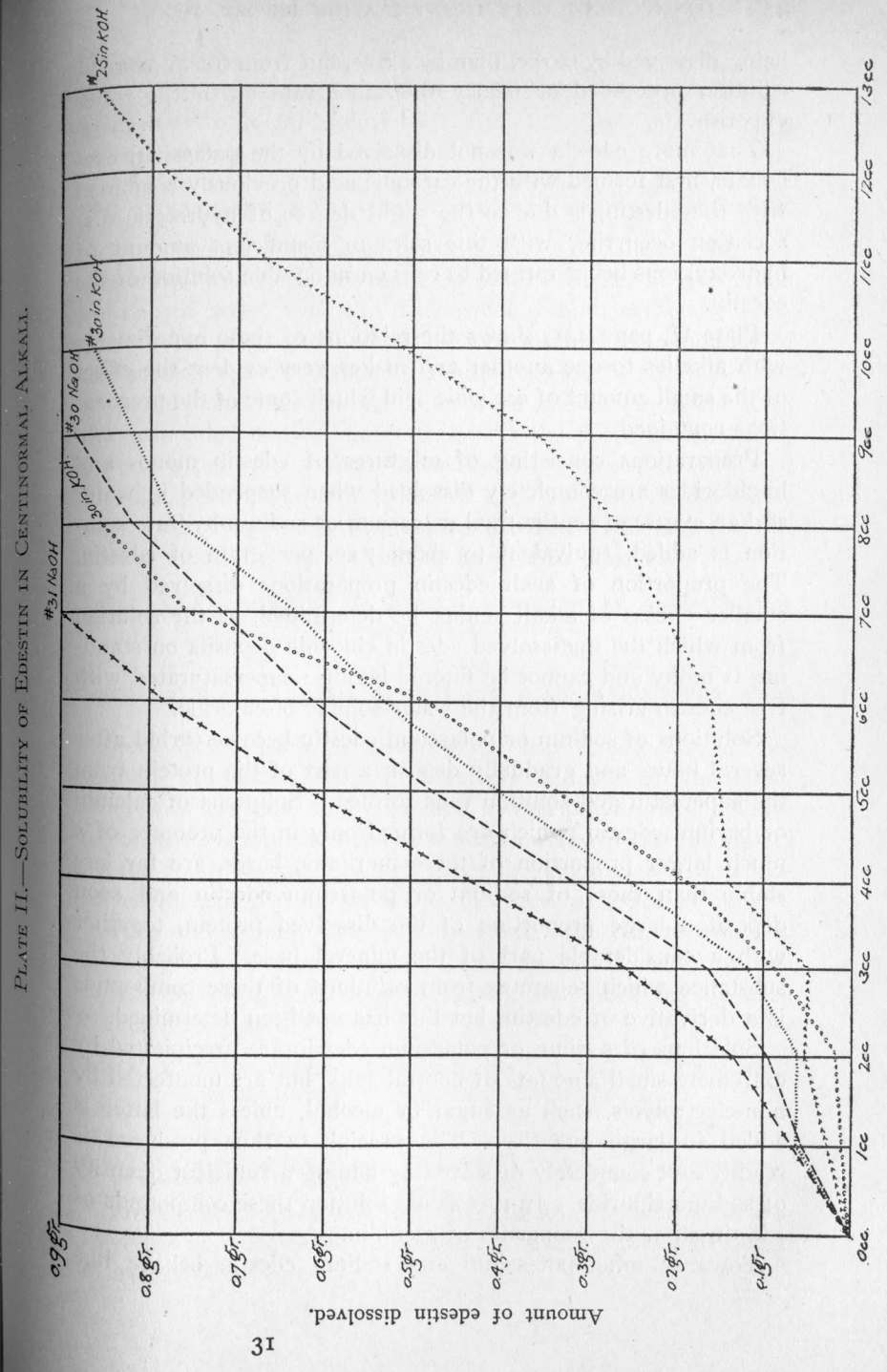


PLATE II.—SOLUBILITY OF EDESTIN IN CENTINORMAL ALKALI.

being dissolved by 6.0 cc. than by 4.0 cc, but from 6 cc. upwards, solution proceeded at nearly the same rate as in the other experiments.

That more edestin was not dissolved by the potassium carbonate, first formed with the carbonic acid previously combined with the edestin, is due to the slight degree of hydrolytic dissociation occurring with this salt, an insufficient amount of hydroxyl ions being formed to cause a noticeable solution of the edestin.

Plate II, page 435, shows the relations of these experiments with alkalies to one another and makes very evident the effect of the small amount of carbonic acid which some of the preparations contained.

Preparations consisting of mixtures of edestin mono- and bi-chlorides are completely dissolved when suspended in water and an excess of centinormal potassium or sodium hydrate solution is added, equivalent to about 7 cc. per gram of edestin. The proportion of such edestin preparations dissolved by a smaller excess of alkali cannot be determined, as the solution from which the undissolved edestin chloride deposits on standing is milky and cannot be filtered because supersaturated with free edestin arising from the water-soluble bi-chloride.

Solutions of sodium or potassium edestin become turbid after several hours and gradually deposit a part of the protein from the supersaturated solution thus formed. Solutions of calcium or barium edestin, which are formed only in the presence of a much larger proportion of these inorganic bases, are far less stable than those of sodium or potassium edestin and soon deposit a large proportion of the dissolved protein, together with a considerable part of the mineral base. Probably the substance which separates from solutions of these compounds is a derivative of edestin, but this has not been determined.

Solutions of sodium or potassium edestin are precipitated by extremely small amounts of neutral salts, but are unaffected by non-electrolytes, such as sugar or alcohol, unless the latter is added in large quantity. The precipitate thus produced is readily and completely dissolved by adding a sufficient quantity of sodium chloride. In this saline solution these compounds of edestin show the properties of globulin.

Towards salts, potassium and sodium edestin behave like

edestin bi-chloride. In the absence of salts, the aqueous solutions of all these compounds are clear and in no way resemble opalescent colloidal solutions. The solutions produced by strong sodium chloride brine are likewise clear.

III. Solubility of Edestin in Sodium Carbonate Solution.

Each one of a series of gram portions of edestin, **30**, was suspended, in a stoppered bottle, in water enough to make a final volume of 20 cc. with the decinormal sodium carbonate solution to be afterwards added. After adding the amounts of decinormal sodium carbonate solution stated in the table and frequently shaking, the solutions were allowed to stand until the suspended matter had settled. As the portions containing 0.2 cc., 0.4 cc. and 0.6 cc. settled slowly, these were filtered through pure paper, and 10 cc. of each solution of the entire series was evaporated, the residue dried at 110°, and the following quantities were found to have been dissolved:

Table XXVII.—Amount of Edestin Dissolved by a Decinormal Sodium Carbonate Solution.

0.2 cc.	0.4 cc.	0.6 cc.	1.0 cc.	1.4 cc.	1.8 cc.	2.2 cc.	2.4 cc.	2.5 cc.	$\frac{Na_2CO_3}{10}$
0.0090	0.0376	0.0580	0.2202	0.4722	0.6036	0.7510	0.8160	0.8618	gram.

Very little edestin is dissolved by less than 0.6 cc. of the sodium carbonate solution, doubtless because of the small amount of carbonic acid contained in this preparation. Above 0.6 cc. the edestin dissolved at a nearly uniform rate, as shown by the following table, which gives the amount in grams dissolved in each portion per 0.1 cc. in excess of 0.6 cc.

Thus the amount dissolved by 1.0 cc. was 0.2202 gram or 0.1622 gram more than was dissolved by 0.6 cc., therefore one-fourth of this quantity, 0.0405 gram, was dissolved by each 0.1 cc. in excess of 0.6 cc.

Table XXVIII.—Edestin Dissolved per 0.1 cc. of Decinormal Sodium Carbonate Solution in Excess of 0.6 cc.

1 cc.	1.4 cc.	1.8 cc.	2.2 cc.	2.4 c.c	2.5 cc.	$\frac{Na_2CO_3}{10}$
0.0405	0.0518	0.0455	0.0433	0.0421	0.0423	Gram dissolved.

From these figures it is seen that the amount of edestin dissolved is proportional to the amount of sodium carbonate added in excess of 0.6 cc.

A larger proportion of sodium carbonate is required to neutralize a preparation of edestin chloride than of potassium hydrate. Five grams of preparation **3** were suspended in water, 5 cc. of decinormal sodium carbonate solution added, the mixture shaken for some time, the edestin filtered out, and to the filtrate and washings 5 cc. of decinormal hydrochloric acid added. The solution was then boiled, cooled, and neutralized to phenolphthalein by 3.8 cc. of potassium hydroxide solution, from which it is evident that only 3.8 cc. of the sodium carbonate solution had been neutralized by the combined acid of the edestin chloride, which contained sufficient acid to neutralize 5 cc. of *caustic alkali.*

Whether the edestin is dissolved by sodium carbonate solely in consequence of the hydrolytic dissociation of this salt, or whether this salt acts also as a solvent, after the manner of neutral salts such as sodium chloride, requires further investigation into the relations of globulins to neutral salts, which is now in progress in this laboratory.

IV. CONCLUSIONS.

1. The proteins are basic bodies and enter into ionic reactions with acids with which they form true salts.

2. Preparations of native proteins, as usually obtained from solutions slightly acid or neutral to litmus, are salts of the basic protein substance.

3. The acid of these salts can be separated from those proteins that are insoluble in water, by making them neutral to phenolphthalein with potassium or sodium hydrate. The acid combined with the protein can then be identified in the aqueous solution, by filtering out the insoluble protein, evaporating the solution and analyzing the alkaline salts thus obtained.

4. Preparations of edestin, made by the methods commonly employed, contain chiefly chlorides, when crystallized from sodium chloride solutions,—chiefly sulphates, when crystallized from a solution containing ammonium sulphate. The salts of edestin which crystallize out are those of the negative ions present in the solution, the predominating salt being that of the negative ion most abundant at the time of crystallization.

5. Edestin preparations, as usually made from sodium chloride solutions, generally dissolve to a considerable extent when

washed with pure water. The part that dissolves is twice as acid toward phenolphthalein as the part that remains undissolved.

6. The degree of acidity of the part insoluble in water is equal to that of a compound of one molecule of edestin with one of hydrochloric acid, assuming that the former has a molecular weight of about 14,500, which is twice as great as the simplest one that can be calculated from its analysis, if there are two atoms of sulphur in its molecule.

Edestin, therefore, forms salts corresponding to a mono- and bi-chloride.

7. The crystals of edestin, as well as those of its different salts, are, so far as has been determined, isomorphous, the mass influence of the protein molecule being so great as to prevent the small amount of combined acid from effecting a change in crystalline form. In this respect, edestin behaves like haemoglobin, the compounds of which with oxygen and with carbonic acid are also isomorphous.

8. The free base edestin, when suspended in pure water, is dissolved by nearly the calculated quantity of hydrochloric acid required for a complete reaction between one molecule of edestin and two of hydrochloric acid. On adding the acid in successive small quantities, no solution takes place, until one-half the required amount has been added. On adding the second half of the acid, solution takes place at a rate proportional to the amount of acid added. The acidity of the solution obtained with the second half of the acid increases at twice the rate at which the acid is added, in accordance with the conversion of an insoluble mono-chloride produced by the first half of the acid into a soluble bi-chloride formed by the second half.

9. Somewhat more than the calculated quantity of hydrochloric acid is required to dissolve a given quantity of edestin, because a more basic hydrolytic derivative of edestin, sparingly soluble in water, is formed by the hydrogen ions set free by hydrolytic dissociation of the chloride.

10. Since solutions of edestin bi-chloride do not appear to be precipitated by hydrolytic dissociation, it is probable that edestin hydroxide may be formed and remain in solution under the conditions of the experiments tried.

11. Edestin sulphates are less soluble than the corresponding

chlorides and, consequently, preparations obtained from solutions containing ammonium sulphate are not soluble in water. Ten times more sulphuric acid is required to dissolve a given quantity of edestin than of hydrochloric acid. Definite compounds with sulphuric acid have not yet been obtained.

12. Hydrochloric acid dissolves more nearly the calculated quantity of edestin than does acetic acid, since the latter, being less ionized than the former, produces, in a given time, only one-third as much of the more basic hydrolytic derivative as does the former.

13. Phosphoric acid reacts with edestin as a monobasic acid, in accordance with its dissociation into the ions H and H_2PO_4. But little more than the calculated quantity of this acid is required to dissolve a given amount of edestin.

14. Edestin forms a salt with nitric acid, which corresponds to the bi-chloride. At 30° edestin bi-nitrate is much more soluble in pure water than at 20°, so that a clear solution containing 5 per cent. of this salt yields a considerable precipitate on cooling.

15. Edestin reacts with potassium or sodium hydrate in a proportion equivalent to that with which it forms the mono-chloride with hydrochloric acid.

A given quantity of edestin is dissolved by an amount of centinormal potassium or sodium hydrate solution, which corresponds closely to a proportion of one molecule of the base to one of protein.

Solutions of potassium and sodium edestin, probably in consequence of hydrolysis, become turbid after standing some time and gradually deposit some of the dissolved protein.

16. About thirteen times as much ammonium hydrate is required to dissolve a given quantity of edestin as of sodium or potassium hydrate.

17. About three times as much sodium in the form of carbonate is required to dissolve a given quantity of edestin as of sodium in the form of hydrate.

18. Edestin conforms strictly with the definition of a globulin, being insoluble in pure water, but readily soluble in neutral solutions of sodium chloride of sufficient strength.

19. Edestin mono-chloride is, likewise, insoluble in water, but readily soluble in saline solutions. Edestin bi-chloride and potassium or sodium edestin are soluble in pure water, but insoluble in the presence of a small proportion of a neutral salt. In the presence of a larger proportion of the neutral salt they are soluble, and in such solutions they show the properties of globulin.

20. The fact that edestin, as well as its salts with strong acids, is soluble in perfectly neutral solutions of sodium chloride shows that the solubility of a globulin does not depend on the presence of alkali, as Starke has recently asserted.

A TYPE OF REACTION BY WHICH SODIUM CARBONATE AND HYDROCHLORIC ACID MAY BE FORMED IN THE ANIMAL ORGANISM.

By Thomas B. Osborne.

In the preceding paper I have called attention to the basic properties of protein substances and have shown that preparations of the crystalline globulin edestin, as usually obtained from the hemp-seed, are mixtures of salts, chiefly chlorides and sulphates. The nature of this combined acid depends upon the salts present in the solution at the time of precipitation, the acid of the seed sufficing to enable some of each of the acids of these salts to combine with the protein.

These facts led me to examine the precipitate produced by carbonic acid, in a dilute sodium chloride solution of edestin, as it seemed possible that this might consist chiefly of chloride.

A quantity of a relatively pure preparation of edestin, which had been several times recrystallized from a warm dilute sodium chloride solution by cooling, was suspended in water and made exactly neutral to phenolphthalein by decinormal potassium hydrate solution. The edestin thus neutralized was washed with water and dissolved in sodium chloride brine. The solution was diluted with water until it became slightly turbid and carbonic acid gas was passed through it until the edestin appeared to be completely precipitated. This was filtered out, washed thoroughly with 1 per cent. sodium chloride solution and then with 50 per cent. alcohol, until no chlorine could be detected in the washings, dehydrated with absolute alcohol and dried over sulphuric acid. The substance thus prepared, while

insoluble in dilute sodium chloride solution, was largely soluble in pure water, as well as in strong sodium chloride brine, yielding solutions acid to litmus and to phenolphthalein; to neutralize one gram to the latter indicator, 1.9 cc. of decinormal potassium hydrate solution being required. Fifteen grams of this preparation were treated with freshly boiled water and 28.5 cc. of decinormal potassium hydrate solution, diluted with much water, were added. The edestin, which separated completely from the solution, was then filtered out, washed with water and filtrate and washings evaporated on a water-bath. The residue was dried at 110° and analyzed with the following results:

	Gram.
Organic matter	0.0222
Inorganic matter	0.2123
Total residue	0.2345

The inorganic residue contained:

	Gram.
Potassium chloride	0.1994
Potassium sulphate	0.0153

The potassium added was equivalent to 0.2127 gram of potassium chloride, so that over 93 per cent. of the potassium added was recovered as chloride. From this analysis we find that with the 15 grams of edestin, equal to 13.5 grams dried at 110°, 0.0976 gram of hydrochloric acid or 0.072 per cent. of the protein had been precipitated. Corresponding to this quantity of hydrochloric acid, 0.1417 gram of sodium carbonate must have been produced in the salt solution by the carbonic acid. It seems probable that by a similar reaction both sodium carbonate and hydrochloride acid may be formed from sodium chloride in the organism, since there is always sodium chloride and protein matter present where carbonic acid is produced in the tissues.*

* Cf. Schulz: Pflüger's Archiv. **27**, 454.

SULPHUR IN PROTEIN BODIES.

By Thomas B. Osborne.

I. Historical.

Krüger (Krüger, Pflüger's Archiv. **43**, 244) has pointed out that the "sulphur content of legumin, casein, fibrin and ovalbumin are to each other as 4: 8: 12: 16, from which one can conclude that the number of sulphur atoms in them are as $1_n : 2_n : 3_n$" . . . "Leaving out of consideration the unknown molecular weight and, instead, taking into account the number of sulphur atoms, an equally great molecular weight may be assumed for all proteins. A comparison of this equally great atomic complex is possible, in respect to sulphur, because the proportion of the other elements in these bodies varies so little that it has no influence on the sulphur content."

Sometime ago, before I was aware of Krüger's suggestion, I reached the same conclusion by a different line of reasoning. I pointed out (Jour. Amer. Chem. Soc. **21**, 486) that the molecular weight of those proteins which contain but 0.4 per cent. of sulphur must be at least 15,000 if there are two atoms of sulphur in their molecules and that similar molecular weights are obtained for a large number of the more carefully analyzed proteins, if their simplest empirical formulas, calculated on the basis of a single atom of sulphur, are multiplied by such a whole number as to give molecular weights nearest to 15,000.

The results thus obtained all fall so near to one another as to strongly suggest that all these bodies have similar molecular weights not far from $(15{,}000)_n$.

The fact that the proteins all react with very small quantities of acids and alkalies and closely resemble one another in many of their physical characters, also indicates that they have similar high molecular weights. Further, the oxyhaemoglobins from horse and dog blood must contain at least one molecule of protein, and as these have been shown by Zinoffsky (Zeit. f. physiol. Chem. **10**, 16) and Jaquet (Ibid. **12**, 284 and **14**, 289) to contain respectively two and three atoms of sulphur to one of iron (see page 465), the protein contained in them cannot have a molecu-

lar weight very far from 15,000, or a multiple of this. Furthermore, Sabanieff (Chem. Centralblatt **10**, 1891), in studying the lowering of the freezing point caused by colloid substances, found that those colloids, of which the molecular weight was known, depressed the freezing point to nearly the calculated extent and that the depression of the freezing point caused by purified ovalbumin indicated a molecular weight of about 15,000, a result which shows that the molecular weight of this substance is, at least, much higher than that corresponding to three atoms of sulphur.

In view of these considerations it seemed important to determine, as accurately as possible, the total sulphur in a considerable number of different proteins, in order to learn whether this formed a perfectly definite constituent of these substances and to also determine whether the fraction of this sulphur converted into sulphide by heating with strong alkaline solutions, corresponded to a definite number of the atoms in the formulas calculated according to the method above described.

Fleitmann (Fleitmann, Liebig's Ann. **61**, 121 and **66**, 380, 1847) long ago showed that a part only of the sulphur of proteins was removed by heating with caustic alkali. Danielewski (Danielewski, Zeit. f. Chem. **12**, 41, 1869) confirmed Fleitmann's observations and later (Danielewski, Zeit. f. physiol. Chem. **7**, 443, 1883) called attention to their importance and to the fact that they had apparently been disregarded by all those writers who had attempted to give formulas for the protein bodies, since these formulas were all constructed on the basis of a single sulphur atom.

Krüger (Krüger, Pflüger's Archiv. **43**, 244, 1888) determined the proportion of sulphur thus detached from ovalbumin and from fibrin and discussed at length the possible ways in which this sulphur could be united within the atomic complex which was split off and also the way in which the remaining sulphur could be united within the protein molecule. He also gave a table showing the structural formulas of various well-known sulphur compounds and, so far as possible, the behavior of these toward alkaline lead solutions.

Suter (Suter, Zeit. f. physiol. Chem. **20**, 564, 1895) studied the behavior of several proteins when treated with hot alkaline lead solutions, and noted, as did Krüger before him, the similarity of their behavior to that of cystin under the same conditions.

Schulz (Schulz, Zeit. f. physiol. Chem. **25**, 16, 1898) reviewed the work of the preceding investigators and attributed the lack of agreement between their quantitative results to a partial oxidation of the sulphide during the long heating required for its complete separation. This he attempted to obviate by adding metallic zinc to the soda solution. After satisfactorily testing this method with sodium thiosulphate, sulpho-urea, and thioacetic acid, he applied it to several proteins.

Since the work to be described in this paper was completed, K. A. H. Moerner (Moerner, Zeit. f. physiol. Chem. **28**, 595, 1899; also Proceed. 13th Inter. Con. Med. Sec. d. physiol., etc., p. 15, Paris, 1900) has isolated cystin from the decomposition products of horn, hair, egg membrane and serum albumin and further found that in the solutions freed from cystin another sulphur-containing body was present which yielded lead sulphide on treatment with hot alkaline lead solutions. This latter body, however, he did not identify. Embden (Embden, Zeit. f. physiol. Chem. **32**, 94, 1901) has independently confirmed Moerner's observations, but considers cystein to be the primary decomposition product of serum and egg albumin and of edestin, and that cystin is a secondary product derived from cystein.

Since Schulz's method appears to yield satisfactory results, I have used it to determine the amount of loosely-bound sulphur in a number of the protein substances which have been prepared and studied during the past few years in this laboratory and have compared the results with those obtained by heating the proteins under pressure with strong alkaline solutions at various temperatures. I have also carefully determined the total sulphur which these proteins contain, and give the amount found in each, in the following pages.

II. Analytical Methods.

a. *Determination of total sulphur.*

About ten grams of sodium peroxide were converted into hydrate* in a nickel crucible by adding a little water and boiling

* I have found commercial sodium peroxide to be freer from sulphur than most preparations of so-called chemically pure sodium hydrate made from the metal, and as the former is very much cheaper than the latter it is advantageous to use it as here described.

over an alcohol lamp until the excess of water was expelled. From one to two grams of the protein was then stirred into the slightly cooled hydrate and oxidized by gradually raising the heat and adding small portions of sodium peroxide until the oxidation was complete. The fused mass was then dissolved in 400 cc. of water, its solution strongly acidified with hydrochloric acid, boiled until the excess of peroxide was destroyed and chlorine expelled, filtered through pure paper, made neutral with ammonia and an excess of 4 cc. of concentrated hydrochloric acid added. From the boiling solution sulphuric acid was precipitated by gradually adding a solution containing one gram of barium chloride. After standing over night, on a steam table, the barium sulphate was filtered out, washed, ignited and weighed.

b. *Determination of loosely-bound sulphur—Schulz's method.*

Schulz's method consists in boiling with a reflex condenser for several hours, one gram of the protein with 50 cc. of 30 per cent. sodium hydrate solution, containing one gram of metallic zinc and a little lead acetate. After slightly acidifying the solution with acetic acid, the lead sulphide formed is filtered out, washed with water, dried and fused, together with the filter paper, with sodium hydrate and potassium nitrate. In following Schulz's method I fused the lead sulphide with sodium hydrate and peroxide. The fusion is dissolved in water, its solution treated with carbonic acid, to remove lead, filtered, evaporated with an excess of hydrochloric acid and sulphur determined as barium sulphate in the usual way.

Pressure method.

From one to five grams of the protein were thoroughly mixed in a nickel crucible with 50 cc. of 50 per cent. sodium hydrate solution containing some lead acetate, and the mixture heated in an autoclave for from two to seven hours, at temperatures of from 135° to 165° C., oxidation being prevented by absorbing the oxygen in the air within the autoclave with sodium pyrogallate. The lead sulphide, formed by thus heating, was filtered out, washed with water, dried, fused with sodium hydrate and peroxide and, since the presence of silica was avoided by using

nickel vessels, the sulphur was precipitated as barium sulphate directly from the acidified solution of the fusion under the conditions used for determining total sulphur.

III. Determination of total and loosely-bound sulphur in various proteins.

Edestin.

This protein occurs in the seeds of hemp, flax, and squash, and also in the castor bean. As edestin separates readily in octahedral crystals when its saline solutions are dialyzed or cooled, relatively pure preparations of it can be easily made.

In order to learn with what degree of accuracy the total sulphur can be estimated and to establish the constancy of its sulphur content I have made the following determinations in twenty-four different crystallized preparations from the hemp seed, representing numerous fractional precipitations and different methods of preparation.

Table I.—Percentage of Total Sulphur in Preparations of Edestin from Hemp-Seed.

I.	II.	III.	IV.	V.	VI.	VII.
0.931	0.934	0.980	0.895	0.983	0.960	0.944
0.942	0.924	0.938	----	0.963	----	0.941
0.910	0.937	----	----	----	----	----
VIII.	IX.	X.	XI.	XII.	XIII.	XIV.
0.990	0.990	0.997	0.943	0.874	0.864	0.900
0.972	----	0.987	----	0.900	0.866	----
0.963	----	----	----	----	----	----
XV.	XVI.	XVII.	XVIII.	XIX.	XX.	XXI.
0.902	0.893	0.934	0.941	0.964	0.939	0.932

The average of these figures is 0.936 per cent.; the lowest being 0.066 per cent. below, the highest 0.06 per cent. above the average. The differences shown by these several preparations are not analytical, as the extreme figures are confirmed by closely agreeing duplicates.

It is evident from these results that it is possible to determine total sulphur with considerable accuracy, and it is also evident that these several preparations do not contain exactly the same amount of sulphur. I have previously shown (see preceding

paper) that, owing to the natural acidity of the seed, crystallized edestin, as usually prepared, consists of a mixture of compounds of a basic protein molecule with acids, the nature of the acids depending upon the character and proportion of the salts present at the time the edestin was precipitated. Thus, when preparation XXIII, crystallized from ammonium sulphate solution, was suspended in water and neutralized to phenolphthalein by potassium hydrate solution, the edestin remained undissolved and was separated by filtration from the water, in which was found a quantity of potassium sulphate corresponding to the amount of acid neutralized. This and another preparation similarly made contained the following amount of total sulphur:

	XXII.	XXIII.
Sulphur	1.125 per cent.	1.084 per cent.
	1.110	
	1.103	

The acidity of these preparations to phenolphthalein was equal to an amount of sulphuric acid corresponding to the excess of sulphur in them above that of the average of I-XXI, all of which latter were made from sodium chloride solutions. These latter preparations, neutralized in the above-described manner, yielded chiefly potassium chloride, but together with this chloride a small proportion of sulphate was always found. The differences in sulphur content of preparations I-XXI are thus explained. This excess of sulphur is therefore not to be regarded as belonging to the protein molecule. The amount of such sulphur is not great, since the total acidity of the preparations in no case exceeded 1.2 cc. of a decinormal solution per gram, which corresponds to sulphuric acid containing sulphur equivalent to 0.19 per cent. of the protein.

Such an excess of sulphur is shown by preparations XXII and XXIII in which, as already stated, I found by actual analysis that the acidity was due to sulphuric acid.

In order to find the true amount of sulphur belonging to the edestin molecule I determined the total sulphur in a very pure and perfectly neutral preparation, made by several times recrystallizing edestin chloride, neutralizing its solution to phenolphthalein and again crystallizing. Two determinations of sulphur in this preparation gave 0.880 and 0.887.

The average of these figures, **0.884**, unquestionably closely represents the total sulphur contained in the edestin *molecule*.

With this result several of the preceding agree closely, namely IV, XII, XIII, XIV, XV and XVI, all of which were either preparations consisting mostly of bichloride, soluble in pure water, which neutralization experiments have shown to yield extremely small amounts of potassium sulphate, or were preparations obtained from solutions made neutral to phenolphthalein.*

In order to learn with how much accuracy the loosely-bound sulphur of edestin can be determined, the following large number of trials were made:

TABLE II.—PERCENTAGE OF LOOSELY-BOUND SULPHUR IN EDESTIN.

One gram boiled with 30 per cent. NaOH, Zn and Pb $(C_2H_3O_2)_2$. 7½ hours.						One gram heated in autoclave with 30 per cent. NaOH and Pb $(C_2H_3O_2)_2$. At 135°. 2 hours.		3 hours.			5 grams at 165°. 7½ hours.	
VIII.	XI.	XVI.	XVII.	XXIII.	XX.	VIII.	XXIII.	VIII.	XVI.	XXIII.	XXIV.	XXV.
0.282	0.376	0.355	0.309	0.297	0.348	0.366	0.307	0.276	0.275	0.314	0.339	0.363
0.263	0.286	0.321	0.303	----	0.302	0.297	----	----	0.265	0.300	0.344	0.347
----	0.277	0.277	----	----	----	----	----	----	----	0.297	----	0.340
----	----	----	----	----	----	----	----	----	----	0.240	----	0.337

Of the determinations made with one gram of edestin, four are as high as those obtained with five grams at the higher temperature; the average of them all, however, is slightly but distinctly lower. As the results obtained with five grams of edestin at the higher temperature are probably the most accurate, their average, **0.346** per cent., may be considered to most closely represent the proportion of loosely-bound sulphur which can be obtained from edestin as lead sulphide.

Excelsin.

Excelsin is obtained from the Brazil-nut (*Bertholletia excelsa*) by extraction with sodium chloride brine and is deposited in crystalline hexagonal plates by dialyzing its saline solutions. Five different preparations of excelsin contained the following amounts of sulphur:

* Cf. the preceding papers.

TABLE III.—PERCENTAGE OF TOTAL SULPHUR IN EXCELSIN.

1[1]	2[1]	3[1]	4[2]	5[2]
1.06	1.12	1.07	1.083	1.109

The average of these figures, **1.088**, closely represents the total sulphur of excelsin.

In making preparation **4**, the oil-free meal was extracted with sodium chloride brine, the extract saturated with ammonium sulphate, the precipitate produced dissolved in water, its solution made neutral to litmus with sodium carbonate and the excelsin precipitated in crystals by dialysis in water.

Preparation **5** was made by dialyzing a perfectly clear sodium chloride extract of the oil-free meal in running water, whereby the excelsin was deposited in uniformly large hexagonal plates.

As no more sulphur was found in preparation **4** than in **5**, it is evident that excelsin does not take up sulphuric acid from its saline solutions as readily as edestin does.

Excelsin is soluble in water when made neutral to phenolphthalein and therefore it has not been possible to identify the acids which are combined with it by the method applied to edestin.

The amount of loosely-bound sulphur was determined in preparations **4** and **5** under the conditions given below.

TABLE IV.—PERCENTAGE OF LOOSELY-BOUND SULPHUR IN EXCELSIN.

One gram boiled with 30 per cent. NaOH, Zn and Pb $(C_2H_3O_2)_2$. 7½ hours.		Heated in autoclave with 30 p. c. NaOH. One gram at 135°. 2 hours.	Five grams at 165°. 4½ hours.
4	5	4	5	5
0.339	0.347	0.294	0.293	0.350
0.321	0.344			
0.289	0.297			
0.277	0.290			
0.257	0.284			
	0.281			

The result obtained at 165° agrees closely with the higher figures found by Schulz's method, and as experimental errors were diminished in this determination by employing a larger amount of substance, **0.350** per cent. may be taken as the proportion of loosely-bound sulphur that can be obtained from excelsin.

[1] Osborne, Amer. Chem. Jour., 14, 662.
[2] Preparations made recently.

Legumin.

Legumin, found in considerable quantity in the seeds of the pea, horse bean, vetch and lentil, is a protein substance having the properties of a globulin. It is not a nucleo-proteid, as stated by Hammarsten, since the many pure preparations, which I have made, were entirely free from phosphorus (Osborne, Report of the Conn. Agri. Expt. Station for 1895, p. 262, and 1897, p. 324; also Jour. Amer. Chem. Soc. **18**, 583 and **20**, 348, 362, 393, 406 and 410). The loosely-bound sulphur was determined in carefully purified preparations, made according to the methods described in my papers last cited. Several closely agreeing new determinations of the total sulphur in these preparations showed them to contain the following proportion:

TABLE V.—PERCENTAGE OF TOTAL SULPHUR IN LEGUMIN.

Pea.	Lentil.	Horse-bean.	Vetch.
0.371	0.390	0.390	0.389

The percentage of loosely-bound sulphur obtained from these preparations by different methods was as follows:

TABLE VI.—PERCENTAGE OF LOOSELY-BOUND SULPHUR IN LEGUMIN.

	One gram boiled with 30 p. c. NaOH, Zn and $Pb(C_2H_3O_2)_2$. 7 1-2 hours.	One gram with 30 p. c. NaOH and $Pb(C_2H_3O_2)_2$ at 135°. 2 hours.	Five grams with 30 p. c. NaOH, Zn and $Pb(C_2H_3O_2)_2$ at 165°. 5 hours.
Pea	0.143		
	0.143		
Horse-bean	0.193	0.164	0.186
Lentil	0.193		
Vetch	0.159		0.150
	0.160		

The average of the figures for total sulphur is **0.385** per cent. and for the loosely-bound sulphur **0.166** per cent.

Vignin.

Under this name I described the chief protein of the cow pea (Report of Conn. Agri. Expt. Station for 1896, p. 380; also Jour. Amer. Chem. Soc. **19**, 494) and gave its sulphur content as 0.50 per cent.

Through an oversight, the correction for a small amount of sulphur contained in the reagents used at that time was omitted

and consequently this figure for sulphur is a little too high. I have since repeated these determinations on all but one of the preparations described, and have obtained the following results:

TABLE VII.—PERCENTAGE OF TOTAL SULPHUR IN VIGNIN.

	1	2	3	4	6	8	9
S.....	0.382	0.443 0.439	0.356	0.365	0.360	0.416	0.417

The average of these figures is 0.391.

Preparation **2** constituted the greater part of all the protein extracted from the seed, whereas **3**, **4**, and **6**, successively precipitated from the filtrate from **2**, formed a relatively small part of the total protein matter. As **8** and **9**, fractions of **2**, contain nearly the same quantity of sulphur as **2**, the average of the figures given for these three preparations, **0.426**, may be taken as closely representing the total sulphur or vignin.

TABLE VIII.—PERCENTAGE OF LOOSELY-BOUND SULPHUR IN VIGNIN.

One gram boiled with 30 p. c. NaOH, Zn and $Pb(C_2H_3O_2)_2$. 7 1-2 hours.	One gram with 30 p. c. NaOH and $Pb(C_2H_3O_2)_2$ at 135°. 3 hours.
0.210	0.220
0.213	

The average of these figures is **0.214** per cent.

Amandin.

Amandin is the most abundant protein in the seeds of the almond and peach.

In a former paper (Osborne and Campbell, Report Conn. Agr. Expt. Station for 1895, Jour. Amer. Chem. Soc. **18**, 487) I gave the total sulphur in five preparations of amandin as follows:

TABLE IX.—PERCENTAGE OF TOTAL SULPHUR IN AMANDIN.

1	2	3	4	5
0.39	0.44	0.48	0.45	0.48

A redetermination of sulphur in **3**, using 1.6688 grams, gave 0.429 per cent. Preparations **2**, **3** and **4** were precipitated with ammonium sulphate; **1** and **5** were made without using this salt.

The recent determination of sulphur, which is probably the most accurate, shows that amandin contains about **0.429** per cent. of sulphur.

TABLE X.—PERCENTAGE OF LOOSELY-BOUND SULPHUR IN AMANDIN.

One gram boiled with 30 p. c. NaOH, Zn and $Pb(C_2H_3O_2)_2$ at 135°. 2 hours.	Five grams with 30 p. c. NaOH and $Pb(C_2H_3O_2)_2$ at 165°. 3 hours,
0.180	0.217
0.172	
0.165	

The result obtained at the higher temperature and with the larger amount of substance is doubtless the most correct of the above figures, so that **0.217** per cent. may be taken as the proportion of sulphur which can be obtained from amandin, as sulphide.

Glycinin.

The greater part of the protein matter of the soy bean is glycinin, a globulin described in a paper previously published (Osborne and Campbell, Report Conn. Agr. Expt. Station for 1897; also Jour. Amer. Chem. Soc. **20**, 419). Careful redeterminations of sulphur in several of the preparations, described in the paper cited, showed that the figures there given were nearly correct; the average of the new determinations gave 0.700 per cent. of sulphur against the published figure, 0.72 per cent. The total sulphur in glycinin is therefore **0.710** per cent.

TABLE XI.—PERCENTAGE OF LOOSELY-BOUND SULPHUR IN GLYCININ.

	One gram boiled with 30 p. c. NaOH, Zn and $Pb(C_2H_3O_2)_2$. 7 1-2 hours.	Five grams with 30 p. c. NaOH and $Pb(C_2H_3O_2)_2$ at 165°. 3 hours.
Preparation 2.	0.321	0.317
	0.305	
	0.274	
	0.263	
Preparation 14.	0.286	

Since the result obtained with five grams of glycinin agrees closely with the higher figures obtained by boiling at the atmospheric pressure, we may safely assume that glycinin yields very nearly **0.320** per cent. of sulphur as sulphide.

Gliadin.

Gliadin, soluble in alcohol of 70-80 per cent., is one of the most abundant proteins of the wheat kernel. In a paper on the protein constituents of this seed (Osborne and Voorhees, Amer. Chem. Jour. **15**, 392), the total sulphur of gliadin was given as 1.14 per cent.

This figure was the average found in a large number of preparations, all of which were not entirely pure. Careful redeterminations of sulphur in several of the purest of these preparations gave the following results:

TABLE XII.—TOTAL SULPHUR IN GLIADIN.

17	23	28	29	33
1.124	1.002	1.022	1.030	1.058
1.124		1.005		1.027

Excluding the figures given for **17**, which for some reason contains more sulphur than the others, the average sulphur content of gliadin appears to be **1.027** per cent.

The preparation of gliadin used in the following experiments consisted of a mixture of several of the purer products obtained in the former investigation and contained 1.044 per cent. of sulphur.

TABLE XIII.—PERCENTAGE OF LOOSELY-BOUND SULPHUR IN GLIADIN.

One gram boiled with 30 p. c. NaOH, Zn and $Pb(C_2H_3O_2)_2$.	One gram, with 30 p. c. NaOH and $Pb(C_2H_3O_2)_2$ at 135°.	Five grams, with 30 p. c. NaOH and $Pb(C_2H_3O_2)_2$ at 165°.
7 1-2 hours.	4 hours.	5 hours.
0.627	0.635	0.624
0.516		0.611
		0.600

The average of these figures, excluding the lowest, is **0.619**, which doubtless nearly represents the percentage of loosely-bound sulphur in gliadin.

Hordein.

Hordein, soluble in strong alcohol, occurs in quantity in the barley grain.

In ten different preparations, representing fractional precipitations of this substance, the average content of sulphur was 0.83 per cent. (Osborne, Report of the Conn. Agri. Expt. Station for 1894, p. 165; also Jour. Amer. Chem. Soc. **17**, 539.) In a preparation recently made for the experiments here described, the total sulphur was **0.847** per cent.

TABLE XIV.—PERCENTAGE OF LOOSELY-BOUND SULPHUR IN HORDEIN.

One gram boiled with 30 p. c. NaOH, Zn and $Pb(C_2H_3O_2)_2$.	One gram with 30 p. c. NaOH and $Pb(C_2H_3O_2)_2$ at 135°.	Five grams, with 30 p. c. NaOH and $Pb(C_2H_3O_2)_2$ at 165°.
7 1-2 hours.	4 hours.	3 hours.
0.348	0.338	0.358

The average of these figures gives **0.348** per cent. of loosely-bound sulphur in hordein.

Zein.

Zein is the most abundant protein found in the maize kernel. It is especially characterized by its ready solubility in alcohol of 90 to 95 per cent., though in absolute alcohol it is wholly insoluble. In a former paper (Chittenden and Osborne, Amer. Chem. Jour. **13**, 327, 385 and **14**, 20) the average amount of total sulphur, in nine different preparations of zein, was given as **0.60** per cent.

TABLE XV.—PERCENTAGE OF LOOSELY-BOUND SULPHUR IN ZEIN.

One gram boiled with 30 p. c. NaOH, Zn and $Pb(C_2H_3O_2)_2$.	One gram with 30 p. c. NaOH and $Pb(C_2H_3O_2)_2$ at 135°.	Five grams with 30 p. c. NaOH and $Pb(C_2H_3O_2)_2$ at 165°.
7 1-2 hours.	2 hours.	4 1-2 hours.
0.243	0.161	0.212
0.248	0.160	

The result obtained with five grams of zein at 165° probably represents most nearly the amount of loosely-bound sulphur yielded by zein, which may therefore be taken as **0.212** per cent.

Phaseolin.

In a former paper on the proteins of the kidney bean (Osborne, Report of the Conn. Agri. Expt. Station for 1893; also Jour. Amer. Chem. Soc. **16**, 633, 703 and 757), I gave the average amount of sulphur found in twenty-four different preparations of phaseolin as 0.56 per cent. Among these preparations was one consisting almost wholly of octahedral crystals in which duplicate determinations give 0.33 and 0.29 per cent.

of sulphur. I have since prepared a large quantity of phaseolin by extracting the bean meal with 10 per cent. ammonium sulphate solution, precipitating the proteins by saturating the extract with the same salt, dissolving the precipitate in water, filtering the resulting solution and then dialyzing it for four days. The precipitate which first formed consisted of relatively large octahedral crystals, with which amorphous matter was afterwards deposited. This precipitate, A1, was filtered out, redissolved in ammonium sulphate solution and the filtered fluid dialyzed for four days, whereupon considerable precipitate, A11, separated, consisting of amorphous matter and octahedral crystals, some of which were large enough to be easily recognized by the naked eye. Several grams of these crystals, A*a.*, were separated by elutriation nearly free from amorphous matter and were found to contain 0.265 per cent. of sulphur. The solution filtered from this last dialysis precipitate yielded, after seven days' further dialysis, 58 grams of partly crystallized phaseolin, A1, which contained 0.328 per cent. of sulphur.

The filtrate from the first dialysis precipitate, A1, above described, after dialyzing for four days more gave a large precipitate which, when redissolved and again precipitated by dialysis, yielded 67 grams of A2, containing 0.356 per cent. of sulphur. By dialyzing the filtrate from the first precipitation of A2 for seven days longer, 22 grams of A3 were obtained, which contained 0.417 per cent. of sulphur.

From these results and those of the earlier investigation, it appears that uncertainty still exists respecting the total sulphur of phaseolin, and until we can prepare this substance in a completely crystallized condition it is impossible to assign a precise value to its sulphur content.

TABLE XVI.—PERCENTAGE OF LOOSELY-BOUND SULPHUR IN PHASEOLIN.

	One gram boiled with 30 p. c. NaOH, Zn and $Pb(C_2H_3O_2)_2$. 7 1-2 hours.	5 grams with 30 p, c. NaOH and $Pb(C_2H_3O_2)_2$ at 165°. 5 1-2 hours.
Preparation A 1.	0.062 0.079	0.063
Preparation A 2.	0.092 0.076	

The average of these figures is **0.072** per cent.

Vicilin.

Vicilin is a globulin, found by the writer in the seeds of the pea, lentil and horse bean and described in papers published some time ago (Osborne and Campbell, Report of the Conn. Agri. Expt. Station for 1897; also Jour. Amer. Chem. Soc. **20**, 348, 362, 393 and 410). This substance, like phaseolin, presents an uncertainty respecting its total sulphur. Twenty-one preparations, whose complete analyses agreed closely in other respects, contained from 0.23 to 0.08 per cent. of sulphur. This difference was not analytical, as the extreme figures were confirmed by duplicate determinations; thus for preparation **62** I found 0.08 and 0.07 per cent., for **84** 0.10 and 0.09, and for **94** 0.103 and 0.099 per cent., while for **55** I got 0.21 and 0.24, and for **58** 0.21 and 0.20 per cent. of sulphur.

This difference among the preparations might be due to a mixture of a sulphur-free protein and legumin, with which vicilin is associated in these seeds, but this seems hardly possible, since the preparations with 0.20 per cent. of sulphur would, in this case, contain 50 per cent., and those with 0.10 per cent. of sulphur 25 per cent. of legumin, which, if present in such different proportions, would probably cause greater differences in composition than were shown by the successive fractional precipitations of vicilin, which apart from sulphur showed no notable differences in composition. Further, the very limited solubility of legumin in the dilute salt solutions, from which vicilin was obtained, makes it highly improbable that we have here a mixture of a sulphur-free protein with a very notable amount of legumin.

The actual sulphur content of vicilin is a matter of importance in relation to the molecular weight of this substance, since, if but one atom of sulphur is contained in its molecule and sulphur is present in all the molecules of those preparations which contained but 0.10 per cent. of sulphur, the molecular weight of vicilin must be approximately 30,000 and if the molecules contain two atoms of sulphur, 60,000. It is possible, however, that the sulphur-containing complex in vicilin is so loosely combined that it is easily detached, so that the preparations become mixtures of molecules containing sulphur and those containing none. This latter possibility seems probable since 1.58 grams of **94**,

from the horse bean, in which two determinations gave 0.103 and 0.099 per cent. of total sulphur, when heated for three hours with 30 per cent. sodium hydrate and lead acetate at a temperature of 165°, yielded but a trace of lead sulphide. Unfortunately no more of any other preparation containing so little sulphur was available, with which this observation could be confirmed.

The amount of loosely-bound sulphur found in vicilin was determined in a preparation from the pea which contained 0.220 per cent. of total sulphur.

TABLE XVII.—PERCENTAGE OF LOOSELY-BOUND SULPHUR IN VICILIN.

One gram boiled with 30 p. c. NaOH, Zn and $Pb(C_2H_3O_2)_2$. 7 1-2 hours.	Five grams with 30 p. c. NaOH and $Pb(C_2H_3O_2)_2$ at 165°. 4 1-2 hours.
0.117	0.084
0.087	

Five grams of another preparation, **93**, which contained 0.150 per cent. of total sulphur, when treated for four and one-half hours at 165° with 30 per cent. sodium hydrate and lead acetate yielded 0.058 per cent. of sulphur as sulphide.

From these results it seems possible that from vicilin, sulphur is more easily detached than from the other proteins.

Conglutin.

An extended study of conglutin has shown (Osborne and Campbell, Report of the Conn. Agri. Expt. Station for 1896, p. 288; also Jour. Amer. Chem. Soc. **18**, 609; also Ritthausen, Jour. f. prakt. Chem. **103**, 78; Ibid., n. F. **24**, 222, and **26**, 422, and Eiweisskörper, etc., Bonn, 1872) that from the seeds of the yellow lupin, by extracting with brine and precipitating by dialysis or by abundant dilution, preparations are obtained which contain about 0.9 per cent. of sulphur, while from the blue lupin preparations similarly obtained contain from 0.40 to 0.50 per cent. By fractional precipitation the conglutin from the yellow lupin can be separated into fractions, which have a pretty constant sulphur content, the one containing from 0.5 to 0.6 per cent., the other 1.4 to 1.5 per cent. The preparations with the larger quantity of sulphur contain about 1.50 per cent. less carbon than those with the smaller and also a little more nitrogen. Fractional precipitation of conglutin from the blue

lupin gives products differing little in composition though the more soluble contain somewhat less carbon and nitrogen and a very little more sulphur. In the less soluble fractions, which have otherwise nearly the same composition and properties, somewhat different amounts of sulphur were found; thus, four fractions contained, **37**, 0.32; **39**, 0.24; **42**, 0.38, and **44**, 0.33 per cent. Although these differences are slight they were shown to be actual by recently repeated determinations, using large quantities of substance.

The average composition of the least soluble fractions from the blue and yellow lupin is very nearly the same with the exception of sulphur, about 0.2 per cent. more of which is found in the latter.

The preparations obtained from these two seeds appear to be either compounds of one and the same protein body, conglutin, with more or less of some substance rich in sulphur, which is present in greater amount in the yellow than in the blue lupin, or mixtures of various proportions of similar proteins which contain very different amounts of sulphur. This latter supposition appears the more probable because about the same *proportion* of loosely-bound sulphur was found in all the preparations, whether they contained 0.30 per cent. or 1.4 per cent. of total sulphur. It is improbable that a sulphur-containing substance is combined with the protein from which the same proportion of lead sulphide can be obtained as from the protein itself.

The total sulphur in the different preparations of conglutin used in the following experiments was:

TABLE XVIII.—PERCENTAGE OF TOTAL SULPHUR IN DIFFERENT FRACTIONAL PRECIPITATES OF CONGLUTIN.

Blue Lupin.		Yellow Lupin.		
I	II	III	IV	V
0.393	0.359	0.530	0.954	1.378

TABLE XIX.—PERCENTAGE OF LOOSELY-BOUND SULPHUR IN THE ABOVE PREPARATIONS.

	One gram boiled with 30 p. c. NaOH, Zn and $Pb(C_2H_3O_2)_2$. 7 1-2 hours.	One gram, with 30 p. c. NaOH and $Pb(C_2H_3O_2)_2$ at 165°. 5 1-2 hours.
Preparation I	0.288	
	0.264	
	0.233	
Preparation II	0.239	
Preparation III	0.344	0.372
Preparation IV	0.558	
Preparation V	0.889	

These figures show that very nearly two-thirds of the sulphur of each of these preparations was obtained as lead sulphide, the amounts found falling between 59 to 70 per cent. of the total sulphur.

Oxyhæmoglobin from dog's blood.

Hoppe-Seyler (Hoppe-Seyler, Med. Untersuch, 1868, p. 370) found 0.39 per cent. of sulphur in oxyhæmoglobin from dog's blood. Jaquet (Jaquet, Zeit. f. physiol. Chem. **12**, 285) found 0.5417 and 0.5414 per cent. of sulphur in this substance and later (Ibid. **14**, 289) 0.5688 and 0.5665. Jaquet's determinations were made with very great care and a large amount of carefully recrystallized substance was used for each determination.

In two carefully prepared and repeatedly recrystallized preparations of this substance,* I have found 0.600 and 0.567 per cent. and in another preparation once recrystallized 0.546 per cent. of total sulphur.

The average of Jaquet's determinations and my own gives **0.5618** per cent. of total sulphur in dog's blood oxyhæmoglobin.

Six grams of oxyhæmoglobin, once recrystallized, when heated for seven and one-half hours at 165° with 30 per cent. sodium hydrate and lead acetate, gave 0.342 per cent. of loosely-bound sulphur, and five grams of another preparation which had been recrystallized several times gave, under the same conditions, 0.328 per cent. The average of these figures, **0.335** per cent., doubtless closely represents the proportion of loosely-bound sulphur contained in this substance.

Ovalbumin.

In an investigation of the protein constituents of the egg white, the results of which have been recently published (Report of the Conn. Agr. Expt. Station for 1899; also Jour. Amer. Chem. Soc. **22**, 422), I determined, with especial care, the total amount of sulphur contained in ovalbumin. In ten different preparations of repeatedly recrystallized ovalbumin I found the following quantities:

* I am indebted to the kindness of Prof. L. B. Mendel for an abundant supply of this oxyhæmoglobin from which the preparations used in these experiments were made.

TABLE XX.—PERCENTAGE OF TOTAL SULPHUR IN OVALBUMIN.

A 1.	A 2.	H 1.	H 2.	B 1.	B 2.	C 1.	C 2.	No. 2.	No. 3.
1.610	1.612	1.572	1.644	1.613	1.619	1.613	1.634	1.590	1.651

The details of the methods employed for the production of these preparations and the evidence of their purity may be found in the paper cited under the designations given in the above table.

These figures agree well with those given by several other investigators, namely:

Hammarsten	1.64
Bondzynski and Zoya	1.66
Krüger	1.66
Hopkins	1.57

Taking the average of my figures as nearly correct, the total sulphur in ovalbumin may be given as **1.616** per cent.

TABLE XXI.—PERCENTAGE OF LOOSELY-BOUND SULPHUR IN OVALBUMIN.

One gram boiled with 30 p. c. NaOH, Zn and $Pb(C_2H_3O_2)_2$. 7 1-2 hours.	1 gram with 30 p. c. NaOH and $Pb(C_2H_3O_2)_2$ at 135°. 2 hours.	5 grams with 30 p. c. NaOH and $Pb(C_2H_3O_2)_2$ at 165°. 4 1-2 hours.
0.523	0.523	0.491
0.511	0 518	
0.504	0.505	
0.471	0.459	
0.455	0.441	
0.425		

The result obtained with five grams at 165° agrees very closely with the average of the others and is also in accord with the results obtained by Krüger (Pflüger's Archiv. **43**, 244), Malerba (Rendic della R. Accad. delle Scienze di Napoli, fasc. 3-5, 1894) and Schulz (l. c.), who found respectively 0.44, 0.49 and 0.49 per cent. of loosely-bound sulphur in ovalbumin. The amount of sulphur that can be obtained as sulphide by treating ovalbumin with hot alkali is therefore **0.491** per cent.

Ovovitellin.

The substance used in these experiments was preparation **2** described in a former paper on the proteins of the egg yolk (Osborne and Campbell, Report Conn. Agr. Expt. Station for 1899; also Jour. Amer. Chem. Soc. **22**). The total sulphur found in four fractional precipitations of this substance was the following:

TABLE XXII.—PERCENTAGE OF TOTAL SULPHUR IN OVOVITELLIN.

2	3	4	5
1.046	1.000	1.047	1.026

The average of these figures gives **1.028** per cent. of total sulphur. The amount of loosely-bound sulphur was found to be the following:

TABLE XXIII.—PERCENTAGE OF LOOSELY-BOUND SULPHUR IN OVOVITELLIN.

One gram with 30 p. c. NaOH and $Pb(C_2H_3O_2)_2$ at 135°. 2 hours.	Five grams with 30 p. c. NaOH and $Pb(C_2H_3O_2)_2$ at 165°. 5 1-2 hours.
0.367	0.357
0.320	

The average of the higher of these figures, **0.362**, probably closely represents the amount of sulphur split from ovovitellin by alkali.

Casein from cow's milk.

Chittenden and Painter (Chittenden and Painter, Studies from the physiol. Lab. of Yale University, II, p. 156) have made an extensive study of the composition of casein prepared in different ways and have confirmed Hammarsten's many analyses of this substance. Hammarsten (Hammarsten, Zeit. f. physiol. Chem. **7**, 269) found by extensive and painstaking experiments that the total sulphur of casein was 0.78 per cent., Chittenden and Painter that it was 0.82 per cent. The average of these figures, **0.80** per cent., may therefore be taken for the total sulphur of casein.

The loosely-bound sulphur was determined in a preparation of casein made from milk from which the fat had been thoroughly separated by centrifugation immediately after it had been drawn from the cow. Just enough hydrochloric acid was immediately added to precipitate the casein and this latter washed repeatedly by decantation, care being taken to keep it in a finely divided condition. The washed precipitate was dissolved by gradually adding portions of decinormal potassium hydrate solution until all the casein redissolved. A milky appearing solution was so obtained which was perfectly neutral to very delicate violet litmus paper. This was filtered on a bed of filter paper pulp and a perfectly clear filtrate obtained, which showed only a minute trace of opalescence. From this solution the casein was precipitated by hydrochloric acid, washed thoroughly by decantation with water, then with alcohol and finally dehydrated with absolute alcohol and washed with ether. Less than nine hours elapsed from the time the milk was taken from the cow until the preparation was put under alcohol.

TABLE XXIV.—PERCENTAGE OF LOOSELY-BOUND SULPHUR IN CASEIN.

Five grams, with 30 p. c. NaOH and $Pb(C_2H_3O_2)_2$ at 165° 3 hours.
0.103
0.099

The average of these figures, **0.101**, show that a very much smaller proportion of the total sulphur can be obtained from casein as sulphide than from any of the other proteins. The amount obtained agrees closely with that found by Fleitmann (Fleitmann l. c.), namely 0.07 per cent.

IV. RELATION OF TOTAL SULPHUR TO THE PROTEIN MOLECULE.

An examination of the figures obtained in determining total sulphur shows that all the proteins examined, with the exception of vicilin, phaseolin and conglutin, contain a constant proportion of sulphur. Those proteins which can be obtained in crystals, and therefore be made quite pure, show such a uniform proportion of sulphur that there can be no doubt whatever that this is a definite constituent of their molecules. If now, as was proposed at the beginning of this paper, we calculate the simplest empirical formulas for these proteins and also for some of the other more carefully prepared and analyzed animal proteins, and multiply the figures obtained by such a whole number as shall give a molecule weight nearest to 15,000, we shall obtain the formulas given in Table XXV. Such formulas are of course to be regarded as only approximate, since the methods of analysis preclude great accuracy. Carbon and nitrogen can be determined with sufficient precision to give figures falling within a few atoms of the truth, but a slight error in determining sulphur leads to serious differences in the formulas. An error of 10 per cent. of the total sulphur leads to an error of about 65 atoms of carbon and 20 of nitrogen. If the protein contains but 0.4 per cent. of sulphur, such an analytical error would equal 0.04 per cent. An examination of

the figures obtained in determining total sulphur indicates that the average amount found for each protein is probably within 0.04 per cent. of the amount actually present. For proteins containing more than 0.4 per cent. of sulphur, the probable error in the formulas is correspondingly decreased, so that for those containing 0.8 per cent. of sulphur it need not much exceed 30 atoms of carbon and 10 of nitrogen, and for a protein which, like ovalbumin, contains 1.6 per cent. of sulphur, the error does not amount to more than about 15 atoms of carbon and 5 atoms of nitrogen. Whether or not the proteins in fact have similar molecular weights, must remain for future investigation to show, but in the meantime the formulas given in the table seem worthy of consideration since they suggest relations not otherwise apparent.

TABLE XXV.—COMPOSITION AND POSSIBLE EMPIRICAL FORMULAS OF SOME PROTEIN BODIES.

Composition.							Vegetable Proteins.	Formula.							
C.	H.	N.	S.	Fe.	P.	O.		C.	H.	N.	S.	Fe	P.	O.	Molecular weight.
51.30	6.90	19.32	0.429	-----	----	22.051	Amandin	638	1030	206	2	--	--	206	14930
52.64	6.95	17.25	0.426	-----	----	22.734	Vignin	660	1040	185	2	--	--	214	15038
51.72	6.95	18.04	0.385	-----	----	22.905	Legumin	718	1158	214	2	--	--	238	16642
55.23	7.26	16.13	0.600	-----	----	20.78	Zein	736	1161	184	3	--	--	208	15993
52.12	6.93	17.53	0.710	-----	----	22.71	Glycinin	780	1248	206	4	--	--	255	17700
54.29	6.80	17.21	0.847	-----	----	20.53	Hordein	675	1014	181	4	--	--	194	14880
51.50	7.02	18.69	0.88	-----	----	21.91	Edestin	624	1021	193	4	--	--	199	14523
55.03	6.67	16.26	0.84	-----	----	21.20	Bynin	706	1026	180	4	--	--	204	15410
52.72	6.86	17.66	1.027	-----	----	21.733	Gliadin	685	1068	196	5	--	--	211	15568
52.18	6.92	18.30	1.086	-----	----	21.514	Excelsin	642	1018	192	5	--	--	198	14738
53.02	6.84	16.80	1.280	-----	----	22.06	Leucosin	663	1026	180	6	--	--	207	15006
							Animal Proteins.								
54.98	7.20	16.89	0.42	-----	----	20.51	Globin	700	1098	184	2	--	--	196	15274
52.68	6.83	16.91	1.10	-----	----	22.48	Fibrin	645	1004	178	5	--	--	207	14708
52.71	7.01	15.85	1.11	-----	----	23.32	Serglobulin, horse	628	1002	160	5	--	--	209	14310
52.93	6.90	16.66	1.25	-----	----	22.26	Fibrinogen	679	1062	183	6	--	--	207	15276
52.82	7.11	16.67	1.27	-----	----	22.03	Myosin	660	1074	181	6	--	--	208	15048
52.75	7.10	15.51	1.616	-----	----	23.024	Ovalbumin	696	1125	175	8	--	--	220	15703
52.19	7.18	15.77	1.73	-----	----	23.13	Lactalbumin	644	1064	166	8	--	--	214	14792
52.99	7.01	15.93	1.930	-----	----	22.14	Seralbumin, horse	662	1051	171	9			207	14989
52.25	6.65	15.88	2.25	-----	----	22.95	Seralbumin, human exudation	684	1045	178	11	--	--	225	15697
							Compound Proteins.								
54.64	7.09	17.38	0.39	0.335	----	20.165	Oxyhæmoglobin, horse	758	1181	207	2	1	--	210	16655
54.57	7.11	16.38	0.568	0.336	----	21.036	Oxyhæmoglobin, dog	758	1185	195	3	1	--	219	16667
53.13	7.06	15.78	0.800	-----	0.86	22.37	Casein	708	1130	180	4	--	4	224	15982
51.56	7.12	16.23	1.028	-----	0.82	23.242	Ovovitellin	671	1112	182	5	--	4	227	15628

The analyses of the vegetable proteins given in the preceding table were made by the writer and his associates in this laboratory; those of globin and serum albumin are by Schulz;* those of fibrin,† fibrinogen,† serum globulin,† serum albumin‡ from human exudation are by Hammarsten; that of casein is the average of a large number of closely agreeing analyses, of many preparations, made by Hammarsten§ and by Chittenden and Painter;‖ that of myosin is the average of many closely agreeing analyses of different preparations obtained from several species of animals by Chittenden and Cummins;¶ and that of lactalbumin is by Sebelien.°

The figures given in the table for the oxyhæmoglobins require explanation since it seems to be generally assumed that the composition of these bodies is still uncertain. The following analyses of oxyhæmoglobin from the horse have been published:

C.	H.	N.	S.	Fe.	
54.87	6.97	17.31	0.65	0.47	Hoppe-Seyler and Kossel.[1]
54.74	7.03	17.28	0.67	0.45	Otto.[2]
54.40	7.20	17.61	0.65	0.47	Büchler.[3]
51.15	6.76	17.94	0.39	0.335	Zinoffsky.[4]
			0.44	0.39	Hoppe-Seyler.[5]
54.56	7.15	17.33	0.43	----	Schulz.[6]
				0.469	Lawrow.[7]

[1] Hoppe-Seyler, Zeit. f. physiol. Chem. **2**, 149.
[2] Otto, quoted by Hüfner, Ibid. **8**, 358.
[3] Büchler, quoted by Hüfner, Ibid. **7**, 59.
[4] Zinoffsky, Ibid. **10**, 16.
[5] Hoppe-Seyler, Handbuch, physiol. and pathol. Chem. Analyse, 1893.
[6] Schulz, Zeit. f. physiol. Chem. **24**, 469.
[7] Lawrow, Ibid. **26**, 343.

In conjunction with Bunge, Zinoffsky determined iron, both gravimetrically and volumetrically, with the utmost care, using very large quantities of oxyhæmoglobin, from 10 to 60 grams, and making many determinations in three different preparations.

* Schulz, l. c.
† Hammarsten, Pflüger's Archiv., **22**, 489.
‡ Hammarsten, Jahresbericht f. Thierchem., **11**, 19.
§ Hammarsten, Zeit. f. physiol. Chem., **7**, 269.
‖ Chittenden and Painter, Studies from the Lab. of physiol. Chem., II., 156.
¶ Chittenden and Cummins, Ibid., III., 156.
° Sebelien, Zeit. f. physiol. Chem., **9**, 463.

None of the other analysts offer any evidence that their figures were obtained under conditions which entitle them to acceptance rather than those given by Zinoffsky. The fact that the ratio between the iron and sulphur, as given by Zinoffsky, is strictly as 1 : 2, is evidence of the accuracy of his determinations, since there is every reason to believe that oxyhæmoglobin is a definite compound containing hæmatin and protein in a molecular proportion. On the other hand, the fact that a definite ratio does not exist between the figures given by the other investigators indicates either a lack of purity in the preparations analyzed or inaccuracy of analysis.

The amount of sulphur given in these analyses differs widely. There is no evidence, however, that any of these analysts, except Zinoffsky, used unusual care in determining sulphur. Zinoffsky subjected his methods for determining sulphur to a very rigid test and employed about 10 grams of oxyhæmoglobin, for each of six determinations. The results obtained with three different preparations fell between 0.3916 and 0.3583. It is to be noted that the later determinations of sulphur by Hoppe-Seyler and Schulz agree with those of Zinoffsky much more closely than they do with the other earlier determinations.

All these analyses agree fairly well for carbon, hydrogen and nitrogen except that given by Zinoffsky, which differs much from the other analyses. Hüfner has suggested that this was caused by the method employed by Zinoffsky in preparing his oxyhæmoglobin, but this cannot be true, because, as Jaquet points out, Zinoffsky made the preparation that he analyzed by the same method that the other investigators employed. It seems more probable that the differences between Zinoffsky's figures for these elements and those of the others are analytical.

For the composition of oxyhæmoglobin from the horse, I have given in the table Zinoffsky's figures for iron and sulphur, together with the average of the figures given by the other analysts for carbon, hydrogen and nitrogen.

In conjunction with Bunge, Jaquet (Zeit. f. physiol. Chem. **14,** 289) analyzed oxyhæmoglobin from dog's blood and determined sulphur and iron with the same precautions and the same care that Zinoffsky used in determining these elements in oxyhæmoglobin from horse blood.

But one other analysis of this substance appears to be on record, made by Hoppe-Seyler (Med. chem. Unterbuch, p. 370), which does not differ very widely from Jaquet's except for sulphur.

As I have been able to confirm the accuracy of Jaquet's figures for sulphur, I have given in the table the average of them, omitting one determination of hydrogen which is manifestly too high.

V. Ratio of loosely-bound to total sulphur.

In most of the proteins examined in this investigation, as well as in those examined by others, the loosely-bound sulphur is approximately a simple fraction, as the following table shows:

Table XXVI.—Ratio of Loosely-Bound to Total Sulphur.

Protein.	Total Sulphur.	Loosely-bound Sulphur.	Per cent. of total Sulphur as loosely bound.	
Seralbumin	1.930*	1.280*	66	
Oxyhæmoglobin (dog)	0.568†	0.335	59	
Serglobulin (horse)	1.110§	0.630*	57	⅔
Gliadin	1.027	0.619	60	
Oxyhæmoglobin (horse)	0.380‡	0.190*	50	
Vignin	0.426	0.214	50	
Amandin	0.429	0.217	50	
Globin	0.420*	0.200*	48	
Glycinin	0.710	0.320	46	½
Vicilin	0.200	0.092	46	
Legumin	0.385	0.165	41	
Edestin	0.880	0.346	40	
Zein	0.600	0.212	35	
Ovovitellin	1.028	0.348	34	
Fibrin	1.100¶	0.380‖	34	⅓
Excelsin	1.086	0.350	32	
Ovalbumin	1.616	0.491	30	
Phaseolin	0.312	0.072	23	¼
Casein	0.800°	0.101	13	⅛

Leaving phaseolin and casein out of consideration for the present, it might be assumed that the protein molecule contains either 2 or 3 atoms of sulphur. Such an assumption presup-

* Schulz, l. c.
† Jaquet, l. c.
‡ Zinoffsky, l. c.
§ Hammarsten, Pflüger's Achiv., **22,** 489.
‖ Krüger, l. c.
¶ Hammarsten, Pflüger's Archiv., **22,** 479.
° Hammarsten, l. c., and Chittenden and Painter, l. c.

poses, however, that in most cases the whole of the loosely-bound sulphur can be counted into lead sulphide under the conditions of our experiments. The results obtained with edestin indicate plainly that one-half of its sulphur cannot be thus separated since the highest figures found fell short of one-half of the total sulphur by a quantity decidedly in excess of any probable analytical error. On the other hand, nearly all fell distinctly above one-third. If this is true for edestin it may also be true for some of the other proteins; thus in excelsin the loosely-bound sulphur falls short of two-fifths of the total by nearly the same proportion that it falls short of one-half in edestin. We should, therefore, consider whether or not the proportion of loosely-bound sulphur agrees with a definite number of the sulphur atoms given in Table XXV quite as well as with these simple fractions.

In the following table these proteins are given, arranged in the order of their sulphur content; the number of atoms of fixed and loosely-bound sulphur with which the results of the determinations agree most closely, assuming the number of atoms of sulphur contained in the molecule to be that shown in Table XXV, the percentage of loosely-bound sulphur found in these proteins; the percentage calculated for the number of atoms of sulphur assumed to be split off; the difference between the amount found and that calculated; and the percentage of the calculated quantity that the amount found is equal to.

The amount of loosely-bound sulphur found in those proteins which appear in this table as containing but one atom of such sulphur agrees almost exactly with that calculated. Of those in which a larger number of atoms appear as loosely bound the majority show a deficiency in the amount found compared with that calculated.

Before a decision can be reached as to the proportion of loosely-bound sulphur actually contained in the molecules of these different protein bodies, it is necessary to know whether all such sulphur can be obtained as lead sulphide under the conditions of the experiments described in this paper. All investigators who have undertaken to determine the proportion of loosely-bound sulphur in the proteins have noted the similarity of the behavior of these substances to that of cystin under similar conditions. Cystin, however, had never been

TABLE XXVII—ATOMS OF FIRMLY AND LOOSELY-BOUND SULPHUR.

PROTEIN.	Total Sulphur.	Atoms of fixed Sulphur.	Atoms of loosely-bound Sulphur.	Percentage of loosely bound Sulphur found.	Percentage of loosely-bound Sulphur calculated.	Differences between found and calculated.	Percentage of the calculated formed by that found.
Legumin	0.385	1	1	0.165	0.193	—0.028	81
Oxyhæmoglobin (horse)	0.390	1	1	0.190	0.195	—0.005	97
Globin (horse)	0.420	1	1	0.200	0.210	—0.010	95
Vignin	0.426	1	1	0.214	0.213	+0.001	100
Amandin	0.429	1	1	0.217	0.213	+0.004	104
Oxyhæmoglobin (dog)	0.568	1	2	0.335	0.379	—0.037	88
Zein	0.600	2	1	0.212	0.200	+0.012	106
Glycinin	0.710	2	2	0.320	0.355	—0.035	90
Hordein	0.847	2	2	0.348	0.423	—0.075	83
Edestin	0.880	2	2	0.347	0.440	—0.093	79
Gliadin	1.027	2	3	0.619	0.629	—0.010	99
Ovovitellin	1.028	3	2	0.348	0.410	—0.062	83
Excelsin	1.086	3	2	0.350	0.430	—0.080	81
Serglobulin (horse)	1.110	2	3	0.630	0.666	—0.036	95
Fibrin	1.100	3	2	0.380	0.440	—0.060	86
Ovalbumin	1.616	5	3	0.491	0.609	—0.118	81
Seralbumin (horse)	1.930	2	7	1.280	1.498	—0.218	85

detected among the decomposition products of protein bodies until K. A. H. Moerner recently (Moerner, Zeit. f. physiol. Chem. **28**, 595-1899, and Proceed. 13th Inter. Cong. Med. Sec., d. physiol., etc., p. 15, Paris, 1900) found it in quantity among those of horn, 6.8 per cent.; of egg membrane, 6.0 per cent.; of human hair, 12.6 per cent., and of serum albumin, over 1.0 per cent.

He also found in the solutions from which the cystin had been separated a not inconsiderable quantity of sulphur which, on treatment with sodium hydrate and lead acetate, yielded lead sulphide. To what complex this latter sulphur belonged Moerner did not determine.

Embden (Embden, Zeit. f. physiol. Chem. **32**, 94, 1901) has very recently confirmed Moerner's observations by investigations undertaken independently and without a knowledge of the latter's results. Embden isolated cystin in quantity from horn and found among the products obtained from serum and egg albumin and edestin, cystein, which latter substance he con-

siders to be the primary decomposition product of these protein bodies, the cystin being a secondary product.

From these recent observations of Moerner's and Embden's, it is highly probable that a part of the loosely-bound sulphur of many protein bodies belongs either to a cystein or a cystin complex. If this is so, the results obtained in attempting to determine quantitatively the proportion of loosely-bound sulphur in such proteins as contain this group must necessarily fall short of the total quantity of sulphur belonging to the cystein or cystin radical, for it is well known that a part only of the sulphur of these two substances can be converted into lead sulphide by boiling with solutions of sodium hydrate and lead acetate.

Thus Baumann and Goldmann (Baumann and Goldmann, Zeit. f. physiol. Chem. **12**, 257, 1888), by heating cystin with 10 per cent. sodium hydrate and lead acetate for nine hours, got only 68 per cent. of the sulphur. Suter (Suter, Zeit. f. physiol. Chem. **20**, 564, 1895), by heating for 33½ hours, got 83 per cent., and Schulz (Schulz, l. c.), by boiling cystin with 30 per cent. sodium hydrate, zinc and bismuth oxide for 10 hours, obtained as sulphide 53 per cent.; by boiling for 25 hours, 53.7 per cent.; by heating in an atmosphere of hydrogen for 10 hours at 105-110°, 52.4 per cent., and by boiling cystein for 10 hours, 52 per cent. of the total sulphur contained in the substance.

In view of these facts it would seem probable that from most proteins, especially those rich in sulphur, we cannot obtain all of the loosely-bound sulphur.

An examination of the figures of Table XXV shows that, with but three exceptions, the loosely-bound sulphur obtained from those proteins which contain more than 0.43 per cent. of sulphur formed from 79-90 per cent. of the calculated, while the amount obtained from those containing less than 0.43 agreed with that calculated well within the limits of accuracy of analysis.

The amount of loosely-bound sulphur found in all those proteins which appear in the table to contain but one atom of such sulphur agrees in every case with the calculated quantity more closely even than could be expected, while with but one exception, in all those proteins which appear as containing more than one atom of loosely-bound sulphur, the quantity found is distinctly less than that calculated.

These facts may find an explanation in Moerner's observations of two sulphur-containing complexes, both of which yield lead sulphide on treating with alkaline lead solutions. It may well be that cystein or cystin is a constituent of only those proteins which are comparatively rich in sulphur, so that from these but a part of the sulphur belonging to these complexes can be obtained as sulphide, while from the others containing only the other complex observed by Moerner, all of the sulphur can be obtained. The amount of loosely-bound sulphur actually found in edestin agrees well with such a supposition, for if one atom of sulphur belongs to a complex yielding all its sulphur as sulphide we would obtain 0.22 per cent. from this source, and if another atom belongs to cystein (Embden has obtained cystein from edestin), which according to Schulz yields about one-half its sulphur as sulphide, from this we would obtain about 0.11 per cent., making 0.33 per cent. in all, which agrees closely with the 0.347 per cent. found. The deficiency found for most of the proteins here represented as containing more than one atom of loosely-bound sulphur is nearly equal to that which would occur if these contained one molecule of cystein, except for serum albumin, in which the deficiency corresponds to two molecules of cystein or one of cystin.

In conclusion, attention should be called to casein, which presents a marked contrast to all the other proteins examined, in the fact that only one-eighth of the total sulphur was obtained as sulphide. If the complex which contains this sulphur yields all its sulphur is sulphide, the molecular weight of casein cannot be less than 30,000; if, on the other hand, it yields only a part of its sulphur as sulphide, it presents a marked contrast to the other protein substances which contain but little loosely-bound sulphur, for these yield almost exactly one-half of their total sulphur as sulphide, which strongly indicates that all the sulphur of the complex containing this is converted into lead sulphide. Of all the proteins examined, casein yields by far the smallest proportion of loosely-bound sulphur.

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